Module One (29201) introduces the trainees to a broad range of welding symbols, describes how they are structured, and explains the basic rules to implement the information that the symbols convey.

### Objectives

**Learning Objective 1**

- Identify and interpret welding symbols and their structure.
  - Describe the structure and placement of welding symbols and identify basic symbols.
  - Identify and interpret size and dimension markings for common types of welds.
  - Identify and interpret various supplemental symbols.
  - Identify and interpret less common welding symbols.

**Performance Tasks**

**Performance Task 1**

(Learning Objective 1)

- Identify and interpret welding symbols on an instructor-provided drawing.

### Teaching Time: 5 hours

(Two 2.5-Hour Classroom Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites

*Core Curriculum and Welding Level One.*

### 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**

Although this module does not require direct exposure to the welding environment, safety must be stressed at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to hazards related to welding equipment. Any deficiencies must be corrected to help ensure the future safety of trainees. All practice sessions and Performance Tasks must be completed under the instructor’s direct supervision.

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**Classroom Equipment and Materials**

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Welding Level Two* PowerPoint® Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with Internet access
- Samples of various weld joints that match welding symbols in the Trainee Guide
- Module Review answer key
- Copies of the Module Examination and Performance Profile Sheets

**Equipment and Materials for Laboratories and Performance Testing**

- Suitable drawing(s) containing a variety of weld symbols for trainees to identify or interpret

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**Additional Resources**

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


There are a number of on-line resources available for trainees who would like more information on welding symbols. 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.

Instructors are also 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 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 welding symbols, their basic structure, identification, and interpretation. This session covers Sections 1.0.0 through 1.4.7.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Introduce the welding symbol structure and how to identify these basic symbols.
4. Describe how to identify and interpret dimensional markings.
5. Describe how to identify and interpret supplemental symbols.
6. Present less common symbols and explain how to interpret them.

**Session Two**

Session Two is a laboratory, review, and testing session. The Performance Task for this module is also administered in this session. Have trainees complete the Module Review. Alternatively, these may be assigned as homework at the end of Session One. Go over the Module Review in class prior to the exam and answer any questions that the trainees may have.

1. Note that no PowerPoint® presentation is associated with this session.
2. Trainees practice and complete the requirements of Performance Task 1.
3. Proctor the module exam.
4. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
## Materials Checklist for Module 29201, Welding Symbols

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Suitable drawing(s) containing a variety of weld symbols for trainees to identify or interpret</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td>None</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td></td>
</tr>
<tr>
<td>Markers/chalk</td>
<td></td>
</tr>
<tr>
<td>Pencils and paper</td>
<td></td>
</tr>
<tr>
<td><em>Welding Level Two PowerPoint® Presentation</em></td>
<td></td>
</tr>
<tr>
<td>DVD player or a computer with a DVD drive</td>
<td></td>
</tr>
<tr>
<td>Computer with Internet access</td>
<td></td>
</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
<td></td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td></td>
</tr>
<tr>
<td>Module Review answer key</td>
<td></td>
</tr>
<tr>
<td>Samples of various weld joints that match welding symbols in the Trainee Guide</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.
Module Two (29202) introduces the trainees to the identification of basic welding detail drawing elements and features. Trainees will learn to identify and interpret notes, bills of material, and dimensional information used on welding detail drawings.

### Objectives

**Learning Objective 1**

- Describe welding detail drawings and identify basic drawing elements and features.
  a. Describe the object views used to depict welding details.
  b. Identify basic drawing elements related to welding detail drawings.

**Learning Objective 2**

- Identify and explain how to interpret dimensional information, notes, and a bill of materials.
  a. Identify and explain how to interpret dimensional information.
  b. Identify and explain how to interpret notes and a bill of materials.

### Performance Tasks

**Performance Task 1**

(learning objectives 1 and 2)

- Draw or sketch a welding drawing based on an instructor-provided image or object.

### Teaching Time: 10 hours

(Four 2.5-Hour Classroom Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites

*Core Curriculum and Welding Level One*

### Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the presentation), and these lesson plans, and to gather the required equipment and materials. Consider the 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 may find trainees in proximity to equipment that could generate high voltages, extremely high temperatures, and intense ultraviolet radiation. Although this module will not call for trainees to be directly involved in welding tasks, safety must be stressed and reinforced at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to hazards related to welding equipment. Any deficiencies must be corrected to help ensure the future safety of trainees. All practice sessions and performance tasks must be completed under the instructor’s direct supervision.

Classroom Equipment and Materials

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Welding Level Two* PowerPoint® Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with Internet access
- Instructor-provided sample welding detail drawings
- Predrilled bar stock scaled to the drawings in *Figure 18*; correct and incorrect samples preferred
- Module Review answer key
- Copies of the Module Examination and Performance Profile Sheets

Equipment and Materials for Laboratories and Performance Testing

- Straight edge or ruler
- Multiple objects suitable for sketching of welding drawings (one object per four trainees suggested)

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 welding detail drawings. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any web sites or videos that may be employed in the lesson plan before using them to ensure their suitability. These web sites and 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.

Instructors are also 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 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 basic welding details and the components of a drawing. This will include orthographic, object, isometric, multiviews, and sections. This session covers Section 1.0.0 through 1.2.4.

1. Open the Session One presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Discuss basic welding detail drawings.
4. Present object views, including isometric view, multiview, and sections used to create welding drawings.
5. Discuss basic drawing components.
6. Explain how lines, material fill symbols, bar stock, pipe breaks, and revolved sections are represented.

**SESSION TWO**

Session Two introduces the trainees to dimensions, notes, material data and the bills of material. This session covers Section 2.0.0 through 2.2.2.

1. Open the Session Two presentation.
2. Use the Kickoff Activity to review material presented in the previous session.
3. Discuss the precise dimensional information contained on a drawing.
4. Explain scale, dimensions, and tolerance data conveyed on a drawing.
5. Discuss the use and importance of the notes and bills of material shown on a drawing.

**SESSION THREE**

Session Three is a laboratory session that provides an opportunity to practice and/or complete the Performance Tasks associated with welding detail drawings.

1. Note that no presentation is associated with this laboratory session.
2. Demonstrate how to draw or sketch a welding drawing using the instructor-provided image or object.
3. Trainees practice and complete the requirements of Performance Task 1.

**SESSION FOUR**

Session Four is a review and testing session. Have trainees complete the Module Review Questions. Alternatively, these may be assigned as homework at the end of Session Three.

1. Go over the Module Review in class prior to the exam and answer any questions that the trainees may have.
2. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
3. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Multiple objects suitable for sketching of welding drawings (one object per four trainees suggested)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td><strong>Straight edge or ruler</strong></td>
</tr>
<tr>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Whiteboard / chalkboard</td>
<td></td>
</tr>
<tr>
<td>Markers/chalk</td>
<td></td>
</tr>
<tr>
<td>Pencils and paper</td>
<td></td>
</tr>
<tr>
<td><em>Welding Level Two PowerPoint® Presentation</em></td>
<td></td>
</tr>
<tr>
<td>DVD player or a computer with a DVD drive</td>
<td></td>
</tr>
<tr>
<td>Computer with Internet access</td>
<td></td>
</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
<td></td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td></td>
</tr>
<tr>
<td>Module Review answer key</td>
<td></td>
</tr>
<tr>
<td>Instructor-provided sample welding detail drawings</td>
<td></td>
</tr>
<tr>
<td>Predrilled bar stock scaled to the drawings in <em>Figure 18</em>; correct and incorrect samples preferred</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.
Module Eleven (29111) introduces the trainees to the method and procedures related to the SMAW groove welding process. Trainees will learn safety procedures, welding joint preparation, specifications, identification of physical characteristics, mechanical properties, and cleaning techniques of SMAW groove welds.

