Please Note:

Apprenticeship Training and Curriculum Standards were developed by the Ministry of Training, Colleges and Universities (MTCU). As of April 8th, 2013, the Ontario College of Trades (College) has become responsible for the development and maintenance of these standards. The College is carrying over existing standards without any changes.

However, because the Apprenticeship Training and Curriculum Standards documents were developed under either the Trades Qualification and Apprenticeship Act (TQAA) or the Apprenticeship and Certification Act, 1998 (ACA), the definitions contained in these documents may no longer be accurate and may not be reflective of the Ontario College of Trades and Apprenticeship Act, 2009 (OCTAA) as the new trades legislation in the province. The College will update these definitions in the future.

Meanwhile, please refer to the College’s website (www.collegeoftrades.ca) for the most accurate and up-to-date information about the College. For information on OCTAA and its regulations, please visit: www.collegeoftrades.ca/about/legislation-and-regulations.
# TABLE OF CONTENTS

## PAGE

Introduction ................................................................................................ II

Program Summary .................................................................................... VII

Program Summary by Level .................................................................. VIII, IX

Evaluation and Testing .......................................................................... X, XI

Level III

<table>
<thead>
<tr>
<th>Table of Contents</th>
<th>XII</th>
</tr>
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<tbody>
<tr>
<td>Reportable Subjects</td>
<td>1</td>
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<tr>
<td>Curriculum</td>
<td>2 – 40</td>
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<tr>
<td>Reference Material</td>
<td>41</td>
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INTRODUCTION

This new Curriculum Standard for the Welder Trade was designed by the Welder Curriculum Development Committee to meet the General Performance Objectives and Performance Objectives in the Industry-approved Welder Apprenticeship Training Standard. The Welder Project Steering Committee validated this project.

This Curriculum Standard is organized into three levels of in-school-training, each including reportable subjects containing like or similar learning outcomes to reflect the units of the Training Standard. The hours chart indicates how the Curriculum can be delivered in a block-release format and summarizes the hours of training for each reportable subject by level. Since all reportable subjects are divisible by three they can be adapted to accommodate a more flexible training delivery.

Reportable subjects are cross-referenced to the Training Standard for ease of comparison.

Additional learning outcomes, fundamental for learning this trade, have been added to those found in the Training Standard. Safety has been stressed throughout to provide the apprentices the ability to work safely and to assist employers in maintaining accident-free workplaces.

Each reportable subject and learning outcome identifies a recommended number of training hours, broken into hours for theory training and hours for practical applications. The division of the Curriculum into reportable subjects that follow a natural progression of learning throughout the three levels will allow training providers and apprentices flexibility in program delivery while still observing the importance of sequencing learning in a logical progression.

The Curriculum Standard focuses on the in-school training of apprentices to acquire the theoretical knowledge required to master the performance objectives of the Training Standard. Employers are expected to expand the apprentice’s knowledge and skills through appropriate training at the workplace.

Regular evaluations and testing of the apprentice’s knowledge and skills are to be conducted throughout training to assure that all apprentices have achieved the learning outcomes identified in the Curriculum Standard.
### ONTARIO WELDER APPRENTICESHIP PROGRAM

Suggested minimum equipment list for Training Delivery Agencies.

<table>
<thead>
<tr>
<th>POWER SOURCES AND EQUIPMENT</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMAW (CC) (AC/DC) power source and equipment</td>
<td>1 per apprentice</td>
</tr>
<tr>
<td>GMAW / FCAW / MCAW (CV) power source and equipment (Capable of Spray-transfer)</td>
<td>1 per apprentice</td>
</tr>
<tr>
<td>GMAW-PULSED power source and equipment</td>
<td>1 per 5 apprentices</td>
</tr>
<tr>
<td>GTAW (CC), AC/DC, High Frequency, Square wave, Pulsed power source and equipment, Water-cooled torch, Foot controller</td>
<td>1 per 5 apprentices</td>
</tr>
<tr>
<td>Plasma Arc Cutting power source and equipment</td>
<td>1 per 5 apprentices</td>
</tr>
<tr>
<td>Air-Carbon-Arc-Gouging power source and equipment</td>
<td>1 per 5 apprentices</td>
</tr>
<tr>
<td>Oxy-Fuel-Gas Manual Cutting equipment</td>
<td>1 per apprentice</td>
</tr>
<tr>
<td>Oxy-Fuel-Gas Semi-Automatic Cutting equipment</td>
<td>1 per 5 apprentices</td>
</tr>
<tr>
<td>Oxy-Fuel-Gas-Heating Torch and equipment</td>
<td>1 per 5 apprentices</td>
</tr>
<tr>
<td>Approved Electrode Storage Oven</td>
<td>1 per shop</td>
</tr>
<tr>
<td>Compressed Air Supply (80-100 PSI)</td>
<td>1 per shop</td>
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</table>

