Module One (29101) introduces trainees to the all-important topic of safety in the welding trade. The work of welders includes joining pipe sections for oil and natural gas pipelines; building ships; and working in a variety of industrial environments such as power plants, refineries, chemical plants, and manufacturing facilities.

### Objectives

**Learning Objective 1**
- Describe basic welding processes, the welding trade, and training/apprenticeship programs.
  - a. Describe basic welding processes and the welding trade.
  - b. Describe NCCER standardized training and explain apprenticeship programs.

**Learning Objective 2**
- Identify, and describe personal protective equipment (PPE) related to the welding trade.
  - a. Identify and describe body, foot, and hand protective gear.
  - b. Identify and describe ear, eye, face, and head protective gear.

**Learning Objective 3**
- Identify and describe welding safety practices related to specific hazards or environments.
  - a. Describe the importance of welding safety and identify factors related to accidents.
  - b. Describe basic welding safety practices related to the general work area.
  - c. Describe hot work permits and fire watch requirements.
  - d. Describe confined spaces and their related safety practices.
  - e. Identify safety practices related to welding equipment.
  - f. Identify and describe respiratory hazards, respiratory safety equipment, and ways to ventilate welding work areas.
  - g. Explain the purpose of the SDS/MSDS and how it is used.

### Performance Tasks

This is a knowledge-based module; there are no performance tasks.

### Teaching Time: 5 hours

(Two 2.5-Hour Classroom Sessions)

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

### Prerequisites

Core Curriculum

### 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 is primarily delivered in the classroom environment. However, some activities are likely to be conducted in shop areas and require trainees to handle common welding materials and tools. 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. Any deficiencies must be corrected to ensure future trainee safety.

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
Examples of SDSs/MSDSs
Copies of the Module Examination

Common welding PPE, including:
Welding hood
Head gear
Face shield
Jacket
Apron
Cape
Arm covers
Chaps
Spats
Tinted hood lenses
Various types of respirators

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 this topic. 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. There are a number of accessible videos related to welding safety on the Internet. Lincoln Electric Company offers a number of short, well-produced videos related to welding safety. The collection of videos can be found by visiting http://www.lincolnelectric.com/assets/us/en/interactive/welding-safety/ppe-home.html. 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 welding trade and add them to the PowerPoint® presentations throughout the program.
Session Outline for 29101

WELDING SAFETY

The Lesson Plan for this module consists of two 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break for each session.

SESSION ONE

Session One covers the first two objectives. It begins with acquainting the trainees with the welding trade and training required for it, and continues through selection and proper fit of PPE.

1. Use the Kickoff Activity to engage trainees in the topic and give them an idea of what they will learn from this session.
2. Show the Session One PowerPoint® presentation.
3. Define the welding processes and discuss the welding trade.
4. Review apprenticeship programs.
5. Describe and point out the differences between SMAW, GTAW, and GMAW.
6. Present welding-related PPE.
7. Introduce hot work permits, fire watches, and confined space operations.

SESSION TWO

Session Two presents various welding safety practices related to different environments and processes. At the end of this session, trainees will complete the written module examination.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to review Session One and introduce Session Two.
3. Discuss why it is important to practice welding safety.
4. Introduce the safety data sheets (SDSs) and material safety data sheets (MSDSs).
5. Administer the written examination.
6. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.
## Materials Checklist for Module 29101, Welding Safety

### Equipment and Materials

<table>
<thead>
<tr>
<th>Personal protective equipment:</th>
<th>Common welding PPE, including:</th>
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<tbody>
<tr>
<td>None</td>
<td>Welding hood</td>
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<tr>
<td>Whiteboard/chalkboard</td>
<td>Head gear</td>
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<tr>
<td>Markers/chalk</td>
<td>Face shield</td>
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<tr>
<td>Pencils and paper</td>
<td>Jacket</td>
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<td><em>Welding Level One</em></td>
<td>Apron</td>
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<td><em>PowerPoint® Presentation</em></td>
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<td><em>Slides</em></td>
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<td>DVD player</td>
<td>Cape</td>
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<td>Computer</td>
<td>Arm covers</td>
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<td>Examples of SDSs/MSDSs</td>
<td>Chaps</td>
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<td>Copies of the Module</td>
<td>Spats</td>
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<td>Examination</td>
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<td></td>
<td>Tinted hood lenses</td>
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<tr>
<td></td>
<td>Various types of respirators</td>
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</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 Three (29103) introduces the trainees to the methods and procedures related to the plasma arc cutting process. Trainees will learn safety procedures, equipment setup, gas types, flow rates, and techniques.

### Objectives

**Learning Objective 1**
- Explain plasma arc cutting processes and identify related safety precautions.
  - Describe the plasma arc cutting processes.
  - Identify safety practices related to plasma arc cutting.

**Learning Objective 2**
- Identify and describe plasma arc cutting equipment.
  - Identify and describe plasma arc power units.
  - Identify and describe plasma arc torches and accessories.
  - Identify and describe plasma arc cutting gases and gas control devices.

**Learning Objective 3**
- Describe how to set up, safely operate, and care for plasma arc cutting equipment.
  - Describe how to set up plasma arc cutting equipment and the adjacent work area.
  - Describe how to safely operate plasma arc cutting equipment.
  - Describe how to care for plasma arc cutting equipment.

### Performance Tasks

**Performance Task 1**
*(Learning Objectives 1, 2, and 3)*
- Set up plasma arc cutting equipment.

**Performance Task 2**
*(Learning Objectives 2 and 3)*
- Set the amperage and gas pressures or flow rates for the type and thickness of metal to be cut using plasma arc equipment.

**Performance Task 3** *(Learning Objective 3)*
- Square-cut metal using plasma arc equipment.

**Performance Task 4** *(Learning Objective 3)*
- Bevel-cut metal using plasma arc equipment.

**Performance Task 5** *(Learning Objective 3)*
- Pierce and cut slots in metal using plasma arc equipment.

**Performance Task 6** *(Learning Objective 3)*
- Dismantle and store the equipment.

### 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*

### 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 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 hazards related to plasma arc cutting equipment. Any deficiencies must be corrected to ensure future trainee safety. 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 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
- An example of the plasma arc cutting unit and torch trainees will operate
- Manufacturer’s documentation for the cutting units to be used (a copy for each trainee is recommended)
- Gas cylinders and regulators (if required)

Equipment and Materials for Laboratories and Performance Testing

- Appropriate PPE:
  - Appropriate flame-retardant clothing
  - Eye and face protection, properly tinted
  - 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
- Plasma arc cutting power units and accessories
- Clean, dry compressed air supply
- Other gases (if required)
- Gas pressure regulators (if required)
- Plasma torch cutting guides
- Sufficient carbon steel plate for all trainees to create the specified workpieces
- Soapstone
- Tape measures or steel rules
- Squares
- Wire brushes

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 plasma arc cutting. 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. The Lincoln Electric web site at [http://newsroom.lincolnelectric.com/Video](http://newsroom.lincolnelectric.com/Video) offers a video entitled “Tech Tips: Plasma Cutting Basics” along with many other welding-related videos. Video length is 5:09.