### Objectives

**Learning Objective 1**
- Identify various types of groove welds and describe how to prepare for groove welding.
  - Identify various types of groove welds and define related terms.
  - Describe how to prepare for groove welding.

**Learning Objective 2**
- Describe the technique required to produce various groove welds.
  - Describe the technique required to produce groove welds in the 1G and 2G positions.
  - Describe the technique required to produce groove welds in the 3G and 4G positions.

### Performance Tasks

**Performance Task 1 (Learning Objective 1)**
- Safely set up arc welding equipment for making groove welds.

**Performance Task 2 (Learning Objective 2)**
- Make flat welds with backing on V-groove joints using E7018 electrodes.

**Performance Task 3 (Learning Objective 2)**
- Make horizontal welds with backing on V-groove joints using E7018 electrodes.

**Performance Task 4 (Learning Objective 2)**
- Make vertical welds with backing on V-groove joints using E7018 electrodes.

**Performance Task 5 (Learning Objective 2)**
- Make overhead welds with backing on V-groove joints using E7018 electrodes.

### Teaching Time: 50 hours

(Twenty 2.5-Hour Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites

*Core Curriculum; Welding Level One, Module 29101-15.*

### 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 equipment that can generate high currents and extreme heat. 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 base metal preparation. Any deficiencies must be corrected to ensure future trainee safety. All practice sessions and performance tasks must be completed under your direct supervision.

Classroom Equipment and Materials
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Welding Level One PowerPoint® presentations
DVD player or a computer with a DVD drive
LCD projector and screen
Computer with internet access
Module Review answer key
Copies of the Module Examination and Performance Profile Sheets

Equipment and Materials for Laboratories and Performance Testing
Appropriate PPE:
  - Appropriate flame-retardant clothing
  - Safety glasses
  - Welding gloves
  - Welding shield or helmet
  - Other welding PPE required for welding in all four positions
  - 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 equipment suitable for SMAW operations
  - Electrodes, E7018

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

www.lincolnelectric.com

There are a number of online resources available for trainees who would like more information on SMAW groove welding. 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. Below are examples of relevant videos available online. Many other videos can be located online using search terms such as “groove welding” or “welding with backing”.


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 PowerPoint® presentations throughout the program.
Session Outline for 29111

SMAW – Groove Welds with Backing

The Lesson Plan for this module is divided into twenty 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 SMAW groove welding, including techniques used to complete V-groove welds with backing and welding techniques used in different positions. This session covers Sections 1.0.0 through 2.2.2.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Explain that safety must be maintained and appropriate protective clothing and equipment must be worn.
4. Describe the types of SMAW groove welds with backing and discuss related terminology.
5. Explain how to set up SMAW welding equipment and prepare welding coupons for groove welding.
6. Describe how SMAW groove welding in the various positions.

**Session Twenty**

Session Twenty is a review and testing session. Have trainees complete the Module Review Questions. Alternatively, these may be assigned as homework at the end of Session Nineteen. Go over the answers to the Module Review in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.

**Sessions Two Through Nineteen**

Sessions Two through Nineteen are laboratory sessions for practice and completion of the performance tasks related to performing groove welds in the 1G, 2G, 3G, and 4G positions.

1. Note that no PowerPoint® presentation is associated with this laboratory session.
2. Review safety procedures and make sure that all trainees are wearing the required PPE.
5. Trainees complete the requirements of Performance Task 1.
## Equipment and Materials

<table>
<thead>
<tr>
<th>Personal protective equipment:</th>
<th>Welding equipment suitable for SMAW operations</th>
<th>Electrodes, E7018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate flame-retardant clothing</td>
<td>Sufficient supply of carbon steel for practice backing, ⅝”-thick minimum</td>
<td>Sufficient supply of carbon steel for practice coupons, ⅝”-thick minimum</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Cutting equipment (appropriate saw, shear, or oxyfuel equipment)</td>
<td>Angle grinders</td>
</tr>
<tr>
<td>Welding gloves</td>
<td>Welding bench with arm for position work</td>
<td>Files</td>
</tr>
<tr>
<td>Welding shield or helmet</td>
<td>Tape measure or steel rules</td>
<td>Squares</td>
</tr>
<tr>
<td>Other welding PPE required for welding in all four positions</td>
<td>Wire brushes</td>
<td>Chipping hammer</td>
</tr>
<tr>
<td>Proper footwear as directed by the instructor or training facility provider</td>
<td>Shop hand tools</td>
<td>Workpiece clamps</td>
</tr>
<tr>
<td>Hearing protection as directed by the instructor or training facility provider</td>
<td>Grinding wheels</td>
<td>Soapstone</td>
</tr>
<tr>
<td>Hard hat as directed by the instructor or training facility provider</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Welding Level One* PowerPoint® presentations
- DVD player
- Computer
- Copies of the Module Examination and Performance Profile Sheets
- Module Review answer key

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 Twelve (29112) introduces trainees to the methods and procedures of the SMAW open-root groove welding process. Trainees will learn about safety procedures and groove joint preparation, and practice open-root groove welding techniques.

### Objectives

**Learning Objective 1**
- Identify various types of groove welds and describe how to prepare for groove welding.
  - a. Identify various types of groove welds and define related terms.
  - b. Describe how to prepare the work area and plate for groove welding.

**Learning Objective 2**
- Describe the technique required to produce various open V-groove welds.
  - a. Describe the technique required to produce open V-groove welds in the 1G and 2G positions.
  - b. Describe the technique required to produce open V-groove welds in the 3G and 4G positions.

### Performance Tasks

**Performance Task 1**

(learning objective 2)
- Make open V-groove welds with E6010 and E7018 electrodes in the following positions:
  - Flat (1G) position
  - Horizontal (2G) position
  - Vertical (3G) position
  - Overhead (4G) 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.

### Prerequisites

Core Curriculum; Welding Level One, Module 29101-15.

### 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 equipment that can generate high currents and extreme heat. 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 open-root groove welding. Any deficiencies must be corrected to ensure future trainee safety. All practice sessions and performance tasks must be completed under your direct supervision.

**Classroom Equipment and Materials**

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Welding Level One PowerPoint®* Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with internet access
- Module Review and Trade Terms Quiz answer keys
- Copies of the Module Examination and Performance Profile sheets

**Equipment and Materials for Laboratories and Performance Testing**

- Appropriate PPE:
  - Appropriate flame-retardant clothing
  - Safety glasses
  - Face shields (tinted if used for oxyfuel cutting)
  - Welding gloves
  - Work gloves
  - Welding shield or hood
  - 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
- Sufficient E6010 and E7018 electrodes
- SMAW equipment, complete with electrode holders, workpiece clamps, and cables
- Sufficient supply of carbon steel for practice, ¼”- (9 or 10 mm) thick minimum
- Welding bench with arm for position work
- Metal cutting equipment (saw or oxyfuel equipment)
- Angle grinders
- Grinding wheels
- Squares
- Tape measures or steel rules
- Soapstone
- Files
- Chipping hammer
- 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 SMAW open-root groove welding. 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.