### OPTIONAL POWER SOURCES AND EQUIPMENT

<table>
<thead>
<tr>
<th>Power Source and Equipment</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>Plasma Arc Welding power source and equipment</td>
<td>1 per shop</td>
</tr>
<tr>
<td>Sub-Arc Welding power source and equipment</td>
<td>1 per shop</td>
</tr>
<tr>
<td>Stud welding power source and equipment</td>
<td>1 per shop</td>
</tr>
</tbody>
</table>
FABRICATION MACHINES (1 each per shop)

- Plate Shear
- Brake Press
- Roll Bending Machine
- Band Saw Nibbler
- Ironworker
- Pedestal grinders
- Cut-off abrasive wheel saw
- Weld-bevel preparation equipment for plate and pipe
- Weld-coupon bending apparatus
- Approved smoke extraction/air make-up unit

Welding and Fabricating shops must be well lit, appropriately heated and ventilated

BASIC HAND TOOLS AND EQUIPMENT (1 per apprentice)

- Adjustable wrenches (various sizes)
- Allen wrenches (metric and imperial)
- Bench vice
- “C” clamps (various sizes)
- Chalk-line
- Cold chisels (various sizes)
- Electric extension cords
- Files (flat, half-round, rat-tail, bastard)
- Friction lighter
- Grinding and sanding disks (for carbon steel, aluminum and stainless steel)
- Hacksaw
- Hammers (chipping, ball peen, claw, sledge, various sizes)
- Hand shears
- Layout table
- Magnets
- Metal markers
- Pipe clamps
- Pipe cutter
- Pipe wrenches
- Pliers (needle nose, slip joint)
- Positioners
- Pry bars
- Punches
- Screwdrivers (flat, Phillips, Robertson, various sizes)
- Scribers
- Snips (heavy duty sheet metal cutting)
- Soapstone markers
- Socket sets (metric and imperial)
- Temperature indicating crayons
- Tip cleaners
- Toolboxes
- Tungsten sharpening grinders
- Vice grips (various sizes and types)
- Wire brushes (for carbon steel, aluminum and stainless steel)
- Wire cutters
- Work bench
- Wrench sets (open and closed ends, both metric and imperial)

MEASURING TOOLS (1 per apprentice)

- Drafting equipment
- Fillet gauges
- Vernier caliper
- Micrometer
- Scriber
- Combination square
- Spirit level
- Square
- Straight edge
- Tape measure

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POWER TOOLS AND EQUIPMENT (1 per 5 apprentices)

- Electric drills [9mm (3/8”) to 12.5mm (1/2”) chuck size]
- Grinders, electric and/or pneumatic (wire brush, angle grinders)
- Sanders
- Wire wheel (angle grinder with wire brush)

HOISTING AND LIFTING EQUIPMENT (1 per shop)

- Rope
- Slings
- Chains
- Chokers
- Come-along (cable or chain)
- Forklift
- Overhead hoist or crane

SAFETY EQUIPMENT (1 per apprentice)

- Earplugs and muffs
- Face shields
- Fire blankets
- Fire extinguishers
- Goggles
- Leather aprons
- Leather gloves
- Leather jackets
- Masks (particle, vapor)
- Respirators
- Safety glasses

RESOURCE MATERIALS

- Codebooks
- Engineering specifications
- Manufacturers’ specifications, manuals and charts
- Safety manuals
PERSONAL AND SAFETY EQUIPMENT

Personal protective equipment is at the discretion of the training delivery agent who must conform to Ontario Provincial Health and Safety Regulations.

Welder apprentices may supply their own work clothing, boots, coveralls and prescription (safety) glasses.

Items such as hard hats, eye and hearing protection, and all other tools and equipment are frequently the responsibility of the employer.