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 29103

PLASMA ARC CUTTING

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

SESSION ONE

Session One explains plasma arc cutting (PAC) processes and identifies related safety precautions. The trainees will also be introduced to PAC power units, torches, accessories, gases and gas control devices. This session covers Sections 1.0.0 through 3.3.3.

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. Describe plasma arc cutting processes and review safety considerations.
4. Introduce plasma arc cutting equipment.
5. Describe how to set up PAC equipment and prepare the adjacent work areas.
6. Describe how to safely operate the PAC equipment.
7. Review common cutting techniques.

SESSION TWO

Session Two is a laboratory session that provides an opportunity to practice and/or complete the Performance Tasks required in this module.

1. Note that no PowerPoint® presentation is associated with this laboratory session.
2. Demonstrate equipment setup and plasma arc cutting techniques, including slots and bevels.
3. Trainees practice and/or complete the specific tasks required by Performance Tasks 1 through 6.

SESSION THREE

Session Three is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. Alternatively, these may be assigned as homework at the end of the previous session. 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 29103, Plasma Arc Cutting

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
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<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
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<tr>
<td>Appropriate flame-retardant clothing</td>
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<tr>
<td>Eye and face protection, properly tinted</td>
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<tr>
<td><strong>Welding or cutting gloves</strong></td>
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<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
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<tr>
<td>Hearing protection as designated by the instructor or training facility provider</td>
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<tr>
<td>Hard hat or welding helmet as designated by the instructor or training facility provider</td>
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<tr>
<td>Whiteboard/chalkboard</td>
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<tr>
<td>Markers/chalk</td>
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<tr>
<td>Pencils and paper</td>
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<tr>
<td><strong>Welding Level One PowerPoint® Presentation Slides</strong></td>
</tr>
<tr>
<td>DVD player or a computer with a DVD drive</td>
</tr>
<tr>
<td>Computer with Internet access</td>
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<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
</tr>
<tr>
<td>Module Review and Trade Terms Quiz answer keys</td>
</tr>
<tr>
<td>An example of the plasma arc cutting unit and torch trainees will operate</td>
</tr>
<tr>
<td>Manufacturer’s documentation for the cutting units to be used (a copy for each trainee is recommended)</td>
</tr>
<tr>
<td>Gas cylinders and regulators (if required)</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 Five (29105) introduces the trainees to the methods and procedures related to preparing base metal for welding. Trainees will learn safety procedures, welding joint preparation, specifications, identification of physical characteristics, mechanical properties, and cleaning techniques related to common base metals.

### Objectives

**Learning Objective 1**
- Identify safety practices related to preparing base metals and describe basic cleaning procedures.
  a. Identify safety practices related to preparing base metals.
  b. Describe the basic properties and types of carbon and stainless steel.
  c. Describe basic metal cleaning procedures and concerns.

**Learning Objective 2**
- Identify and describe basic weld joint design and types of welds.
  a. Identify and describe the loads that are routinely placed on weld joints.
  b. Identify and describe the various types of weld joints.
  c. Describe a welding procedure specification (WPS) and the information it provides.

**Learning Objective 3**
- Describe how to prepare joints for welding.
  a. Describe how to mechanically prepare joints for welding.
  b. Describe how to thermally prepare joints for welding.

### Performance Tasks

**Performance Task 1 (Learning Objectives 1 and 3)**
- Mechanically or hand grind a bevel on the edge of a $\frac{1}{4}''$- to $\frac{3}{8}''$-thick mild steel plate (6 to 20 mm metric plate) at $22\frac{1}{2}$ degrees.

**Performance Task 2 (Learning Objectives 1 and 3)**
- Thermally bevel the edge of a $\frac{1}{4}''$- to $\frac{3}{8}''$-thick mild steel plate (6 to 20 mm metric plate) at $22\frac{1}{2}$ degrees.

### Teaching Time: 12.5 hours

(Five 2.5-Hour Classroom Sessions)

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

### Prerequisites

*Cored Curriculum; Welding Level One, Module 29101.*

### 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 the time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profiles 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 power tools, flammable gases, and an open flame. 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.

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**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
- Copies of an SDS/MSDS for a metal cleaning chemical
- Examples of workpieces prepared for welding, matching the common joint styles
- Examples of weld joint backing tapes
- Copies of various WPSs

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

- Appropriate PPE:
  - Appropriate flame-resistant clothing
  - Safety glasses
  - Face shields
  - Properly-tinted goggles or face shields
  - Work gloves
  - 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
- Nibblers and/or cutters
- Tape measure or steel rule
- Squares
- Files
- Wire brushes
- Soapstone
- Common hand tools
- ¼" to ⅜" thick mild steel plate (6 to 20 mm metric plate)
- Oxyfuel cutting equipment, including hoses and torches
- Track burner (optional)
- Gas regulators
- Oxygen cylinders
- Fuel gas cylinders
- Chipping hammers

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**Additional Resources**

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

- Association for Iron & Steel Technology, 186 Thorn Hill Road, Warrendale, PA, USA. [www.aist.org](http://www.aist.org)
- “How to Weld: Joint Prep and Beveling” Independent Video, last accessed November 26, 2014. [www.youtube.com](http://www.youtube.com)

There are a number of online resources available for trainees who would like more information on base metal preparation. 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 base metal preparation. These can be located by searching “weld joint preparation” or “beveling plate” and using the Video tab on the results page of your preferred search engine.
Session Outline for 29105

Base Metal Preparation

The Lesson Plan for this module is divided into five 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 safety and cleaning, including basic metal cleaning procedures and concerns. This session will also introduce basic properties and types of carbon and stainless steel. This session covers Sections 1.0.0 through 1.3.2.

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 safety practices related to welding and base metal preparation.
4. Discuss the common properties of carbon steel and stainless steel.
5. Describe base metal cleaning using both chemicals and mechanical methods.

**SESSION TWO**

Session Two introduces the trainees to joint design and weld types. This session covers Sections 2.0.0 through 3.2.0.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to review material presented in the previous session.
3. Describe the types of loads that are commonly imposed on weld joints.
4. Present different types of weld joints.
5. Explain codes and review welding procedure specifications.
7. Review the thermal methods of joint preparation.