Instructors are also 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 PowerPoint® presentations throughout the program.
Session Outline for 29112

SMAW – OPEN-ROOT GROOVE WELDS – PLATE

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 SMAW open-root groove welding on plate. Standard safety practices are reviewed, along with guidance in the proper preparation of the weld coupons and work area. This session covers Sections 1.0.0 through 2.2.2.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Review the various types of groove joints and their details.
4. Review the common safety practices associated with welding.
5. Discuss the electrodes to be used for groove welding.
6. Explain how to properly prepare the work area for welding.
7. Describe the techniques used in SMAW groove welding and the differences in technique required for each position.

**SESSIONS TWO THROUGH TWENTY-THREE**

Sessions Two through Twenty-Three are laboratory sessions dedicated to the practice and completion of Performance Task 1.

1. Note that no PowerPoint® presentation is associated with this laboratory session.
2. Demonstrate how to safely perform the required tasks using SMAW equipment.
3. Describe preparation of welding coupon and welding of V-groove joints using E6010 or E7018 electrodes.
4. Demonstrate open-root groove welding in the various positions.
5. Trainees practice and complete Performance Task 1.

**SESSION TWENTY-FOUR**

Session Twenty-Four is a review and testing session. Have trainees complete the Module Review and Trade Terms Quiz. Alternatively, these may have been assigned as homework at the end of Session Twenty-Three. Go over the Module Review and Trade Terms Quiz in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
**Materials Checklist for Module 29112, SMAW – Open-Root Groove Welds – Plate**

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>SMAW equipment, complete with electrode holders, workpiece clamps, and cables</th>
<th>Sufficient supply of carbon steel for practice, 3/8” (9 or 10 mm) thick minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal protective equipment:</td>
<td>Welding bench with arm for position work</td>
<td>Metal cutting equipment (saw or oxyfuel equipment)</td>
</tr>
<tr>
<td>Appropriate flame-retardant clothing</td>
<td>Angle grinders</td>
<td>Grinding wheels</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Face shields (tinted if used for oxyfuel cutting)</td>
<td>Squares</td>
</tr>
<tr>
<td>Face shields (tinted if used for oxyfuel cutting)</td>
<td>Welding gloves</td>
<td>Soapstone</td>
</tr>
<tr>
<td>Welding gloves</td>
<td>Work gloves</td>
<td>Chipping hammer</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Welding shield or hood</td>
<td>Common hand tools</td>
</tr>
<tr>
<td>Welding shield or hood</td>
<td>Proper footwear as directed by the instructor or training facility provider</td>
<td></td>
</tr>
<tr>
<td>Proper footwear as directed by the instructor or training facility provider</td>
<td>Hearing protection as directed by the instructor or training facility provider</td>
<td></td>
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<td>Hearing protection as directed by the instructor or training facility provider</td>
<td>Hard hat as directed by the instructor or training facility provider</td>
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<td>Whiteboard/chalkboard</td>
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<td>Pencils and paper</td>
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<td>Welding Level One PowerPoint® Presentation</td>
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<td>DVD player</td>
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<tr>
<td>Computer</td>
<td>Copies of the Module Examination and Performance Profile sheets</td>
<td></td>
</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile sheets</td>
<td>Module Review and Trade Terms Quiz Answer Keys</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.
**Module Five (29205)** introduces trainees to the methods and procedures related to GMAW and FCAW processes and basic safety practices required for each type. It also provides an overview of GMAW and FCAW equipment, set up, and filler metals.

### Objectives

**Learning Objective 1**
- Describe basic GMAW/FCAW processes and related safety practices.
  - a. Describe basic GMAW processes.
  - b. Identify GMAW/FCAW-related safety practices.
  - c. Describe the various GMAW metal transfer modes.
  - d. Describe the FCAW metal transfer process.

**Learning Objective 2**
- Describe GMAW and FCAW equipment and explain how to prepare for welding.
  - a. Identify common GMAW/FCAW welding equipment.
  - b. Describe power source control considerations.
  - c. Identify and describe welding cables and terminations.
  - d. Identify and describe external wire feeders and their controls.
  - e. Identify and describe GMAW and FCAW guns, contact tips, and nozzles.
  - f. Identify various shielding gases and their related equipment.
  - g. Explain how to set up welding equipment for GMAW and FCAW welding.

**Learning Objective 3**
- Identify various GMAW and FCAW filler metals.
  - a. Identify various GMAW filler metals.
  - b. Identify various FCAW filler metals.

**Performance Task**

**Performance Task 1**
(Learning Objectives 1 through 3)
- Set up GMAW and FCAW equipment with appropriate shielding gases and filler metals.

### Teaching Time: 10.0 hours
(Four 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Prerequisites**

*Core Curriculum* and *Welding Level One*

**Before You Begin**

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the presentation), and these lesson plans, and to gather the required equipment and materials. Consider the 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.
**Classroom Equipment and Materials**

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- **Welding Level Two PowerPoint® Presentation**
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Copies of the Module Examination and Performance Profile Sheets
- GMAW/FCAW-G guns
- Shielding gas regulators and flowmeters

**Safety Considerations**

This module requires that trainees work with and around equipment that may generate 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 GMAW and FCAW equipment and filler metals. Any deficiencies must be corrected to help ensure the future safety of trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

**Equipment and Materials for Laboratories and Performance Testing**

- Appropriate PPE:
  - Appropriate flame-resistant clothing
  - Safety glasses
  - Work gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provider
  - Hard hat as designated by the instructor or training facility provider
- GMAW- and FCAW-compatible welding machines
- GMAW and FCAW welding cable and torches
- Wire feeders
- GMAW- and FCAW-appropriate filler wire
- MIG welding pliers
- Common hand tools
- Shielding gas cylinders with hoses, regulators, and flowmeters

**Additional Resources**

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

- Lincoln Electric website: [http://www.lincolnelectric.com](http://www.lincolnelectric.com) offers sources for products and training.

There are a number of online resources available for trainees who would like more information on GMAW/FCAW equipment and filler metals. 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.

One video to consider is entitled “Mig Welding—Short Arc—Pushing vs. Pulling vs. Spray Transfer” and can be found on YouTube. There are a number of videos available on the Internet related to GMAW and FCAW. These can be located by searching GMAW or FCAW and similar terms, then using the Video tab on the results page of your preferred search engine.