Resource materials, charts, regulations, specifications, service bulletins, manufacturers’ manuals, and logbooks are supplied by the employer or equipment owner.
## PROGRAM SUMMARY

(In-school training hours)

<table>
<thead>
<tr>
<th>Level</th>
<th>Theory hours</th>
<th>Practical hours</th>
<th>Total hours</th>
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<tbody>
<tr>
<td>Level I</td>
<td>138</td>
<td>162</td>
<td>300</td>
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<tr>
<td>Level II</td>
<td>53</td>
<td>127</td>
<td>180</td>
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<tr>
<td>Level III</td>
<td>126</td>
<td>114</td>
<td>240</td>
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<td><strong>TOTAL HOURS</strong></td>
<td><strong>324</strong></td>
<td><strong>396</strong></td>
<td><strong>720</strong></td>
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# PROGRAM SUMMARY BY LEVEL

## LEVEL I:

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<tr>
<th>Reportable Subjects</th>
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<th>Theory</th>
<th>Practical</th>
<th>Prerequisite:</th>
<th>Co-requ.</th>
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<tbody>
<tr>
<td>1. Trade Practices</td>
<td>33</td>
<td>28</td>
<td>5</td>
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<td>None</td>
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<tr>
<td>2. Applied Blueprint Reading</td>
<td>60</td>
<td>39</td>
<td>12</td>
<td>None</td>
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<tr>
<td>3. Welding Theory I</td>
<td>30</td>
<td>39</td>
<td>0</td>
<td>Unit 1</td>
<td>Unit 4, 5, 6</td>
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<td>4. Material and Process Quality I</td>
<td>27</td>
<td>27</td>
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<td>Unit 1, 3</td>
<td>Unit 5, 6</td>
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<td>5. Shielded Metal Arc Welding (SMAW) Practical I</td>
<td>69</td>
<td>3</td>
<td>66</td>
<td>Unit 1, 3</td>
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<td>6. Gas Shielded Semi-Automatic Welding Practical I</td>
<td>54</td>
<td>2</td>
<td>52</td>
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<td>Unit 4, 5</td>
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<td>7. Thermal Cutting</td>
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<td>9</td>
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**LEVEL III:**

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<td>3. Gas Tungsten Arc Welding (GTAW)</td>
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EVALUATION AND TESTING

LEVEL I:

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<td>Material &amp; Process Quality I</td>
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<td>10%</td>
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<tr>
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<tr>
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LEVEL II:

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<th>Notebook and Organizational Skills</th>
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<td>Unit 5</td>
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<td>90%</td>
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EVALUATION AND TESTING (continued)

LEVEL III:

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<th>Topic</th>
<th>Theory Testing</th>
<th>Practical Application Exercises</th>
<th>Research Project</th>
<th>Notebook and Organizational Skills</th>
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</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>Fitting</td>
<td>50%</td>
<td>30%</td>
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<tr>
<td>Unit 2</td>
<td>Quality</td>
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<td>20%</td>
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<td>Unit 3</td>
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<td>30%</td>
<td>10%</td>
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<tr>
<td></td>
<td>Practical II</td>
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<td></td>
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<td></td>
<td>Plasma Arc Welding (PAW)</td>
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</tr>
<tr>
<td>Unit 4</td>
<td>Automatic and Semi-Automatic Processes</td>
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<td>50%</td>
<td>10%</td>
<td>10%</td>
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<tr>
<td>Unit 5</td>
<td>Shielded Metal Arc Welding (SMAW)</td>
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<td>90%</td>
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</tr>
<tr>
<td></td>
<td>Practical III</td>
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</tbody>
</table>

Implementation:

January 2003
# Table of Contents

Summary of Total Program In-School Training Hours ........................................................... 1

1. Fitting .................................................................................................................................. 2
   1.1 Layout and Pattern Development................................................................. 3
   1.2 Fabrication Equipment................................................................. 5
   1.3 Practical Fitting Projects ................................................................. 7

2 Quality10
   2.1 Metallurgy II ......................................................................................... 10
   2.2 Distortion II ......................................................................................... 13
   2.3 Inspection and Codes.................................................................. 14

3 Gas Tungsten Arc Welding (GTAW) II / Plasma Arc Welding (PAW) ................. 17
   3.1 Gas Tungsten Arc Welding (GTAW) Theory II .................................... 18
   3.2 Fillet and Groove Welds with the Gas Tungsten Arc Welding (GTAW) Process .............................................................................. 20
   3.3 Pipe Welding with the Gas Tungsten Arc Welding (GTAW) Process ................................................................................... 22
   3.4 Fillets and Groove Welds on Aluminum with the Gas Tungsten Arc Welding (GTAW) Process .................................................... 24
   3.5 Plasma Arc Welding (PAW) .................................................................... 26

