Industrial Welder
Level 2
Industrial Welder

Unit: C1 Metallurgy I

Level: Two

Duration: 20 hours
   Theory: 16 hours
   Practical: 4 hours

Overview:

This unit of instruction is designed to provide the Industrial Welder Apprentice with the knowledge and understanding of the SMAW process. Material covered includes:

- SMAW groove welds on gray cast iron
- Production and properties of metals
- Carbon and alloy steels
- Alloy steels filler metals
- Metal identification
- Distortion
- Hardfacing

Objectives and Content:

<table>
<thead>
<tr>
<th>Percent of</th>
<th>Unit Mark (%)</th>
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</thead>
<tbody>
<tr>
<td>1. Identify SMAW groove welds on gray cast iron</td>
<td>10%</td>
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<tr>
<td>a. Welding cast iron:</td>
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<tr>
<td>• Hot welding</td>
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<td>• Cold welding</td>
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<tr>
<td>b. Special problems in welding gray cast iron</td>
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<tr>
<td>• Rigid nature of gray cast iron</td>
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<tr>
<td>• Heating and cooling gray cast iron</td>
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<tr>
<td>c. Electrodes for welding gray cast iron</td>
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<tr>
<td>• SMAW Electrodes for cast iron repair</td>
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<tr>
<td>- ESt Group (Mild Steel Electrodes)</td>
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<td>- Lime-coated group (Low Hydrogen Deposit)</td>
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<td>- Ni Group (Nickel-based electrodes)</td>
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<td>- ECu Group (Copper-based electrodes)</td>
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<tr>
<td>• Choosing the right electrode</td>
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<tr>
<td>• Recommended welding procedures</td>
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<tr>
<td>d. Joint preparation for gray cast iron</td>
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<tr>
<td>• Preparing gray cast iron for cold welding</td>
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<tr>
<td>- Gouging</td>
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<tr>
<td>- Grinding</td>
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<td>- Chiseling</td>
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<tr>
<td>• Groove weld joint preparation</td>
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<tr>
<td>- Buttering</td>
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<tr>
<td>• Repairing gray cast iron with a steel patch</td>
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<tr>
<td>e. SMAW groove welds in the flat position (1G) on single vee butt joints on gray cast iron</td>
<td></td>
</tr>
</tbody>
</table>
2. Identify production and properties of metals 20%
   a. Production processes for iron and steel
      • Blast furnace
      • Basic oxygen steel-making (BOS)
      • Electric arc furnace (EAF)
   b. Types of iron and steel
      • Pig iron
      • Cast iron
         - Gray cast iron
         - White cast iron
         - Malleable cast iron
         - Ductile or nodular cast iron
      • Steel
         Cast steels
         • Classification of steels by deoxidization process
            - Rimmed steels
            - Semi-killed steels
            - Killed steels
   c. Mechanical properties of metals
      • Strength
         - Comprehensive strength
         - Shear strength
         - Tensile strength
         - Yield strength
         - Impact strength
      • Ductility
      • Brittleness
      • Hardness
      • Toughness
      • Elasticity
      • Malleability
   d. Physical properties of metals
      • Density
      • Corrosion resistance
      • Conductivity
         - Electrical conductivity
         - Thermal conductivity
      • Thermal expansion
      • Melting temperature

3. Identify carbon and alloy steel filler metals 10%
   a. Carbon content and the uses for low carbon steel, medium carbon steel and high carbon steel
      • Low carbon steel
      • Medium carbon steel
      • High carbon steel and very high carbon steel
   b. Classification system for steel
      • Canadian Standards Association (CSA) system
      • Society of Automotive Engineers (SAE) – American Iron and Steel Institute (AISI) system
      • American Society for Testing and Materials (ASTM) system
      • (American Society of Mechanical Engineers (ASME) system
   c. Effect of carbon content on the weldability of steel
      • Carbon content and its effect on steel
      • Welding low carbon steels
      • Welding medium carbon steels
      • Welding high carbon steels
      • Welding very high carbon steels
   d. Effects of elements on the properties of carbon steel
   e. Major alloying elements in alloy steels
      • Elements found in alloy steels
   f. Types, properties and weldability of low alloy steels
• Properties of low alloy steels
  - Nickel steels
  - Chromium steels
  - Nickel-chromium steels
  - Molybdenum steels