**Appropriate PPE:**

- Appropriate flame-resistant clothing
- Safety glasses
- Work gloves
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider
- Hard hat as designated by the instructor or training facility provider

**GMAW- and FCAW-compatible welding machines**

- GMAW and FCAW welding cable and torches
- Wire feeders
- GMAW- and FCAW-appropriate filler wire
- MIG welding pliers
- Common hand tools
- Shielding gas cylinders with hoses, regulators, and flowmeters
The Lesson Plan for this module is divided into four 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

### Session Outline for 29205

#### GMAW and FCAW – Equipment and Filler Metals

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

<table>
<thead>
<tr>
<th>Session One</th>
<th>Session Two</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session One introduces trainees to basic GMAW and FCAW welding equipment, processes, and safety. The various metal transfer modes are discussed. This session will also introduce power source control, welding cables, and termination considerations. This session covers Sections 1.0.0 through 2.4.0.</td>
<td></td>
</tr>
<tr>
<td>1. Open the Session One presentation.</td>
<td></td>
</tr>
<tr>
<td>2. Use the Kickoff Activity to generate discussion about GMAW/FCAW and determine what trainees may already know about the topic.</td>
<td></td>
</tr>
<tr>
<td>3. Review the safety practices related to GMAW/FCAW.</td>
<td></td>
</tr>
<tr>
<td>4. Identify and describe the basic GMAW/FCAW processes.</td>
<td></td>
</tr>
<tr>
<td>5. Identify the various GMAW/FCAW metal transfer modes.</td>
<td></td>
</tr>
<tr>
<td>6. Identify common GMAW/FCAW equipment.</td>
<td></td>
</tr>
<tr>
<td>7. Describe power source control, welding cables, and termination considerations.</td>
<td></td>
</tr>
<tr>
<td>Session Two introduces the trainees to GMAW/FCAW equipment and use of wire feeders, guns, shielding gases, equipment set up, and filler metals used. This session covers Sections 2.5.0 through 3.2.3.</td>
<td></td>
</tr>
<tr>
<td>1. Open the Session Two presentation.</td>
<td></td>
</tr>
<tr>
<td>2. Use the Kickoff Activity as a peer instruction opportunity related to the setup and operation of wire feeders.</td>
<td></td>
</tr>
<tr>
<td>3. Review GMAW/FCAW external wire feeders, controls, guns, contact tips, and nozzles.</td>
<td></td>
</tr>
<tr>
<td>4. Identify the various shielding gases and related equipment.</td>
<td></td>
</tr>
<tr>
<td>5. Describe how to set up welding equipment for GMAW/FCAW welding.</td>
<td></td>
</tr>
<tr>
<td>6. Discuss the selection of GMAW/FCAW welding machines.</td>
<td></td>
</tr>
<tr>
<td>7. Identify various GMAW/FCAW filler metals.</td>
<td></td>
</tr>
</tbody>
</table>
Session Three is a laboratory session that provides an opportunity to practice and/or complete the Performance Task associated with this module.

1. Note that no presentation is associated with this laboratory session.
2. Demonstrate how to properly and safely set up GMAW and FCAW equipment with the appropriate shielding gases and filler metals.
3. Trainees practice and complete the requirements of Performance Task 1.

Session Four is a review and testing session. Have trainees complete the Module Review. Alternatively, these may be assigned as homework at the end of Session Three. Go over the Module Review in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
### Materials Checklist for Module 29205, GMAW and FCAW – Equipment and Filler Metals

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>GMAW- and FCAW-compatible welding machines</th>
<th>MIG welding pliers</th>
<th>Common hand tools</th>
<th>Shielding gas cylinders with hoses, regulators, and flowmeters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td>GMAW- and FCAW-compatible welding machines</td>
<td>MIG welding pliers</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
</tr>
<tr>
<td>Appropriate flame-resistant clothing</td>
<td>GMAW and FCAW welding cable and torches</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Wire feeders</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
</tr>
<tr>
<td>Work gloves</td>
<td>GMAW- and FCAW-appropriate filler wire</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
</tr>
<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing protection as designated by the instructor or training facility provider</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard hat as designated by the instructor or training facility provider</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pencils and paper</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Welding Level Two Powerpoint® Presentation</em></td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVD player</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer with Internet access</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module Review answer key</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GMAW/FCAW-G guns</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shielding gas regulators and flowmeters</td>
<td>Common hand tools</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
<td></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.
Module Six (29209) introduces the trainees to the methods and procedures related to gas metal arc welding (GMAW) of plate. Trainees will learn safety procedures and the techniques used to produce various basic weld beads.

### Objectives

**Learning Objective 1**
- Identify GMAW-related safety practices and explain how to set up for welding.
  - a. Describe basic GMAW processes.
  - b. Identify GMAW-related safety practices.
  - c. Explain how to safely set up the equipment and work area for welding.

**Learning Objective 2**
- Describe equipment control and welding procedures for GMAW and explain how to produce basic weld beads.
  - a. Describe equipment control and welding techniques related to GMAW.
  - b. Explain how to produce basic GMAW weld beads.

**Learning Objective 3**
- Describe the welding procedures needed to produce proper fillet and V-groove welds using GMAW welding techniques.
  - a. Describe the welding procedures needed to produce proper fillet welds using GMAW welding techniques.
  - b. Describe the welding procedures needed to produce proper V-groove welds using GMAW welding techniques.

### Performance Tasks

**Performance Task 1**
(Learning Objectives 1 through 3)
- Make multiple-pass GMAW-S (short-circuit) fillet welds on carbon steel plate coupons in all four 1F through 4F positions, using solid or composite electrode.

**Performance Task 2**
(Learning Objectives 1 through 3)
- Make multiple-pass GMAW-S (short-circuit) V-groove welds on carbon steel plate coupons in all four 1G through 4G positions, with or without backing, using solid or composite electrode.

**Performance Task 3**
(Learning Objectives 1 through 3)
- Make multiple-pass GMAW spray-transfer fillet welds on carbon steel plate coupons in both the 1F and 2F positions, using solid or composite electrode.

**Performance Task 4**
(Learning Objectives 1 through 3)
- Make multiple-pass GMAW spray-transfer V-groove welds on carbon steel plate coupons in the 1G position, with backing, using solid or composite electrode.

### Teaching Time: 60.0 hours
(Twenty-four 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites
*Core Curriculum and Welding Level One*

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the presentation), and these lesson plans, and to gather the required equipment and materials. Consider the 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 GMAW. Any deficiencies must be corrected to help ensure the future safety of trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Welding Level Two* PowerPoint® Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Copies of the Module Examination and Performance Profile Sheets
- Example of a gas nozzle that has been contaminated
- Examples of carbon steel plate coupons prepared for welding

Equipment and Materials for Laboratories and Performance Testing
- Appropriate PPE:
  - Appropriate flame-resistant clothing
  - Safety glasses
  - Face shields
  - Welding hoods with proper lens tint
  - Welding gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provider
  - Hard hat as designated by the instructor or training facility provider
  - Angle and/or die grinders
- Grinding wheels and points
- Tape measure or steel rule
- Squares
- Files
- Wire brushes
- Chipping hammers
- Soapstone
- Common hand tools
- ¼” to ⅜” thick mild steel plate (6 to 20 mm metric plate)
- Welding equipment, torch, and leads suitable for GMAW
- Solid and/or composite electrodes
- Shielding gas cylinders with regulators and flow meters

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


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


- “MythBusters®: Air Cylinder Rocket” presented by Hai-Yue Han, last accessed March 20, 2015.
- “Gas Metal Arc Welding Vertical Uphill and Downhill” independently produced by Welding Tips And Tricks, last accessed March 20, 2015.
Additional Resources (continued)

There are a number of online resources available for trainees who would like more information on 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.

There are numerous videos available on the Internet related to GMAW. These can be located by searching “gas metal arc welding” or similar terms and using the Video tab on the results page of your preferred search engine.

Instructors are also encouraged to locate additional audiovisual aids, make personal videos, and take still pictures related to the subject matter and add them to the program presentations.
SESSION ONE

Session One introduces trainees to basic GMAW procedures, safety, equipment setup, and equipment control. This session covers Sections 1.0.0 through 2.1.6.