**SESSION THREE**

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

1. Note that no PowerPoint® presentation is associated with this laboratory session.
2. Demonstrate how to properly and safely bevel plate using various power tools.
3. Trainees practice and/or complete the requirements of Performance Task 1.

**SESSION FOUR**

Session Four is a laboratory session that provides an opportunity to practice and/or complete the Performance Tasks associated with thermal welding joint preparation.

1. Note that no PowerPoint® presentation is associated with this session.
2. Demonstrate how to properly and safely bevel plate using selected oxyfuel and/or plasma arcing cutting equipment.
3. Trainees practice and/or complete the requirements of Performance Task 2.

**SESSION FIVE**

Session Five is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session Four.) Go over the Module Review Questions 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>Equipment and Materials</strong></th>
<th><strong>Personal protective equipment:</strong></th>
<th><strong>Appropriate flame-resistant clothing</strong></th>
<th><strong>Safety glasses</strong></th>
<th><strong>Face shields</strong></th>
<th><strong>Properly-tinted goggles or face shields</strong></th>
<th><strong>Work gloves</strong></th>
<th><strong>Welding gloves</strong></th>
<th><strong>Proper footwear as designated by the instructor or training facility provider</strong></th>
<th><strong>Hearing protection as designated by the instructor or training facility provider</strong></th>
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<td></td>
<td><strong>Gas regulators</strong></td>
<td><strong>Oxygen cylinders</strong></td>
<td><strong>Angle and/or die grinders</strong></td>
<td><strong>Nibblers and/or cutters</strong></td>
<td><strong>Squares</strong></td>
<td><strong>Wire brushes</strong></td>
<td><strong>Common hand tools</strong></td>
<td><strong>Oxyfuel cutting equipment, including hoses and torches</strong></td>
<td><strong>Track burner (optional)</strong></td>
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<td><strong>Chipping hammers</strong></td>
<td><strong>Fuel gas cylinders</strong></td>
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<td><strong>Tape measure or steel rule</strong></td>
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<td>Examples of workpieces</td>
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<td>matching the common joint</td>
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<td>Examples of weld joint</td>
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<td>backing tapes</td>
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<td>Copies of various WPSs</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 Six (29106) introduces trainees to the methods and procedures to produce high-quality welds. Trainees will become familiar with welding codes and provisions, discontinuities, examination practices, and weld procedure testing. Trainees will then complete a visual inspection on a fillet and/or groove weld and complete an inspection report to document the results.

**Objectives**

**Learning Objective 1**
- Identify and describe the various code organizations that apply to welding and their basic elements.
  a. Identify the various welding code organizations and their sponsoring organizations.
  b. Identify and describe the basic provisions of welding codes.

**Learning Objective 2**
- Identify and describe weld discontinuities and their causes.
  a. Identify and describe discontinuities related to porosity and inclusions.
  b. Identify and describe discontinuities that result in cracking.
  c. Identify and describe discontinuities related to joint penetration, fusion, and undercutting.
  d. Identify and describe acceptable and unacceptable weld profiles.

**Learning Objective 3**
- Describe various non-destructive and destructive weld examination practices.
  a. Describe basic visual inspection methods including measuring devices and liquid penetrants.
  
  (continued)
  b. Describe magnetic particle and electromagnetic inspection processes.
  c. Describe the radiographic and ultrasonic inspection processes.
  d. Describe destructive testing processes.

**Learning Objective 4**
- Describe the welder performance testing process.
  a. Describe the qualification of welders by position.
  b. Describe welder qualification testing to meet American Welding Society (AWS) and American Society of Mechanical Engineers (ASME) requirements.
  c. Describe the process for completing a weld test.

**Performance Task**

**Performance Task 1**
(Learning Objectives 2 and 3)
- Perform a visual inspection (VT) on a fillet and/or groove weld and complete an inspection report.

**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; Welding Level One, Module 29101.*

**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**

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 welding environment. Although no welding tasks are associated with this module, trainees will likely be in the vicinity of welding operations and the related equipment. Any deficiencies in safety practices must be corrected to ensure future trainee safety.

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**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 Question and Trade Terms Quiz answer keys
- Examples and/or excerpts from various welding codes
- Undercut gauge
- Butt-weld reinforcement gauge
- Fillet-weld blade gauge set
- Liquid penetrant and appropriate developer
- Fillet and groove weld coupons to demonstrate the use of inspection tools

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

- Appropriate PPE:
  - Safety glasses
  - Work gloves
- Completed fillet weld coupons using ¼" (6 mm) plate; minimum of 6” (15.2 cm) long
- Completed joint-penetration groove weld coupons; minimum of 6” (15.2 cm) long
- Undercut gauges
- Butt weld reinforcement gauges
- Fillet weld blade gauge sets
- Copies of the Visual Test Inspection Report (found in the Appendix of the Trainee Guide)

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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 weld quality and inspection. A search for additional information may be assigned as homework to interested trainees. The additional resources listed in the Trainee Guide and in this lesson plan identify excellent resources for further learning.

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 weld inspection. These can be located by using the search term “weld inspection” and using the video tab on the results page of your preferred search engine.
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 presents basic codes, standards, and specifications. It covers Sections 1.0.0 through 2.4.0 of the module. The various types of weld discontinuities are discussed.

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. Describe the welding codes and their related organizations.

4. Present basic provisions of welding codes.

5. Define discontinuities.

6. Describe how to identify porosity and inclusions.

7. Describe how to identify cracking or conditions that can lead to cracking.

8. Describe discontinuities related to joint penetration, fusion, and undercutting.

9. Show the difference between acceptable and unacceptable weld profiles.

**SESSION TWO**

Session Two describes various non-destructive and destructive weld testing procedures, along with welder qualification testing. This session covers Sections 3.0.0 through 4.3.4 of the module.

1. Show the Session Two PowerPoint® presentation.

2. Use the Kickoff Activity to review the information covered in the previous session.

3. Demonstrate how to use tools to do a visual inspection.

4. Describe magnetic particle and electromagnetic inspections.

5. Describe radiographic and ultrasonic inspections.

6. Discuss destructive testing processes.

7. Describe welding qualification by position.

8. Describe the process for completing a welder qualification test.
**SESSION THREE**

Session Three is a laboratory session devoted to the completion of Performance Task 1 and practice in using weld measurement gauges.

1. Note that no PowerPoint® presentation is associated with this laboratory session.

2. Demonstrate to the trainees how the discontinuities can be found within the sample weld using the appropriate test instruments.