  g. Properties and weldability of high strength, low alloy steels (HSLA)
  h. Alloy steel filler material classifications in the accordance with AWS and CSA specifications
    • Low alloy steel welding filler metals
      • AWS and CSA specifications
        - Low alloy steel SMAW electrodes
        - Low alloy steel filler metals for GMAW, PAW and GTAW
        - Low alloy steel electrodes for flux cored arc welding

  i. Commonly used low alloy steel filler metals and their applications
    • Characteristics and applications for commonly used low allow steel filler metals
      - Low alloy steel SMAW electrodes
      - Low alloy steel GMAW and GTAW electrodes and welding rods
      - Low alloy steel FCAW electrodes
      - Low alloy steel MCAW electrodes

4. Describe metal identification 30%
   a. Identification of metals by visual appearance, colour, relative weight, typical shape and texture
      • Definition of metal
      • Ferrous and non-ferrous metals
      • Identification by visual appearance and colour
      • Examining the fractured surface of a metal
      • Identification of relative weight
      • Identification by typical shape
      • Identification by texture
   b. Chip testing, spark testing, file hardness tests and flame tests
   c. Information supplied on mill test reports
      • Interpretation of information supplied on mill test reports
      • Metal specification tags

5. Identify distortion 10%
   a. Identification of how heat and temperature relates to distortion
      • Heat and temperature
      • Expansion and contraction of metals
      • Three types of expansion
      • Free and restrained expansion and contraction
   b. Three types of distortion, their causes and control of each type:
      • Angular distortion
      • Transverse distortion
      • Longitudinal
   c. Mechanical, procedural and design methods of controlling distortion:
      • Mechanical methods of controlling distortion:
        - Pre-setting or pre-bending
        - Rigid clamping and fixturing
        - Jigs and skeleton frames
        - Strongbacks
        - Chill strips
        - Backing strips
        - Sub-assemblies
      • Procedural methods of controlling distortion:
        - Avoid the use of too many passes
        - Weld at an even and fast rate of travel
        - Prepare joint edges accurately
        - Preheat the work
        - Weld around the natural axis
        - Use adequate tacks
      • Stagger, skip and back step welding
• Welding sequence
• Using specialized equipment to minimize distortion
• Design methods of controlling distortion
  - Use the minimum number of pieces
  - Use welds in the flat position
  - Use a rounded corner instead of a square corner when possible
    o Avoid welding across carrying members
    o Avoid accumulation of weld intersections

6. Identify hardfacing 10%
   a. Hardfacing process and its applications
      • Process of hardfacing
      • Purpose of hardfacing
      • Applications of hardfacing
   b. Types of wear
      • Abrasion
      • Impact
      • Erosion
      • Metal to metal
      • Corrosion
      • Oxidation
      • Compression
      • Thermal shock
   c. Filler metals for hardfacing
      • Interpreting AWS hardfacing filler metal classifications
      • Classifications of hardfacing filler metals
   d. Problems associated with hardfacing, how to avoid them and remedies
      • Dilution
      • Spalling
      • Stress failure
      • Underbead cracking
      • Distortion
   e. Procedures for applying hardfacing materials
      • Procedural considerations
        - Surface preparations
        - Buildup
        - Preheating
        - Cooling rate
      • Procedures
        - Shielded Metal Arc Surfacing (SMAW)
        - Gas Tungsten Arc Surfacing (GTAW)
        - Gas Metal Arc Surfacing (GMAW)
        - Flux Cored Arc Surfacing (FCAW)
        - Plasma Transferred Arc Surfacing (PAW)
        - Oxyfuel Gas Surfacing (OAW)
        - Thermal spray surfacing
        - MCAW

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Industrial Welder

Unit: C2 SMAW Welds on Mild Steel

Level: Two

Duration: 120 hours
  Theory: 20 hours
  Practical: 100 hours

Overview:

This unit of instruction is designed to provide the Industrial Welder Apprentice with the knowledge and understanding of the SMAW process.