1. Open the Session One presentation.
2. Use the Kickoff Activity to get trainees engaged and make them aware of the hazards associated with pressurized gas cylinders.
3. Present the GMAW processes for plate.
4. Discuss the safety procedures, including protective clothing, fire/explosion prevention, and work area ventilation.
5. Describe how to prepare the welding area, welding coupons, and the welding equipment.
6. Describe the welding procedures and basic beads.
7. Present welding voltage, amperage, travel speeds, and how these can affect penetration and bead size.
8. Discuss welding gun position, electrode extension, stickout, and standoff distances.

SESSION THREE THROUGH TWENTY-THREE

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

1. Note that no presentation is associated with these laboratory sessions.
2. Demonstrate how to properly and safely make multiple-pass GMAW-S fillet and V-groove welds, and GMAW spray-transfer fillet and V-groove welds on carbon steel coupons.
3. Trainees practice and complete the requirements of Performance Tasks 1 through 4.

SESSION TWENTY-FOUR

Session Twenty-Four is a review and testing session. Have trainees complete the Module Review. Alternatively, these may be assigned as homework at the end of Session Twenty-Three. Go over the Module Review in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
## Materials Checklist for Module 29209, GMAW – Plate

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td>Angle and/or die grinders</td>
</tr>
<tr>
<td>Appropriate flame-resistant clothing</td>
<td>Tape measure or steel rule</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Files</td>
</tr>
<tr>
<td>Face shields</td>
<td>Chipping hammers</td>
</tr>
<tr>
<td>Welding hoods with proper lens tint</td>
<td>Common hand tools</td>
</tr>
<tr>
<td>Welding gloves</td>
<td>Welding equipment, torch, and leads suitable for GMAW</td>
</tr>
<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
<td>Shielding gas cylinders with regulators and flow meters</td>
</tr>
<tr>
<td>Hearing protection as designated by the instructor or training facility provider</td>
<td></td>
</tr>
<tr>
<td>Hard hat as designated by the instructor or training facility provider</td>
<td></td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td></td>
</tr>
<tr>
<td>Markers/chalk</td>
<td></td>
</tr>
<tr>
<td>Pencils and paper</td>
<td></td>
</tr>
<tr>
<td><em>Welding Level Two</em> PowerPoint® Presentation</td>
<td></td>
</tr>
<tr>
<td>DVD player or a computer with a DVD drive</td>
<td></td>
</tr>
<tr>
<td>Computer with Internet access</td>
<td></td>
</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
<td></td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td></td>
</tr>
<tr>
<td>Module Review answer key</td>
<td></td>
</tr>
<tr>
<td>Example of a gas nozzle that has been contaminated</td>
<td></td>
</tr>
<tr>
<td>Examples of carbon steel plate coupons prepared for welding</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.
**Module Seven (29210)** introduces the trainees to the methods and procedures related to flux-cored arc welding (FCAW). Trainees will learn safety procedures and the techniques used to produce various types of basic weld beads.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Performance Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning Objective 1</strong></td>
<td><strong>Performance Task 1</strong> (Learning Objectives 1 through 3)</td>
</tr>
<tr>
<td>• Identify FCAW-related safety practices and explain how to prepare for welding.</td>
<td>• Make multiple-pass FCAW-G/GM (gas-shielded) and/or FCAW-S (self-shielded) fillet welds on carbon steel plate coupons in all four 1F through 4F positions.</td>
</tr>
<tr>
<td>a. Describe basic FCAW processes.</td>
<td></td>
</tr>
<tr>
<td>b. Identify FCAW-related safety practices.</td>
<td></td>
</tr>
<tr>
<td>c. Explain how to safely set up the equipment and work area for welding.</td>
<td></td>
</tr>
<tr>
<td><strong>Learning Objective 2</strong></td>
<td><strong>Performance Task 2</strong> (Learning Objectives 1 through 3)</td>
</tr>
<tr>
<td>• Describe equipment control and welding procedures for FCAW and explain how to produce basic weld beads.</td>
<td>• Make multiple-pass FCAW-G/GM (gas-shielded) and/or FCAW-S (self-shielded) V-groove welds on carbon steel plate coupons in all four 1G through 4G positions, with or without backing.</td>
</tr>
<tr>
<td>a. Describe equipment control and welding techniques related to FCAW.</td>
<td></td>
</tr>
<tr>
<td>b. Explain how to produce basic FCAW weld beads.</td>
<td></td>
</tr>
<tr>
<td><strong>Learning Objective 3</strong></td>
<td></td>
</tr>
<tr>
<td>• Describe the welding procedures needed to produce proper fillet and V-groove welds using FCAW welding techniques.</td>
<td></td>
</tr>
<tr>
<td>a. Describe the welding procedures needed to produce proper fillet welds using FCAW welding techniques.</td>
<td></td>
</tr>
<tr>
<td>b. Describe the welding procedures needed to produce proper V-groove welds using FCAW welding techniques.</td>
<td></td>
</tr>
</tbody>
</table>

**Teaching Time:** 60.0 hours  
(Twenty-four 2.5-Hour Classroom Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Prerequisites**  
*Core Curriculum* and *Welding Level 1*

**Before You Begin**

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the presentation), and these lesson plans, and to gather the required equipment and materials. Consider the 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 FCAW. Any deficiencies must be corrected to help ensure the future safety of trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Welding Level Two PowerPoint® Presentation
LCD projector and screen
Computer with Internet access
Module Review answer key
Copies of the Module Examination and Performance Profile Sheets
Example of a flux-cored electrode
FCAW welding machine
Example of gas nozzle with spatter buildup

Equipment and Materials for Laboratories and Performance Testing
Appropriate PPE:
- Appropriate flame-resistant clothing
- Safety glasses
- Face shields
- Welding hoods with proper lens tint
- Welding gloves
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider
- Hard hat as designated by the instructor or training facility provider
- Angle and/or die grinders

Grinding wheels and points
Tape measure or steel rule
Squares
Files
Wire brushes
Chipping hammers
Soapstone
Common hand tools
¼” to ¾” thick mild steel plate (6 to 20 mm metric plate)
Welding equipment, torch, and leads suitable for FCAW
FCAW electrodes
Shielding gas cylinders with regulators and flowmeters

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

Lincoln Electric website: http://www.lincolnelectric.com offers sources for products and training.
“FCAW-S Troubleshooting Video” Produced by Lincoln Electric, last accessed March 18, 2015.

There are a number of online resources available for trainees who would like more information on FCAW processes. 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.

There are also numerous videos available on the Internet related to FCAW. These can be located by searching flux core arc welding or similar terms and using the Video tab on the results page of your preferred search engine.

Instructors are also encouraged to locate additional audiovisual aids, make personal videos, and take still pictures related to the subject matter and add them to the program presentations.
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 basic flux-cored arc welding procedures, safety, equipment setup, and equipment control. This session covers Sections 1.0.0 through 2.1.6.

1. Open the Session One presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Present the FCAW processes for plate.
4. Discuss safety procedures, including protective clothing, fire/explosion prevention, and work area ventilation.
5. Describe how to prepare the welding area, practice coupons, and the welding equipment.
6. Describe welding procedures and basic beads.
7. Discuss FCAW voltage, amperage, travel speeds, and their effect on the weld.
8. Review welding gun position, electrode extension, stickout, and standoff distances.

**SESSION TWO**
Session Two introduces the trainees to welding procedures for FCAW, producing a basic weld bead, and the techniques used to produce fillet and V-groove welds using FCAW. This session covers Sections 2.2.0 through 3.2.7.