3. Have the trainees practice using weld measurement gauges.

4. Demonstrate how to fill out the Visual Test Inspection Report.

5. Trainees practice and/or complete the specific tasks required by Performance Task 1.

**SESSION FOUR**

Session Four is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. Alternatively, these may be assigned as homework at the end of Session Three. Go over the Module Review questions 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 29106, Weld Quality

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Equipment and Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal protective equipment:</td>
<td>Examples and/or excerpts from various welding codes</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Butt-weld reinforcement gauge</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Liquid penetrant and appropriate developer</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Completed fillet weld coupons using ¼” (6 mm) plate; minimum of 6” (15.2 cm) long</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Undercut gauges</td>
</tr>
<tr>
<td>Pencils and paper</td>
<td>Fillet weld blade gauge sets</td>
</tr>
<tr>
<td>Welding Level One PowerPoint® Presentation Slides</td>
<td></td>
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<tr>
<td>DVD player</td>
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<tr>
<td>Computer</td>
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<tr>
<td>Copies of the Module Examination and Performance Profile sheets</td>
<td></td>
</tr>
<tr>
<td>Module Review Question 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 Ten (29110) introduces the trainees to the techniques and procedures to perform proper joint fit-up and inspection. Trainees will become familiar with using codes, specifications, special tools, and measuring devices to ensure quality during welding.

Objectives

Learning Objective 1
• Identify and describe various types of fit-up and alignment tools.
  a. Identify and describe various fit-up gauges and measuring devices.
  b. Identify and describe common weldment positioning equipment.
  c. Identify and describe various plate alignment tools.
  d. Identify and describe various pipe and flange alignment tools.

Learning Objective 2
• Describe techniques to avoid weldment distortion and describe the role of codes and specifications.
  a. Describe the causes of weldment distortion.
  b. Describe the techniques and tools used to control weldment distortion.
  c. Describe the role of codes and specifications in welding procedures and techniques.

Performance Tasks

Performance Task 1
(Learning Objectives 1 and 2)
• Fit up joints using plate and pipe fit-up tools.

Performance Task 2
(Learning Objectives 1 and 2)
• Check the joint for proper fit-up and alignment using gauges and measuring devices.

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; 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 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**
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 welding environment. Although no welding tasks are associated with this module, the trainees will likely be in the vicinity of welding operations and the related equipment. Any deficiencies in safety practices must be corrected to ensure future trainee safety.

**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
- Examples and/or excerpts from various welding codes

**Equipment and Materials for Laboratories and Performance Testing**
- Appropriate PPE:
  - Safety glasses
  - Face shields (with proper tint if oxyfuel cutting will be performed)
  - 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
- Angle grinders
- Bench grinders
- Grinding wheels
- Plate and pipe cutting equipment (saws or oxyfuel cutting equipment)
- Plate alignment tools
- Combination square
- Pipefitter’s square
- Levels
- Straight edges
- Files
- Hi-Lo gauge
- Pipe pullers
- Wedges
- Small-diameter pipe clamping devices
- Chain clamps, cage clamps, rim clamps, and/or other pipe and fitting clamping devices
- Flange alignment tools
- Carbon steel plate and pipe of various sizes

**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 joint fit-up and alignment tools. 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 the correct conduct and techniques.

There are also numerous videos available on the internet related to joint fit-up. These can be located by using various relevant search terms, and then 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 PowerPoint® presentations throughout the program.
Session Outline for 29110  
**JOINT FIT-UP AND ALIGNMENT**

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

---

**SESSION ONE**

Session One introduces the trainees to the identification of various fit-up alignment tools, measuring devices, positioning equipment, and techniques to reduce weldment distortion. Trainees will also learn the role of codes, standards, and specifications. This session covers Sections 1.0.0 through 2.3.3.

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. Describe fit-up gauges.
4. Describe common weldment positioning equipment.
5. Describe various plate, pipe, and flange alignment tools.
6. Present techniques and tools to control weldment distortion.
7. Describe the role of codes and specifications.
8. Present welding techniques and procedures.

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**SESSION TWO**

Session Two is a laboratory session devoted to the completion of Performance Tasks 1 and 2.

1. Note that no PowerPoint® presentation is associated with this laboratory session.
2. Demonstrate to the trainees how to fit-up joints using plate and pipe fit-up tools.
3. Demonstrate how to check for proper joint fit-up and alignment using gauges and measuring devices.
4. Trainees practice and complete Performance Tasks 1 and 2.

---

**SESSION THREE**

Session Three 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 the previous session. 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>Equipment and Materials</th>
<th>Examples and/or excerpts from various welding codes</th>
<th>Angle grinders</th>
</tr>
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<tbody>
<tr>
<td>Safety glasses</td>
<td>Bench grinders</td>
<td>Grinding wheels</td>
</tr>
<tr>
<td>Face shields (with proper tint if oxyfuel cutting will be performed)</td>
<td>Plate and pipe cutting equipment (saws or oxyfuel cutting equipment)</td>
<td>Plate alignment tools</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Combination square</td>
<td>Pipefitter’s square</td>
</tr>
<tr>
<td>Proper footwear</td>
<td>Combination square</td>
<td>Pipefitter’s square</td>
</tr>
<tr>
<td>Hearing protection</td>
<td>Combination square</td>
<td>Pipefitter’s square</td>
</tr>
<tr>
<td>Hard hat</td>
<td>Pipe pullers</td>
<td>Wedges</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Small-diameter pipe clamping devices</td>
<td>Chain clamps, cage clamps, rim clamps, and/or other pipe and fitting clamping devices</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Flange alignment tools</td>
<td>Carbon steel plate and pipe of various sizes</td>
</tr>
<tr>
<td>Pencils and paper</td>
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<tr>
<td>DVD player</td>
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<td>Computer</td>
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<tr>
<td>Copies of the Module Examination and Performance Profile sheets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module Review and Trade Terms Quiz answer keys</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 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.
  - a. Describe the structure and placement of welding symbols and identify basic symbols.
  - b. Identify and interpret size and dimension markings for common types of welds.
  - c. Identify and interpret various supplemental symbols.
  - d. 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.nccerinc.com](http://www.nccerinc.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.