Objectives and Content:

<table>
<thead>
<tr>
<th>Objective</th>
<th>Percent of Unit Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identify SMAW welds on mild steel processes</td>
<td>20%</td>
</tr>
<tr>
<td>2. Demonstrate the ability to weld lap joints in the 3F position uphand on 10 mm (3/8&quot;) mild steel using E41010 or E41011 and E48018 filler metals</td>
<td>15%</td>
</tr>
<tr>
<td>3. Demonstrate the ability to weld lap joints in the 3F position downhand on 6 mm (¼&quot;) mild steel using E41010 or E41011 or E48010-G filler materials</td>
<td>15%</td>
</tr>
<tr>
<td>4. Demonstrate the ability to weld lap joints in the 4F position of 10 mm (3/8&quot;) mild steel using E41010 or E41011 and E48018 filler materials</td>
<td>10%</td>
</tr>
<tr>
<td>5. Demonstrate the ability to weld groove welds in the 2G position on 10 mm (3/8&quot;) mild steel using E41010 or E41011 root and E48018 fill and cap</td>
<td>10%</td>
</tr>
<tr>
<td>6. Demonstrate the ability to weld groove welds in the 2G position on mild steel single bevel plate with a backing plate using E48018 filler materials</td>
<td>10%</td>
</tr>
<tr>
<td>7. Demonstrate the ability to weld groove welds in the 3G position uphand on 10 mm (3/8&quot;) mild steel using E41010 or E41011 root and E48018 fill and cap</td>
<td>10%</td>
</tr>
<tr>
<td>8. Demonstrate the ability to weld groove welds in the 3GF position on 10 mm (3/8&quot;) mild steel with a backing plate using E48018 filler materials.</td>
<td>10%</td>
</tr>
</tbody>
</table>

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Industrial Welder

Unit: D1 Gas Tungsten Arc Welding (GTAW) Process

Level: Two
Duration: 20 hours
  Theory: 20 hours
  Practical: 0 hours

Overview:
This unit of instruction is designed to provide the Industrial Welder Apprentice with the knowledge and understanding of the GTAW process. Material covered includes:

- GTAW process
- GTAW electrodes, filler metals and shielding gases
- GTAW equipment maintenance and troubleshooting
- GTAW welds on stainless steel

Objectives and Content:

<table>
<thead>
<tr>
<th>Percent of</th>
<th>Unit Mark (%)</th>
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</thead>
<tbody>
<tr>
<td>1. Describe the GTAW process and applications</td>
<td>30%</td>
</tr>
<tr>
<td>a. GTAW process and applications</td>
<td></td>
</tr>
<tr>
<td>- Gas tungsten arc welding process</td>
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<tr>
<td>- GTAW applications</td>
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<tr>
<td>- GTAW process variations</td>
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<tr>
<td>- Spot welding</td>
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<tr>
<td>- Hot wire GTAW</td>
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<tr>
<td>- Cold wire GTAW</td>
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<tr>
<td>- High amperage GTAW</td>
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<tr>
<td>b. Advantages and disadvantages of the GTAW process</td>
<td></td>
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<tr>
<td>c. Hazards and protective measures associated with GTAW</td>
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<tr>
<td>- Safety considerations with GTAW:</td>
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<tr>
<td>- Electric shock hazards</td>
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<tr>
<td>- Eye, face and hearing protection</td>
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<tr>
<td>- Protective clothing</td>
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<td>- Fire prevention</td>
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<td>- Ventilation</td>
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<tr>
<td>d. Basic components of a GTAW workstation</td>
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<tr>
<td>- Basic equipment required for the GTAW process consists of the following items:</td>
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<td>- Welding power source</td>
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<td>- Welding torch assembly</td>
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<td>- Work lead</td>
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<td>- Non-consumable tungsten electrode</td>
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<td>- Shielding gas and related gas control equipment and</td>
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<td>- Filler metal (if required)</td>
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<td>- Optional accessories</td>
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<tr>
<td>- Pulsed GTAW</td>
<td></td>
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<tr>
<td>- Pulsed GTAW advantages</td>
<td></td>
</tr>
</tbody>
</table>
e. Types of GTAW power sources
   • Remote control units