1. Open the Session Two presentation.
2. Use the Kickoff Activity to present videos on FCAW welding basics or troubleshooting.
3. Review bead types, restarts, terminations, and overlapping beads.
4. Describe FCAW fillet welding in all positions.
5. Identify acceptable and unacceptable groove weld profiles.
6. Describe V-groove welding in all positions, including the root pass.

**SESSIONS THREE THROUGH TWENTY-THREE**
Session Three through Twenty-Three are laboratory sessions that provide an opportunity to practice and complete the Performance Tasks associated with this module.

1. Note that no presentation is associated with these laboratory sessions.
2. Demonstrate how to properly and safely make multiple-pass FCAW-G/GM (gas-shielded) and FCAW-S (self-shielded) fillet and V-groove welds, on carbon steel coupons.
3. Trainees practice and complete the requirements of Performance Tasks 1 and 2.

**SESSION TWENTY-FOUR**
Session Twenty-Four is a review and testing session. Have trainees complete the Module Review. Alternatively, these may be assigned as homework at the end of Session Twenty-Three. Go over the Module Review in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
# Materials Checklist for Module 29210, FCAW – Plate

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Angle and/or die grinders</th>
<th>Grinding wheels and points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate flame-resistant clothing</td>
<td>Tape measure or steel rule</td>
<td>Squares</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Files</td>
<td>Wire brushes</td>
</tr>
<tr>
<td>Face shields</td>
<td>Chipping hammers</td>
<td>Soapstone</td>
</tr>
<tr>
<td>Welding hoods with proper lens tint</td>
<td>Common hand tools</td>
<td>⅛” to ⅜” thick mild steel plate (6 to 20 mm metric plate)</td>
</tr>
<tr>
<td>Welding gloves</td>
<td>Welding equipment, torch, and leads suitable for FCAW</td>
<td>FCAW electrodes</td>
</tr>
<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
<td>Shielding gas cylinders with regulators and flowmeters</td>
<td></td>
</tr>
<tr>
<td>Hearing protection as designated by the instructor or training facility provider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard hat as designated by the instructor or training facility provider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td></td>
<td></td>
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<tr>
<td>Markers/chalk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pencils and paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Welding Level Two PowerPoint® Presentation</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module Review answer key</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer with Internet access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Example of a flux-cored electrode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCAW welding machine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Example of gas nozzle with spatter buildup</td>
<td></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.
Module Eight (29207) introduces the trainees to the methods and procedures related to gas-tungsten arc welding (GTAW). Trainees will learn safety procedures and techniques used to produce various types of basic weld beads.

Objectives

Learning Objective 1
- Identify GTAW-related safety practices and describe the electrical characteristics that affect GTAW.
  a. Identify GTAW-related safety practices.
  b. Describe the electrical characteristics that affect GTAW.

Learning Objective 2
- Identify and describe GTAW equipment and consumables.
  a. Identify and describe GTAW welding machines.
  b. Identify and describe GTAW torches.
  c. Identify and describe GTAW torch nozzles and electrodes.
  d. Identify and describe GTAW shielding gases.
  e. Identify and describe GTAW filler metals.

Learning Objective 3
- Explain how to set up for GTAW welding.
  a. Explain how to select and position the welding machine.
  b. Explain how to connect and set up the shielding gas flow rate.
  c. Explain how to select and prepare the tungsten electrode.
  d. Explain how to select and install the nozzle along with the tungsten electrode.

Performance Tasks

Performance Task 1
(Learning Objective 2)
Select a GTAW shielding gas.

Performance Task 2
(Learning Objective 2)
Select a GTAW filler metal.

Performance Task 3
(Learning Objective 3)
Connect the shielding gas and set the flow rate.

Performance Task 4
(Learning Objective 3)
Select and prepare the tungsten electrode.

Performance Task 5
(Learning Objectives 2 and 3)
Break down and reassemble a GTAW torch.

Teaching Time: 10.0 hours
(Four 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Core Curriculum and Welding Level One

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the presentation), and these lesson plans, and to gather the required equipment and materials. Consider the 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 GTAW. Any deficiencies must be corrected to help ensure the future safety of trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- Welding Level Two PowerPoint® Presentation
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Copies of the Module Examination and Performance Profile Sheets
- Copies of the manufacturer’s documentation for the GTAW welding machines on hand
- Complete GTAW torch assemblies

Equipment and Materials for Laboratories and Performance Testing
- Appropriate PPE:
  - Safety glasses
  - Face shields
  - Work gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provider
  - Hard hat as designated by the instructor or training facility provider
- GTAW-appropriate welding machines
- GTAW shielding gas cylinders with flowmeters and regulators
- GTAW torch assemblies
- A variety of compatible GTAW torch nozzles and collets
- Tungsten electrodes for preparation practice
- Grinders for tungsten preparation
- Common hand tools

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

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

There are a number of online resources available for trainees who would like more information on GTAW. 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.

Instructors should also 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 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 GTAW-related safety practices and the electrical characteristics that must be considered. This session covers Sections 1.0.0 through 1.2.4.

1. Open the Session One presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Present the GTAW safety information.
4. Describe the specific equipment required to perform GTAW welding.

**SESSION TWO**

Session Two introduces the trainees to the equipment accessories required for GTAW. Trainees also have an opportunity to complete Performance Task 5 during this session. This session covers Sections 2.0.0 through 2.5.8.

1. Open the Session Two presentation.
2. Use the Kickoff Activity to share tips and guidance from experienced GTAW welders.
3. Identify and describe the required welding equipment and the torch assemblies used for GTAW.
4. Demonstrate how to properly disassemble and reassemble a torch. Trainees then practice the process until they are competent. This activity corresponds to Performance Task 5.
5. Discuss the selection of shielding gases and filler metals.

**SESSION THREE**

Session Three explains how to set up GTAW equipment and prepare for welding. This session covers Sections 3.0.0 through 3.4.1. At the end of this session, trainees have an opportunity to complete the requirements of Performance Tasks 1 through 4.

1. Open the Session Three presentation.
2. Use the Kickoff Activity to show a brief video related to GTAW basics.
3. Explain how to select and position the welding equipment.
4. Explain how to set the required shielding gas flow rate and prepare the electrode for use.
5. Have trainees select a shielding gas and filler metals for various applications. This activity corresponds to Performance Task 1 and 2.
6. Demonstrate how to connect the shielding gas and set the required flow rate. Demonstrate how to prepare a tungsten electrode for use.
7. Have trainees connect the shielding gas to the welding machine or torch and set a specified flow rate. This activity corresponds to Performance Task 3.
8. Have trainees select a tungsten electrode for an application and prepare the electrode for welding. This activity corresponds to Performance Task 4.
Session Four is a review and testing session. Have trainees complete the Module Review. Alternatively, these may be assigned as homework at the end of Session Three. Go over the Module Review in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.

2. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
<table>
<thead>
<tr>
<th><strong>Personal protective equipment:</strong></th>
<th><strong>Equipment and Materials</strong></th>
<th><strong>Common hand tools</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety glasses</td>
<td>GTAW torch assemblies</td>
<td>Common hand tools</td>
</tr>
<tr>
<td>Face shields</td>
<td>GTAW-appropriate welding</td>
<td>GTAW shielding gas</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Grinders for tungsten</td>
<td>cylinders with flowmeters and regulators</td>
</tr>
<tr>
<td>Proper footwear</td>
<td>Tungsten electrodes for</td>
<td></td>
</tr>
<tr>
<td>Hearing protection</td>
<td>preparation practice</td>
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<tr>
<td>Hard hat</td>
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<td>Whiteboard/chalkboard</td>
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<td>Markers/chalk</td>
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<td>Pencils and paper</td>
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<tr>
<td><em>Welding Level Two PowerPoint®</em></td>
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<tr>
<td>DVD player</td>
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<tr>
<td>Computer with Internet access</td>
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<tr>
<td>Copies of the Module</td>
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<tr>
<td>Examination and Performance</td>
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<tr>
<td>Profile Sheets</td>
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<tr>
<td>LCD projector and screen</td>
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<tr>
<td>Module Review answer key</td>
<td></td>
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</tr>
<tr>
<td>Copies of the manufacturer’s</td>
<td></td>
<td></td>
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<tr>
<td>documentation for the GTAW</td>
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<td></td>
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<tr>
<td>welding machines on hand</td>
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<tr>
<td>Complete GTAW torch</td>
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<td></td>
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<tr>
<td>assemblies</td>
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</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 Nine (29208) introduces the trainees to GTAW welding techniques and provides them with sufficient practice to master those techniques.

### Objectives

**Learning Objective 1**
- Identify GTAW-related safety practices and explain how to set up for welding.
  a. Identify GTAW-related safety practices.
  b. Explain how to safely set up the equipment and work area for welding.

**Learning Objective 2**
- Describe welding techniques for GTAW and explain how to produce basic weld beads.
  a. Describe welding techniques related to GTAW.
  b. Explain how to produce basic GTAW weld beads.

**Learning Objective 3**
- Describe the welding techniques needed to produce proper fillet and open V-groove welds using GTAW welding techniques.
  a. Describe the welding techniques needed to produce proper fillet welds using GTAW.
  b. Describe the welding techniques needed to produce proper open V-groove welds using GTAW.

### Performance Tasks

**Performance Task 1**
*(Learning Objectives 2 & 3)*
- Build a pad with stringer beads on carbon steel plate coupons in the flat position using GTAW equipment and carbon steel filler material.

**Performance Task 2**
*(Learning Objectives 2 & 3)*
- Perform multiple-pass fillet welds on carbon steel plate coupons in all four 1F through 4F positions, using GTAW equipment and carbon steel filler metal.

**Performance Task 3**
*(Learning Objectives 2 & 3)*
- Perform multiple-pass open V-groove welds on carbon steel plate coupons in all four 1G through 4G positions, using GTAW equipment and carbon steel filler metal.

### Teaching Time: 60.0 hours
*(Twenty-four 2.5-Hour Classroom Sessions)*
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites
*Core Curriculum and Welding Level One*

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the presentation), and these lesson plans, and to gather the required equipment and materials. Consider the 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 GTAW welding. Any deficiencies must be corrected to help ensure the future safety of trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

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**Classroom Equipment and Materials**

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- Welding Level Two PowerPoint® Presentation
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Copies of the Module Examination and Performance Profile Sheets

**Equipment and Materials for Laboratories and Performance Testing**

- Appropriate PPE:
  - Appropriate flame-resistant clothing
  - Safety glasses
  - Welding hoods with proper lens tint
  - Welding gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provider
  - Hard hat as designated by the instructor or training facility provider
  - Angle and/or die grinders
  - Grinding wheels and points
  - Grinders appropriate for tungsten preparation
- Tape measures or steel rules
- Squares
- Files
- Wire brushes
- Chipping hammers
- Soapstone
- Common hand tools
  - ¼” to ¾” thick mild steel plate
  - (6 to 20 mm metric plate)
  - Shielding gas cylinders with regulators and flow meters
  - GTAW-compatible welding machines, torches, and nozzles
  - A selection of tungsten electrodes
  - A selection of appropriate filler metals

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**Additional Resources**

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

- Lincoln Electric website: [http://www.lincolnelectric.com](http://www.lincolnelectric.com) offers sources for products and training.

There are a number of online resources available for trainees who would like more information on GTAW. 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.

There are also numerous videos available on the Internet related to GTAW. These can be located by searching “GTAW welding” or related terms and using the Video tab on the results page of your preferred search engine.

Instructors are also 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 basic GTAW welding procedures, safety, and equipment setup. This session covers Sections 1.0.0 through 2.1.4.

1. Open the Session One presentation.
2. Use the Kickoff Activity to expose trainees to professional GTAW tips and stimulate interest.
3. Present the GTAW safety information.
4. Explain how the work area is to be set up for GTAW welding.
5. Discuss common GTAW welding techniques and the various welding positions.

**Sessions Three through Twenty-Three**

Sessions Three through Twenty-Three are laboratory sessions that provide an opportunity to practice and complete the Performance Tasks associated with GTAW of plate materials.

1. Note that no presentation is associated with this laboratory session.
2. Demonstrate how to properly and safely make stringer beads, multiple-pass GTAW fillet welds, and multiple-pass open V-groove welds on carbon steel coupons.
3. Trainees practice and complete the requirements of Performance Tasks 1 through 3.

**Session Twenty-Four**

Session Twenty-Four is a review and testing session. Have trainees complete the Module Review. Alternatively, these may be assigned as homework at the end of Session Two. Go over the Module Review in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
# Materials Checklist for Module 29208, GTAW – Plate

## Equipment and Materials

<table>
<thead>
<tr>
<th>Personal protective equipment:</th>
<th>Angle and/or die grinders</th>
<th>Grinding wheels and points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate flame-resistant clothing</td>
<td>Grinders appropriate for tungsten preparation</td>
<td>Tape measures or steel rules</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Squares</td>
<td>Files</td>
</tr>
<tr>
<td>Welding hoods with proper lens tint</td>
<td>Wire brushes</td>
<td>Chipping hammers</td>
</tr>
<tr>
<td>Welding gloves</td>
<td>Soapstone</td>
<td>Common hand tools</td>
</tr>
<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
<td>1/4” to 3/4” thick mild steel plate (6 to 20 mm metric plate)</td>
<td>Shielding gas cylinders with regulators and flow meters</td>
</tr>
<tr>
<td>Hearing protection as designated by the instructor or training facility provider</td>
<td>GTAW-compatible welding machines, torches, and nozzles</td>
<td>A selection of tungsten electrodes</td>
</tr>
<tr>
<td>Hard hat as designated by the instructor or training facility provider</td>
<td>A selection of appropriate filler metals</td>
<td></td>
</tr>
</tbody>
</table>

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Welding Level Two PowerPoint® Presentation*
- DVD player
- Computer with Internet access
- Copies of the Module Examination and Performance Profile Sheets
- LCD projector and screen
- Module Review answer key

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 29203

Physical Characteristics and Mechanical Properties of Metals

Module Three (29203) introduces the trainees to the various physical and mechanical characteristics of ferrous and nonferrous metals. Welders must be familiar with the metallurgical factors that need to be considered during welding activities. This module presents metal composition, properties, structural steel, and common milled shapes used for fabrication.

Objectives

Learning Objective 1
- Describe the composition and classification systems for a variety of metals.
  a. Describe the composition and classification system for ferrous metals.
  b. Describe the composition and classification system for low-alloy steel.
  c. Describe the composition and classification system for common-grade stainless steel.
  d. Describe the composition and classification system for specialty-grade stainless steel.
  e. Describe the composition and classification system for nonferrous metals.