**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

**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.

<table>
<thead>
<tr>
<th>SESSION ONE</th>
<th>SESSION TWO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session One introduces welding symbols, their basic structure, identification, and interpretation. This session covers Sections 1.0.0 through 1.4.7.</td>
<td>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.</td>
</tr>
<tr>
<td>1. Show the Session One PowerPoint® presentation.</td>
<td>1. Note that no PowerPoint® presentation is associated with this session.</td>
</tr>
<tr>
<td>2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.</td>
<td>2. Trainees practice and complete the requirements of Performance Task 1.</td>
</tr>
<tr>
<td>3. Introduce the welding symbol structure and how to identify these basic symbols.</td>
<td>3. Proctor the module exam.</td>
</tr>
<tr>
<td>4. Describe how to identify and interpret dimensional markings.</td>
<td>4. Record the testing results on the Registration of Training Modules form, and submit the report to your Training Program Sponsor.</td>
</tr>
<tr>
<td>5. Describe how to identify and interpret supplemental symbols.</td>
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<tr>
<td>6. Present less common symbols and explain how to interpret them.</td>
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</tr>
</tbody>
</table>
# Materials Checklist for Module 29201, Welding Symbols

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td>Suitable drawing(s) containing a variety of weld symbols for trainees to identify or interpret</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</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>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 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](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 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.

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

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.
“Shape Memory Alloy Demonstration”, Independent Video by David & Toby, last accessed March 10, 2015.
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 Outline for 29203

**PHYSICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF METALS**

The Lesson Plan for this module is divided into three 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 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**

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**

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

| Personal protective equipment: | Examples of the current AISI, ASTM International, and /or UNS specifications | Examples of different types of metals for examination, including ferrous and nonferrous |
| None | Samples of SDS/MSDS for one or more metal-cleaning chemical | Samples of reinforcement bars with grade marks |

Whiteboard/chalkboard  
Markers/chalk  
Pencils and paper  
Welding Level Two PowerPoint® Presentation  
LCD projector and screen  
Computer with Internet access  
Copies of the Module Examination  
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 Four (29204) 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.
**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
- At least one of the following:
  - Temperature-indicating crayons
  - Pyrometer
  - Thermocouple device(s)
  - Temperature-sensitive tape or labels

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**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.

**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 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.
# Materials Checklist for Module 29204, Preheating and Postheating of Metals

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
</tr>
<tr>
<td>Appropriate flame-retardant clothing</td>
</tr>
<tr>
<td>Safety glasses and face shields, tinted as required</td>
</tr>
<tr>
<td>Welding or cutting gloves</td>
</tr>
<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
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<tr>
<td>Hearing protection as designated by the instructor or training facility provider</td>
</tr>
<tr>
<td>Hard hat or welding helmet as designated by the instructor or training facility provider</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
</tr>
<tr>
<td>Markers/chalk</td>
</tr>
<tr>
<td>Pencils and paper</td>
</tr>
<tr>
<td><em>Welding Level Two PowerPoint® Presentation</em></td>
</tr>
<tr>
<td>DVD player</td>
</tr>
<tr>
<td>Computer with Internet access</td>
</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
</tr>
<tr>
<td>LCD projector and screen</td>
</tr>
<tr>
<td>Module Review answer key</td>
</tr>
<tr>
<td>Sample weld defects from improper preheating or postheating treatment</td>
</tr>
<tr>
<td>Temperature-indicating crayons</td>
</tr>
<tr>
<td>Gas preheating torch</td>
</tr>
<tr>
<td>Open-top or open flat-top preheater</td>
</tr>
<tr>
<td>Resistance heating elements</td>
</tr>
<tr>
<td>Induction heaters</td>
</tr>
</tbody>
</table>

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

At least one of the following:
- Temperature-indicating crayons
- Pyrometer
- Thermocouple device(s)
- Temperature-sensitive tape or labels

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/FCAW 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. 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 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.

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

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 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.
Session One

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.

1. Open the Session One presentation.
2. Use the Kickoff Activity to generate discussion about GMAW/FCAW and determine what trainees may already know about the topic.
3. Review the safety practices related to GMAW/FCAW.
4. Identify and describe the basic GMAW/FCAW processes.
5. Identify the various GMAW/FCAW metal transfer modes.
6. Identify common GMAW/FCAW equipment.
7. Describe power source control, welding cables, and termination considerations.

Session Two

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.

1. Open the Session Two presentation.
2. Use the Kickoff Activity as a peer instruction opportunity related to the setup and operation of wire feeders.
3. Review GMAW/FCAW external wire feeders, controls, guns, contact tips, and nozzles.
4. Identify the various shielding gases and related equipment.
5. Describe how to set up welding equipment for GMAW/FCAW welding.
6. Discuss the selection of GMAW/FCAW welding machines.
7. Identify various GMAW/FCAW filler metals.
SESSION THREE

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

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>
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</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td></td>
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</tr>
<tr>
<td>Appropriate flame-resistant clothing</td>
<td>GMAW and FCAW welding cable and torches</td>
<td>Common hand tools</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Wire feeders</td>
<td>Shielding gas cylinders with hoses, regulators, and flowmeters</td>
</tr>
<tr>
<td>Work gloves</td>
<td>GMAW- and FCAW-appropriate filler wire</td>
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<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
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<td>Module Review answer key</td>
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<tr>
<td>GMAW/FCAW-G guns</td>
<td></td>
<td></td>
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<tr>
<td>Shielding gas regulators and flowmeters</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 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](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
- 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

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.

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 videos 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 available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
Session Outline for 29207

GTAW – 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.

**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

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 29207, GTAW – Equipment and Filler Metals

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
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</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
</tr>
<tr>
<td>Safety glasses</td>
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<tr>
<td>Face shields</td>
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<td>Work gloves</td>
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<td>Proper footwear as designated by the instructor or training facility provider</td>
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<td>Hearing protection as designated by the instructor or training facility provider</td>
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<td>Hard hat as designated by the instructor or training facility provider</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
</tr>
<tr>
<td>Markers/chalk</td>
</tr>
<tr>
<td>Pencils and paper</td>
</tr>
<tr>
<td><em>Welding Level Two</em> PowerPoint® Presentation</td>
</tr>
<tr>
<td>DVD player</td>
</tr>
<tr>
<td>Computer with Internet access</td>
</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
</tr>
<tr>
<td>LCD projector and screen</td>
</tr>
<tr>
<td>Module Review answer key</td>
</tr>
<tr>
<td>Copies of the manufacturer’s documentation for the GTAW welding machines on hand</td>
</tr>
<tr>
<td>Complete GTAW torch assemblies</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 One (29401) presents gas metal arc welding (GMAW)—one of the more common welding processes now used. As with most welding systems, GMAW equipment is available in many different sizes and varieties. However, the basic operating principles of GMAW apply to all makes and models of equipment. This module describes how GMAW equipment is used to weld aluminum plate and examines different techniques used to produce fillet and V-groove plate welds in aluminum base metals.