f. Welding currents used in GTAW:
   • Alternating (AC) current
   • Direct current (DC) current
   • Arc starting and arc stability
   • High frequency current
   • High voltage injection
   • AC square wave output
   • AC unbalanced and balanced wave control
   • Welding current selection

g. Torch assembly
   • GTAW torches:
     - Air-cooled torches
     - Water-cooled torches
     - Torch current-carrying capacity
     - Torch head design
   • Torch components
     - Air-cooled torch components
     - Water-cooled torch components
     - Torches cap
     - Torches body
     - Collet body and electrode collet
     - Gas nozzles
     - Gas lenses

h. Gas regulation and flowmeters
   • Regulators
   • Flowmeters
   • Regulator/flowmeter
   • Selecting a regulator/flowmeter
   • Hoses
   • Solenoid valves
   • Compressed gas cylinders
     - Cylinder valves
     - Storage and handling of cylinders
   • Shielding gas flow rates
   • Liquid containers
   • Gas mixes

2. Identify GTAW electrodes, filler metals and shielding gases 30%
   a. Function of the electrode in GTAW
   b. Electrodes by AWS designations and their applications
      • GTAW electrodes
      • GTAW electrode identification
        - Number code system
        - Colour code system
      • Selecting GTAW electrodes
      • Description and intended use of electrodes
      • Finish
      • Typical current ranges
   c. Care and preparation of electrodes
      • Preparation of electrodes
        - Tapered ends
      • Balled end
      • Methods of preparing GTAW electrodes
        - Chemical sharpening
        - Grinding
        - Electric arc method
      • Electrode conditioning and use
        - Reconditioning a contaminated electrode
Factors that influence electrode end conditions
   - Using welding to determine electrode type

d. Functions of the filler metals in GTAW
   - GTAW filler metals
     - Available packaging
   - Selecting a GTAW filler metal

e. Filler metals by AWS and CSA designations and their applications
   - Classification of mild steel filler metals for GTAW
   - Examples of GTAW filler metals
     - Carbon steel – AWS
     - Carbon steel – CSA
     - Stainless steel – AWS
     - Aluminum alloys – AWS
     - Copper and copper alloys AWS

f. Types and purpose of consumable inserts
   - Consumable inserts
   - Consumable insert joint preparation
   - Welding with consumable inserts

g. Care and handling of GTAW filler metals
   - Care and handling of GTAW filler metals
     - Storage and handling

h. Types and applications of shielding gases used in GTAW
   - Definition of terms related to shielding gases:
     - Compressed gas
     - Cyrogenic liquid
     - Density
     - Dewar
     - Inert
     - Liquefied
     - Compressed gas
     - Specific gravity
   - Shielding gases
     - Argon
     - Helium
     - Nitrogen
     - Argon helium
     - Argon-hydrogen
   - Shielding gas flow rates
     - Leading and trailing gases

i. Advantages and disadvantages of various shielding gases

3. Identify GTAW equipment maintenance and troubleshooting 30%
   a. Power source output
      - GTAW power source output problems
      - Setting up and operating with GTAW equipment
        - Locating and hooking up the welding power source
        - Torch assembly
        - Work lead
        - Selecting the current type
        - Setting the current
        - High frequency current problems
        - Shutdown
      - Maintenance of equipment
      - Tool and cable assembly
        - Torch handle and head
        - Air-cooled GTAW torches
        - Water-cooled GTAW torches
        - Gas control valves
        - Cable covers
        - Nozzles
- Collet and collet body
- Gas lens
- Electrode condition

b. Care and handling of GTAW equipment components
- Care and handling of GTAW equipment
  - Regulator/flowmeter unit
  - Hoses
  - Remote control switches and current controls
  - Cooling systems
  - Flow-through cooling systems

c. Shielding and gas coverage problems and identify corrective measures
- Problems associated with shielding gas coverage
  - Inadequate gas flow
  - Excessive gas flow
  - Incorrect gas selection
- Troubleshooting summary
  - Process problems