Learning Objective 2
- Describe the physical and mechanical characteristics of metals and explain how to identify base metals.
  a. Describe the physical characteristics of different metals.
  b. Describe the mechanical properties of different metals.
  c. Explain how to identify base metals in field conditions.
  d. Describe metallurgy-related considerations for welding.

Learning Objective 3
- Identify the common structural shapes of metal.
  a. Identify the most common structural steel shapes.
  b. Identify different structural beam shapes.
  c. Identify pipe and tubing types.
  d. Identify other common metal forms, including rebar.

Performance Tasks
This is a knowledge-based module; there are no Performance Tasks.

Teaching Time: 7.5 hours
(Three 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Core Curriculum and Welding Level One

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the presentation), and these lesson plans, and to gather the required equipment and materials. Consider the 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 may find trainees in proximity of equipment that could generate high voltages, extremely high temperatures, and intense ultraviolet radiation. Although this module will not call for any direct welding tasks, safety must be stressed at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to hazards related to the shop welding work environment. Any deficiencies must be corrected to help ensure the future safety of trainees. All classroom and shop areas of operation must be under the instructor’s direct supervision.

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**Classroom Equipment and Materials**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Welding Level Two* PowerPoint® Presentation
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Copies of the Module Examination
- Examples of the current AISI, ASTM International, and/or UNS specifications
- Examples of different types of metals for examination, including ferrous and nonferrous
- A hardness tester
- Samples of SDS/MSDS for one or more metal-cleaning chemical
- Samples of reinforcement bars with grade marks

**Equipment and Materials for Laboratories and Performance Testing**
This is a knowledge-based module; there are no Performance Tasks.

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


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


- “Shape Memory Alloy Demonstration”, Independent Video by David & Toby, last accessed March 10, 2015.
**Additional Resources (continued)**

There are a number of on-line resources available for trainees who would like more information on the physical characteristics and mechanical properties of metals. 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. Below are two examples of available videos:

“Shape Memory Alloy Demonstration” explains how some alloys can return to their original shape when cooled. Video length is 5:31 and it can be found on YouTube.

“Physical Properties of Metals.” Video length is 5:36 and it is also available on YouTube.

Instructors are also 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 One introduces trainees to metal composition, classification, and metal characteristics. This session covers Section 1.0.0 through 1.5.8.

1. Open the Session One presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Review the composition and classification system used for ferrous metals and low alloy steel.
4. Discuss the composition and classification system for common-grade and specialty-grade stainless steel.
5. Present the composition and classification system for nonferrous metals.

Session Two introduces the trainees to the physical and mechanical properties of metal and explains how to identify base metals and the common structural shapes of metal. This session covers Section 2.0.0 through 3.4.4.

1. Open the Session Two presentation.
2. Use the Kickoff Activity to show a video that explains how alloys can be made to hold their shapes.
3. Review the physical and mechanical characteristics of different metals.
4. Describe how to identify base metals in field conditions.
5. Present different types of metallurgy-related considerations for welding.
6. Review the common structural steel shapes, structural beam shapes, and pipe and tubing types.
7. Review the other common metal forms including reinforcing bars, forged and cast shapes, and powdered metals.

Session Three is a review and testing session. Have trainees complete the Module Review. Alternatively, these may be assigned as homework at the end of Session Two. Go over the Module Review in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. This is a knowledge-based module; there are no Performance Tasks.
2. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
# Materials Checklist for Module 29203, Physical Characteristics and Mechanical Properties of Metals

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Personal protective equipment:</th>
<th>Examples of the current AISI, ASTM International, and /or UNS specifications</th>
<th>Examples of different types of metals for examination, including ferrous and nonferrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td>Examples of SDS/MSDS for one or more metal-cleaning chemical</td>
<td>Samples of reinforcement bars with grade marks</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td></td>
<td>A hardness tester</td>
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<td>Module Review answer key</td>
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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 (29204-15) introduces the trainees to the relationship between heat and metal. It also describes various devices and methods that welders use to heat metals and measure temperature. Trainees will learn how to safely control heating during each stage of a welding operation.

**Objectives**

**Learning Objective 1**
- Describe the relationship between heat and metal and identify preheating methods.
  a. Describe the relationship between heat and metal.
  b. Identify and describe methods used to preheat metal prior to welding.
  c. Identify and describe devices and products used to measure temperature.

**Learning Objective 2**
- Describe interpass temperature control and postheating processes.
  a. Describe interpass temperature control.
  b. Describe various postheating processes.

**Performance Task**

**Performance Task 1**
(learning objectives 1 and 2)
- Preheat base metal to 350°F (177°C) and verify preheat using a temperature-indicating device.

**Teaching Time: 5.0 hours**
(Two 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Prerequisites**
Core Curriculum and Welding Level One

**Before You Begin**
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the 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 may generate 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 hazards related to preheating and postheating of metals. Any deficiencies must be corrected to help ensure the future safety of trainees. All practice sessions and performance tasks must be completed under the instructor’s direct supervision.

Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- Welding Level Two PowerPoint® Presentation
- LCD projector and screen
- Computer with Internet access
- Sample weld defects from improper preheating or postheating treatment
- Temperature-indicating crayons
- Gas preheating torch
- Open-top or open flat-top preheater
- Resistance heating elements
- Induction heaters
- Module Review answer key
- Copies of the Module Examination and Performance Profile Sheets

Equipment and Materials for Laboratories and Performance Testing
- Appropriate PPE:
  - Appropriate flame-retardant clothing
  - Safety glasses and face shields, tinted as required
  - Welding or cutting gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provider
  - Hard hat or welding helmet as designated by the instructor or training facility provider
- At least one of the following:
  - Oxyfuel torches with appropriate heating tips; required fuel gas cylinders and regulators
  - Open-top preheaters
  - Resistance heaters
  - Induction heaters
  - Temperature-indicating crayons
  - Pyrometer
  - Thermocouple device(s)
  - Temperature-sensitive tape or labels

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

- Tempilstik Preheat and Interpass Demo, Independent Video by Tempilstik, last accessed March 04, 2015.

There are a number of on-line resources available for trainees who would like more information on preheating and postheating of metals. 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.

There are numerous videos available on the Internet related to preheating and postheating of metals. Use search terms such as preheating postheating for welding and similar terms, then use the Video tab of your preferred search engine to locate video resources. One example of a video offered on YouTube is entitled “Tempilstik Preheat and Interpass Demo.” Video length is 5:50.

Instructors are also 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 two 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

SESSION ONE
Session One explains metal preheating and postheating processes and identifies related temperature and metal relationships. The trainees will also be introduced to various methods, devices, and products to measure the temperature of preheated and postheated metal. This session covers Section 1.0.0 through 2.2.7.

1. Open the Session One presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
4. Introduce the temperature and metal relationship.
5. Describe preheating methods and how to use temperature measuring devices.
6. Introduce interpass temperature control.
7. Describe the process of stress relieving, annealing, tempering, and hardening.
8. Introduce the trainees to heat treatment devices and time-at-temperature considerations.

SESSION TWO
Session Two is a laboratory, review, and testing session that provides an opportunity to practice and complete the Performance Task associated with preheating and postheating of metals. Have trainees complete the Module Review. Alternatively, these may be assigned as homework at the end of Session One. Go over the Module Review in class prior to the exam and answer any questions that the trainees may have.

1. Note that there is no presentation associated with this session.
2. Trainees practice and complete the requirements of Performance Task 1.
3. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
4. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
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