### Objectives

#### Learning Objective 1
- Identify aluminum-welding metallurgical considerations and the types of weld problems commonly encountered.
  - Describe various aluminum alloys and their characteristics.
  - Identify key characteristics of aluminum welding using GMAW.
  - Describe the types of problems commonly encountered in aluminum welding.

#### Learning Objective 2
- Explain how to prepare for GMAW of aluminum plate and describe specific welding techniques.
  - Identify common welding safety practices.
  - Explain how to prepare the area and materials for GMAW practice.
  - Describe how to prepare GMAW equipment for aluminum welding.
  - Describe how to accomplish terminations and restarts and create basic GMAW weld beads.
  - Describe how to make aluminum fillet welds in various positions.
  - Describe how to make aluminum plate V-groove welds in various positions.

### Performance Tasks

#### Performance Task 1 (Learning Objective 2)
- Complete the following GMAW aluminum-plate welding tasks:
  - Stringer beads
  - Weave beads
  - Weld terminations
  - Weld restarts
  - Overlapping beads

#### Performance Task 2 (Learning Objective 2)
- Complete GMAW fillet welds on aluminum plate in the following positions:
  - 1F
  - 2F
  - 3F
  - 4F

#### Performance Task 3 (Learning Objective 2)
- Complete GMAW V-groove welds on aluminum plate with backing in the following positions:
  - 1G
  - 2G
  - 3G
  - 4G

### Teaching Time: 30 Hours
(Twelve 2.5-Hour Sessions)

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

### Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the accompanying 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; all Performance Tasks are graded pass or fail.
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 aluminum plate using the GMAW process. A search for additional information may be assigned as homework to interested trainees. Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques. Numerous videos related to the topic are available on the Internet. These can be located by searching “GMAW plate welding” or similar terms, and using the Video tab on the results page of your preferred search engine.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
Session Outline for Module 29401
GMAW – Aluminum Plate

The Lesson Plan for this module is divided into twelve 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 the characteristics of aluminum and aluminum alloys, as well as welding safety practices and the required preparations for GMAW plate welding. This session covers Sections 1.0.0 through 2.3.6.

1. Open the Session One presentation.
2. Use the Kickoff Activity to emphasize the importance of cleaning aluminum thoroughly.
3. Review the issues related to welding aluminum and aluminum alloys.
4. Review common welding safety practices, emphasizing any practices directly related to GMAW.
5. Describe how to prepare the welding area, welding coupons, and the welding equipment.
6. Use the Section Review questions to review the topics of this session.

**SESSION TWO**

Session Two reviews the techniques needed to produce GMAW fillet and V-groove welds on aluminum plate. This session covers Sections 2.4.0 through 2.6.4.

1. Open the Session Two presentation.
2. Use the Kickoff Activity to review the use of spool guns for GMAW.
3. Discuss terminations, restarts, and basic GMAW beads.
4. Discuss acceptable and unacceptable weld profiles.
5. Review the techniques and required positions for aluminum fillet welds.
6. Review the techniques and required positions for aluminum V-groove welds.
7. Use the Section Review questions to review the topics of this session.
8. Go over the Module Review to prepare trainees for the Module Exam.
9. Administer the Module Exam. Record the testing results on the Registration of Training Modules form and submit the form to your Training Program Sponsor.

**SESSIONS THREE THROUGH TWELVE**

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

1. Note that no slide presentation is associated with these laboratory sessions.
2. Demonstrate how to complete GMAW fillet and V-groove welds on aluminum plate.
3. Trainees practice and complete the requirements of Performance Tasks 1 through 3.
4. Document successful Performance Task completions for each trainee on the Performance Profile sheet and submit the results to the Training Program Sponsor.
### Materials Checklist for Module 29401, GMAW – Aluminum Plate

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Personal protective equipment:</th>
<th>Wire feeders or spool guns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Whiteboard/chalkboard</td>
<td>Sufficient supply of appropriate electrode wire</td>
</tr>
<tr>
<td>Appropriate flame-retardant clothing</td>
<td>Dry erase markers / chalk</td>
<td></td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Pencils and paper</td>
<td>Sufficient supply of shielding gas</td>
</tr>
<tr>
<td>Face shields</td>
<td>Poster board</td>
<td>Metal cutting equipment</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Flip chart</td>
<td>Angle grinders</td>
</tr>
<tr>
<td>Welding gloves</td>
<td>LCD projector and screen</td>
<td>Welding bench with arm suited for position work; alternatively, a welding positioner may be used</td>
</tr>
<tr>
<td>Welding hood with a lens of the appropriate shade</td>
<td>Computer with Internet access (optional)</td>
<td>Grinding wheels appropriate for aluminum</td>
</tr>
<tr>
<td>Proper footwear as designated by instructor or training facility provider</td>
<td>Copies of Module Examination and Module Examination answer key (for paper-based exams)</td>
<td>Wire brushes dedicated to aluminum</td>
</tr>
<tr>
<td>Hearing protection as directed by instructor or training facility provider</td>
<td>Welding Level Four PowerPoint® Presentation Slides</td>
<td>Squares</td>
</tr>
<tr>
<td>Hard hat as directed by instructor or training facility provider</td>
<td>Performance Profile Sheets</td>
<td>Tape measures or steel rules</td>
</tr>
<tr>
<td>Fire extinguisher</td>
<td>Welding machines capable of GMAW, complete with welding guns, cables, and shielding gas hoses</td>
<td>Sufficient supply of aluminum plate for practice, ¼” (6 mm metric plate) preferred; up to ½” (12 mm metric plate) thickness with the joint design described herein</td>
</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Lesson Plans for 29402

GTAW – Aluminum Plate

Module Three (29402) provides insight into welding aluminum using the GTAW process and an opportunity to hone the necessary skills. The GTAW process is unique since the welder must add the filler metal using the opposite hand. The process is well suited for welding aluminum, using the freehand or walking-the-cup technique and both stringer and weave beads.

Objectives

Learning Objective 1
- Explain how to prepare for GTAW aluminum welding and describe specific fillet and groove welding techniques.
  a. Describe common GTAW welding techniques.
  b. Identify common welding safety practices.
  c. Explain how to prepare the area and materials for aluminum GTAW practice.
  d. Explain how to prepare GTAW equipment for welding.
  e. Describe how to accomplish terminations and restarts and create basic GTAW weld beads.
  f. Describe how to make aluminum fillet welds in various positions.
  g. Describe how to make aluminum plate V-groove welds in various positions.

Performance Tasks

Performance Task 1 (Learning Objective 1)
- Weld a pad on aluminum plate in the flat position using GTAW stringer and weave beads.