4. Identify GTAW welds on stainless steel

a. Filler metals used on stainless steel
- Selecting filler metals for GTAW on stainless steel
- Stainless steel
- Identifying stainless steel
- Welding stainless steel
- GTAW filler metals for stainless steel
- Choosing GTAW stainless steel filler metal

b. Welding procedure and welding current for GTAW on stainless steel gauge
- Procedures for welding stainless steel
  - Requirements for preheat and post-weld heat treatments
  - Preventing carbide precipitation
  - Effects of thermal expansion and thermal conductivity
- Selecting the current for GTAW on stainless steel

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Industrial Welder

Unit: D2 GTAW Welds on Mild Steel and Stainless Steel

Level: Two
Duration: 30 hours
Theory: 0 hours
Practical: 30 hours

Overview:
This unit of instruction is designed to provide the Industrial Welder Apprentice with the knowledge and understanding of the process of Gas Tungsten Arch Welding GTAW welds on mild steel. A wide range of material types are welded in all positions with the GTAW process. Gas tungsten arc welding of fillet weld is commonly specified for many applications.

Objectives and Content:

1. Demonstrate the GTAW process, skills and techniques. 50%
2. Demonstrate the GTAW welds on mild steel and stainless steel (ss). 50%
Industrial Welder

Unit: D3 GTAW and GMAW Welds on Aluminum

Level: Two
Duration: 30 hours
  Theory: 15 hours
  Practical: 15 hours

Overview:

This unit of instruction is designed to provide the Industrial Welder Apprentice with the knowledge and understanding of aluminum welding. Material covered includes:
  - Aluminum
  - GTAW welds on aluminum
  - GMAW welds on aluminum

Objectives and Content:

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<thead>
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<th>Percent of Unit Mark (%)</th>
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<tbody>
<tr>
<td>10%</td>
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</table>

1. Describe aluminum welding.
   a. Physical and chemical properties of aluminum
      - Aluminum and its alloys
      - Definition of terms
      - Physical properties of aluminum
      - Chemical properties of aluminum
   b. Consideration of physical and chemical properties for welding aluminum
      - Effect of refractory oxide
      - Thermal conductivity
      - Coefficient of linear expansion
      - Melting points
      - Heating effects of welding
      - Effect of hydrogen
   c. Wrought aluminum alloys
      - Aluminum wrought alloy four-digit numerical designation system
   d. Aluminum Association numerical designation for casting alloys
      - Cast aluminum alloys
        - Die casting
        - Permanent mould castings
        - Sand castings
      - Centrifugal casting
        - Aluminum cast alloy four-digit numerical designation system
   e. Effects of welding on heat-treatable and on-heat treatable alloys:
      - Aluminum alloys
      - Heat-treatable and non-heat-treatable aluminum alloys
      - Heat-treatable wrought alloys
        - Processes used for heat treating aluminum
        - Temper designations
      - Non-heat-treatable alloys
   f. Preferred welding processes for joining aluminum and its alloys
- Welding aluminum and aluminum alloys
- Oxyacetylene welding
- Shielded metal arc welding
- Gas tungsten arc welding
  - GTAW electrodes
  - GTAW shielding gases
- Gas metal arc welding
  - GMAW welding equipment
  - Stud Welding (SW)
  - Resistance welding
- Codes and standards for welding aluminum

  g. Filler metals most commonly used for welding aluminum with GTAW and GMAW
  - Aluminum filler metals for GTAW and GMAW
  - Selecting filler metals for welding aluminum
  - Distinguishing between ER4043 and ER5356
  - Storing aluminum spooled filler wire