Performance Task 2 (Learning Objective 1)
- Make multiple-pass GTAW fillet welds on aluminum plate in the following positions:
  - 1F
  - 2F
  - 3F
  - 4F

Performance Task 3 (Learning Objective 1)
- Make multiple-pass GTAW V-groove welds with backing on aluminum plate in the following positions:
  - 1G
  - 2G
  - 3G
  - 4G

Teaching Time: 30 Hours
(Twelve 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the accompanying 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; all Performance Tasks are graded pass or fail.
Additional Resources

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


The following websites offer resources for products and training:


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

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
Session Outline for 29402

GTAW – Aluminum Plate

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

**SESSION ONE**

Session One introduces trainees to welding safety practices and the required preparations for GTAW aluminum plate welding. This session covers Sections 1.0.0 through 1.5.4.

1. Open the Session One presentation.
2. Use the Kickoff Activity to determine trainees’ experience with GTAW and aluminum, and to review some basic GTAW concepts.
3. Review the basic concepts of GTAW aluminum plate welding.
4. Review common welding safety practices, emphasizing any practices directly related to GTAW.
5. Describe how to prepare the welding area, welding coupons, and the welding equipment.
6. Discuss how trainees will practice basic stringer and weave beads by building pads.
7. Use the Section Review questions to review the topics of this session.

**SESSION TWO**

Session Two reviews the techniques needed to produce GTAW fillet and V-groove with backing welds in aluminum plate. This session covers Sections 1.6.0 through 1.7.4.

1. Open the Session Two presentation.
2. Use the Kickoff Activity to review the use of helium to reduce the required welding current.
3. Review the primary fillet-weld positions.
4. Discuss acceptable and unacceptable fillet-weld profiles.
5. Review the techniques required for fillet welds on aluminum.
6. Review the primary V-groove weld positions.
7. Discuss acceptable and unacceptable V-groove weld profiles.
8. Review the techniques required for V-groove welds with backing on aluminum.
9. Use the Section Review questions to review the topics of this session.
10. Go over the Module Review to prepare trainees for the Module Exam.
11. Administer the Module Exam. Record the testing results on the Registration of Training Modules form and submit the form to your Training Program Sponsor.

**SESSIONS THREE THROUGH TWELVE**

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

1. Note that no slide presentation is associated with these laboratory sessions.
2. Demonstrate how to complete GTAW fillet and V-groove welds on aluminum plate coupons.
3. Trainees practice and complete the requirements of Performance Tasks 1 through 3.
4. Document successful Performance Task completions for each trainee on the Performance Profile sheet and submit the results to the Training Program Sponsor.
### Materials Checklist for Module 29402, GTAW – Aluminum Plate

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td>Welding Level Four PowerPoint® presentation slides</td>
</tr>
<tr>
<td></td>
<td>Sufficient supply of appropriate filler metal</td>
</tr>
<tr>
<td>Appropriate flame-retardant clothing</td>
<td>LCD projector and screen</td>
</tr>
<tr>
<td></td>
<td>Sufficient supply of appropriate tungsten electrodes</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Computer (Internet access optional)</td>
</tr>
<tr>
<td></td>
<td>Grinding wheels suitable for aluminum</td>
</tr>
<tr>
<td>Face shields</td>
<td>Module Review answer key</td>
</tr>
<tr>
<td></td>
<td>Metal cutting equipment</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Copies of the Module Examination and answer key (for paper-based exams)</td>
</tr>
<tr>
<td></td>
<td>Wire brushes dedicated to aluminum</td>
</tr>
<tr>
<td>Welding gloves</td>
<td>Performance Profile sheets</td>
</tr>
<tr>
<td></td>
<td>Tape measures or steel rules</td>
</tr>
<tr>
<td>Welding hood with lens of the appropriate shade</td>
<td>Welding machines capable of GTAW, complete with torches, cables, and shielding gas hoses</td>
</tr>
<tr>
<td></td>
<td>Welding bench with arm suited for position work; alternatively, a welding positioner may be used</td>
</tr>
<tr>
<td>Proper footwear as designated by instructor or training facility provider</td>
<td>Sufficient supply of appropriate tungsten electrodes</td>
</tr>
<tr>
<td></td>
<td>Sufficient supply of aluminum plate for practice, preferably ( \frac{1}{4}'' ) (6 mm metric plate) but no more than ( \frac{1}{2}'' ) thickness (12 mm metric plate)</td>
</tr>
<tr>
<td>Hearing protection as designated by instructor or training facility provider</td>
<td>Angle grinders</td>
</tr>
<tr>
<td></td>
<td>Files dedicated to aluminum</td>
</tr>
<tr>
<td>Hard hat as designated by instructor or training facility provider</td>
<td>Soapstone</td>
</tr>
<tr>
<td></td>
<td>Squares</td>
</tr>
<tr>
<td>Fire extinguisher</td>
<td>Common hand tools</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>Poster board</td>
<td></td>
</tr>
<tr>
<td>Flip chart</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.
Lesson Plans for 29403

GTAW – Aluminum Pipe

Module Four (29403-16) provides insight into welding aluminum pipe using the GTAW process and the modified U-groove joint, which does not require a metal backing or a backing gas. The GTAW process is unique since the welder must add the filler metal using the opposite hand. The process is well suited for welding aluminum, using the freehand or walking-the-cup technique. One thing welders must understand about welding aluminum is that a significant amount of welding current is required, especially when working with thick materials.

<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 (Learning Objective 1)</strong></td>
</tr>
<tr>
<td>• Explain how to prepare for GTAW aluminum pipe welding and describe specific pipe-welding techniques.</td>
<td>• Make GTAW modified U-groove welds on aluminum pipe in the following positions:</td>
</tr>
<tr>
<td>a. Describe common GTAW pipe-welding techniques.</td>
<td>– 2G</td>
</tr>
<tr>
<td>b. Identify common welding safety practices.</td>
<td>– 5G</td>
</tr>
<tr>
<td>c. Explain how to prepare the area and materials for aluminum GTAW practice.</td>
<td>– 6G</td>
</tr>
<tr>
<td>d. Explain how to prepare GTAW equipment for welding.</td>
<td></td>
</tr>
<tr>
<td>e. Describe techniques and positions related to aluminum pipe GTAW.</td>
<td></td>
</tr>
<tr>
<td>f. Describe how to make modified U-groove GTAW welds on aluminum pipe.</td>
<td></td>
</tr>
</tbody>
</table>

**Teaching Time: 50 Hours**

(Twenty 2.5-Hour Sessions)

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

**Before You Begin**

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the accompanying 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; all Performance Tasks are graded pass or fail.
Additional Resources

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


The following websites offer resources for products and training:

The Lincoln Electric Company, www.lincolnelectric.com

Miller Electric Manufacturing, www.millerwelds.com

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

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
The Lesson Plan for this module is divided into 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 welding safety practices and the required preparations for GTAW pipe welding. This session covers Sections 1.0.0 through 1.5.2.

1. Open the Session One presentation.
2. Use the Kickoff Activity to expose trainees to some of the unique applications and positions related to welding aluminum pipe and tube.
3. Review the basic concepts of GTAW aluminum pipe welding.
4. Review common welding safety practices, emphasizing any practices directly related to GTAW.
5. Describe how to prepare the welding area, welding coupons, and the welding equipment.
6. Review the positions related to pipe welding.
7. Use the Section Review questions to review the topics of this session.

**SESSION TWO**

Session Two reviews the techniques used to produce GTAW pipe welds on aluminum using the U-groove joint configuration. This session covers Sections 1.6.0 through 1.6.3.

1. Open the Session Two presentation.
2. Use the Kickoff Activity to expose trainees to the welding of cast aluminum materials.
3. Review the primary pipe-welding positions.
4. Review the techniques and steps required to complete welds in the 2G, 5G, and 6G position.
5. Use the Section Review questions to review the topics of this session.
6. Go over the Module Review to prepare trainees for the Module Exam.
7. Administer the Module Exam. Record the testing results on the Registration of Training Modules form and submit the form to your Training Program Sponsor.

**SESSIONS THREE THROUGH TWENTY**

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

1. Note that no slide presentation is associated with these laboratory sessions.
2. Demonstrate how to complete GTAW U-groove welds on aluminum pipe coupons.
3. Trainees practice and complete the requirements of Performance Task 1.
4. Document successful Performance Task completions for each trainee on the Performance Profile sheet and submit the results to the Training Program Sponsor.
# Materials Checklist for Module 29403, GTAW – Aluminum Pipe

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td></td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td></td>
</tr>
<tr>
<td>Computer (Internet access optional)</td>
<td></td>
</tr>
<tr>
<td>Sufficient supply of shielding gases</td>
<td></td>
</tr>
<tr>
<td><strong>Appropriate flame-retardant clothing</strong></td>
<td></td>
</tr>
<tr>
<td>Computer (Internet access optional)</td>
<td></td>
</tr>
<tr>
<td>Sufficient supply of appropriate filler metal</td>
<td></td>
</tr>
<tr>
<td><strong>Safety glasses</strong></td>
<td></td>
</tr>
<tr>
<td>Welding Level Four PowerPoint® presentation slides</td>
<td></td>
</tr>
<tr>
<td>Sufficient supply of appropriate tungsten electrodes</td>
<td></td>
</tr>
<tr>
<td><strong>Face shields</strong></td>
<td></td>
</tr>
<tr>
<td>Module Review answer key</td>
<td></td>
</tr>
<tr>
<td>Metal cutting equipment</td>
<td></td>
</tr>
<tr>
<td><strong>Work gloves</strong></td>
<td></td>
</tr>
<tr>
<td>Performance Profile sheets</td>
<td></td>
</tr>
<tr>
<td>Grinding wheels suitable for aluminum</td>
<td></td>
</tr>
<tr>
<td><strong>Welding gloves</strong></td>
<td></td>
</tr>
<tr>
<td>Copies of Module Examination and answer key (for paper-based exams)</td>
<td></td>
</tr>
<tr>
<td>Wire brushes dedicated to aluminum</td>
<td></td>
</tr>
<tr>
<td><strong>Welding hood with lens of the appropriate shade</strong></td>
<td></td>
</tr>
<tr>
<td>Welding machines capable of GTAW, complete with torches, cables, and shielding gas hoses</td>
<td>Welding bench with arm suited for position work; alternatively, a welding positioner may be used</td>
</tr>
<tr>
<td><strong>Proper footwear as designated by instructor or training facility provider</strong></td>
<td>Sufficient supply of aluminum pipe for practice, preferably SCH 40 3” to 12” (DN80 to DN300) pipe</td>
</tr>
<tr>
<td>Files dedicated to aluminum</td>
<td></td>
</tr>
<tr>
<td><strong>Hearing protection as designated by instructor or training facility provider</strong></td>
<td>Tape measures or steel rules</td>
</tr>
<tr>
<td><strong>Hard hat as designated by instructor or training facility provider</strong></td>
<td>Angle grinders</td>
</tr>
<tr>
<td><strong>Fire extinguisher</strong></td>
<td></td>
</tr>
<tr>
<td>Soapstone</td>
<td></td>
</tr>
<tr>
<td><strong>Whiteboard/chalkboard</strong></td>
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<td><strong>Markers/chalk</strong></td>
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<td><strong>Pencils and paper</strong></td>
<td></td>
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<tr>
<td><strong>Poster board</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Flip chart</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Computer</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Copies of the Module Examination</strong></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 (29405) presents soldering and brazing as the two thermal methods used for joining copper tubing and fittings. It describes the safety equipment, tools, and materials needed for soldering and brazing copper tubing for various applications. It also presents the preparations required and the processes involved in soldering and brazing copper tubing.

### Objectives

**Learning Objective 1**
- Describe how to properly prepare and solder copper tubing.
  a. Describe the proper use of the PPE, tools, and materials needed to solder copper tubing.
  b. Describe how to prepare materials for soldering.
  c. Describe how to solder copper tubing.

**Learning Objective 2**
- Describe how to properly prepare and braze copper tubing.
  a. Describe the proper use of the PPE, tools, and materials needed to braze copper tubing.
  b. Describe how to prepare the equipment and materials for brazing.
  c. Describe how to braze copper to copper as well as to dissimilar metals.

### Performance Tasks

**Performance Task 1** *(Learning Objective 1)*
- Properly set up and shut down air-acetylene equipment.

**Performance Task 2** *(Learning Objective 1)*
- Properly prepare and solder copper tubing in various planes, using various fittings.

**Performance Task 3** *(Learning Objective 2)*
- Properly set up and shut down oxyfuel equipment.

**Performance Task 4** *(Learning Objective 2)*
- Properly prepare and braze copper tubing in various planes, using various fittings.

### Teaching Time: 12.5 hours

*(Five 2.5-Hour Sessions)*

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

### Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the accompanying 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; all Performance Tasks are graded pass or fail.
Additional Resources

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

- Filler Metal Selection Chart (PDF). The Harris Products Group, Mason, Ohio. www.harrisproductsgroup.com.

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

Numerous videos related to the topic are available on the Internet. These can be located by searching “soldering” and “brazing”, and using the Video tab on the results page of your preferred search engine.

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