2. Identify GTAW welds on aluminum. 20%
   a. Using GTAW on aluminum
      - Stringer beads
      - Fillet welds in the 1F position on aluminum gauge plate
      - Fillet welds in the 2F position on aluminum gauge plate
      - Fillet welds in the 3F position on aluminum gauge plate

3. Identify GMAW welds on aluminum. 20%
   a. Welding safety: Safe work practices module
   b. GMAW on aluminum
   c. GMAW on aluminum troubleshooting guide

4. Perform GMAW welds on aluminum. 50%

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Industrial Welder

Unit: D4 GMAW, SMAW, FCAW and MCAW Welds On Mild Steel Pipe

Level: Two
Duration: 20 hours
   Theory: 20 hours
   Practical: 0 hours

Overview:
This unit of instruction is designed to provide the Industrial Welder Apprentice with the knowledge and understanding of GMAW, MCAW and FCAW welds on mild steel pipe. Additional information on SMAW welds on mild steel is provided. Material covered includes: GMAW, SMAW, FCAW and MCAW welds on mild steel pipe.

Objectives and Content:

5. Identify GMAW, FCAW and SMAW welds on mild steel pipe 100%

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Industrial Welder

Unit: E2 Layout

Level: Two

Duration: 24 hours

Theory: 8 hours

Practical: 16 hours

Overview:

This unit of instruction is designed to provide the Industrial Welder Apprentice with the knowledge and understanding of layout practice. Material covered includes:

- Basic fabrication layout
- Plate layout
- Pipe layout

Objectives and Content:

1. **Identify basic fabrication layout practice**
   
   a. Various symbols and abbreviations used in material mark-up
   
   b. Plate layout tools
      
      - Measuring tools
      - Marking tools
      - Special application tools
   
   c. Purpose for various types of markers
      
      - Markers and marking tools
      - Stamps
   
   d. Mark-up procedures for flame cutting, drilling, punching, rolling, (forming), breaking, shearing and match marking
      
      - Flame cutting mark-ups
      - Material mark-up for small objects
      - Material mark-up for shearing and breaking operations
      - Material mark-up for alignment or match marking
   
   e. Use of templates
      
      - Layout templates
      - Checking templates
      - Guiding templates
   
   f. Types of materials required on templates
      
      - Template identification information

2. **Perform basic fabrication layout practice**

3. **Identify basic plate layout**
   
   a. Making and checking for square corners
   
   b. 3-4-5 method
   
   c. Diagonal method
   
   d. Using material efficiently when laying out
      
      - Nesting

Percent of Unit Mark (%)

10%

10%
• Using templates
  e. Layout for flanges
  f. Marking out an elliptical opening in plate
     - Trammel point method
     - Parallel line method
  g. Using orthographic projection to develop patterns for a cone and hopper
     - Cone section
     - Layout for a cone or circular hopper
     - Development of a rectangular or square hopper
  h. Angle of cut and lengths for cover plates
  i. Marking plate according to calculated dimensions

4. Perform basic plate layout 35%

5. Identify basic pipe layout 10%
  a. Pipe sizes and schedules
     - Pipe and its uses
     - Pipe size
     - Pipe wall thickness
  b. Pipe layout tools
     - Strip of paper
     - Angle iron as a straight edge
     - Wraparound
     - Contour marker
     - Templates
     - Centrehead
     - Centrefinder
  c. Develop patterns for various pipe fabrications
     - Developing templates for pipe fabrication
       - Making a template
       - Using the template
     - Template development for two-piece elbows
     - Template development for multiple piece elbows
     - Template development for tee joints
     - Template development for laterals
  d. Angle of cut, measureback and length of pieces for various pipe turns
     - Template identification information
     - Angle of cut, measureback and length of pieces
       - Angle of cut
       - Measureback
     - Length of end and centre pieces
     - Layout of a three-piece 60° turn
  e. Pipe mark out and fabrication

6. Perform basic pipe layout 35%

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Industrial Welder

Unit: E3 Welding Symbols

Level: Two

Duration: 16 hours
Theory: 16 hours
Practical: 0 hours

Overview:
This unit of instruction is designed to provide the Industrial Welder Apprentice with the knowledge and understanding of the purpose of welding symbols.

Objectives and Content:

<table>
<thead>
<tr>
<th>Objectives and Content</th>
<th>Percent of Unit Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identify the purpose of welding symbols</td>
<td>20%</td>
</tr>
<tr>
<td>2. Identify weld symbol, welding symbol and supplementary symbols</td>
<td>40%</td>
</tr>
<tr>
<td>a. Basic weld symbol</td>
<td></td>
</tr>
<tr>
<td>b. Supplementary weld symbols</td>
<td></td>
</tr>
<tr>
<td>c. Welding symbol</td>
<td></td>
</tr>
<tr>
<td>3. Identify construction of weld and welding symbols</td>
<td>20%</td>
</tr>
<tr>
<td>a. Basic rules</td>
<td></td>
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<tr>
<td>• Reference line</td>
<td></td>
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<tr>
<td>• Arrow line</td>
<td></td>
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<tr>
<td>b. Arrow side, other side and both sides orientation of weld symbols</td>
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</tr>
<tr>
<td>• Arrow side</td>
<td></td>
</tr>
<tr>
<td>• Other side</td>
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<tr>
<td>• Both sides</td>
<td></td>
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<tr>
<td>c. Broken Arrow line</td>
<td></td>
</tr>
<tr>
<td>d. The surfacing weld symbol</td>
<td></td>
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<tr>
<td>e. The fillet weld symbol</td>
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<tr>
<td>f. The plug or slot weld symbol</td>
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<tr>
<td>g. Basic groove weld symbols</td>
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<tr>
<td>• The vee groove weld symbol</td>
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<tr>
<td>• The bevel groove weld symbol</td>
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<td>• The U groove weld symbol</td>
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<tr>
<td>• The J groove weld symbol</td>
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<tr>
<td>h. Supplementary weld symbols</td>
<td></td>
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<tr>
<td>• Weld all around symbol</td>
<td></td>
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<tr>
<td>• Field weld symbol</td>
<td></td>
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<tr>
<td>• Back or backing weld symbol</td>
<td></td>
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<tr>
<td>• Welding symbols for joints with backing or spacers</td>
<td></td>
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<tr>
<td>• Melt through symbol</td>
<td></td>
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<tr>
<td>• Contour and finishing symbols</td>
<td></td>
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<tr>
<td>• The tail</td>
<td></td>
</tr>
<tr>
<td>i. Designation of common welding and cutting processes by letters</td>
<td></td>
</tr>
<tr>
<td>j. Combined weld symbols</td>
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</tr>
</tbody>
</table>

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k. Multiple reference lines and their applications

4. Identify the dimensioning of weld symbols 10%
   a. Basic rules for dimensioning weld symbols
   b. Surfacing weld dimensioning
   c. Plug weld and slot weld dimensioning
      • Plug welds
      • Slot welds
   d. Fillet weld dimensioning
      • Dimensions
      • Size of fillet welds
      • Length of fillet welds
   e. Dimensioning of intermittent fillet welding
      • Length
      • Pitch
      • Chain intermittent welding
      • Staggered intermittent welding
   f. Indicating welds across solid members
   g. Dimensioning of groove welds
      • Effective throat and weld size
      • Root opening and bevel angle
      • Dimensions
      • Groove dimensions
      • Dimensions for double-groove welds
      • Dimensioning of combination welding symbols

5. Identify non-destructive testing symbols 10%
   a. Non-destructive testing symbols (NDE)
   b. Elements and the location of the examination symbol
   c. Significance of arrow side, other side and both sides
   d. Direction of radiation symbol
   e. Combined welding and NDE symbols
   f. Dimensioning of NDE symbols

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