4 Automatic and Semi-Automatic Processes ........................................................................ 27
   4.1 Gas Metal Arc Welding (GMAW) III (Pulsed) ..................................... 28
   4.2 Fillets and Groove Welds with the Gas Metal Arc Welding – Pulsed (GMAW-P) Process ................................................................. 29
   4.3 Metal Cored Arc Welding (MCAW) .................................................... 30
   4.4 Submerged Arc Welding (SAW) ......................................................... 31
   4.5 Stud Welding....................................................................................... 34

5 Shielded Metal Arc Welding (SMAW) Practical III ...................................................... 35
   5.1 Groove Welds on Plate with the Shielded Metal Arc Welding (SMAW) Process ................................................................. 36
   5.2 Groove Welds on Pipe with the Shielded Metal Arc Welding (SMAW) Process ................................................................. 38
   5.3 Fillets and Groove Welds with Stainless Steel Electrodes Using the Shielded Metal Arc Welding (SMAW) Process .................. 40

Reference Material .................................................................................................................. 41
## Welder – Level III

### Summary Of Total Program In-School Training Hours

<table>
<thead>
<tr>
<th>Reportable Subjects</th>
<th>Total</th>
<th>Theory</th>
<th>Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fitting</td>
<td>87</td>
<td>54</td>
<td>33</td>
</tr>
<tr>
<td>2. Quality</td>
<td>39</td>
<td>33</td>
<td>6</td>
</tr>
<tr>
<td>3. Gas Tungsten Arc Welding (GTAW) Practical II/Plasma Arc Welding (PAW)</td>
<td>42</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>4. Automatic and Semi-Automatic Processes</td>
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<td>12</td>
<td>15</td>
</tr>
<tr>
<td>5. Shielded Metal Arc Welding (SMAW) Practical III</td>
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<td>3</td>
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<tr>
<td><strong>Total</strong></td>
<td>240</td>
<td>126</td>
<td>114</td>
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1.1 – Layout and Pattern Development

39 Total Hours  Theory: 39 hour  Practical: 0 hours

1.2 – Fabrication Equipment

9 Total Hours  Theory: 9 hours  Practical: 0 hours

1.3 – Practical Fitting Projects

39 Total Hours  Theory: 6 hours  Practical: 33 hours
1.1 – Layout and Pattern Development

Cross-Reference to Learning Outcomes:

6004.01; 6005.01; 6006.06

**Duration:** 39 Total Hours  Theory: 39 hour  Practical: 0 hours

**General Learning Outcome:**

Demonstrate a working knowledge of fundamental layout and pattern making techniques.

**Learning Outcomes:**

Upon successful completion, the apprentice is able to:

**Learning Content:**

1.1.1 Identify the purpose and fundamentals of layout development. [1/0]

- classes of geometric forms
- manual layout development
- computer based pattern development

1.1.2 Describe the methods of pattern development. [1/0]

- radial line
- parallel line
- triangulation
1.1.3 Perform pattern developing for shapes.

- layout method for flat surfaces
  - flat surfaces
  - bend allowance
    - hoppers, chutes
  - flat, angled (sloping) surfaces
    - hoppers, chutes, pyramidal shapes
    - truncated pyramidal shapes
- layout method for conical surfaces with a common apex
  - concentric cones
  - offset cones
  - truncated cones
- layout method for cylindrical surfaces
  - straight, round, rolled shells and tanks
  - circular ducting
  - circular piping
  - circular elbows
  - circular branches
  - piping intersections
- layout method for odd shaped surfaces
  - square / rectangle to round
  - round to round
  - elliptical to round
  - elliptical to elliptical
  - concentric and offset shapes
1.2 – Fabrication Equipment

Cross-Reference to Learning Outcomes:
6000.02, .03; 6004.07, .08

Duration: 9 Total Hours    Theory: 9 hours    Practical: 0 hours

General Learning Outcome:
Demonstrate a working knowledge of the use and maintenance of fabricating equipment.

Learning Outcomes:
Upon successful completion, the apprentice is able to:

Learning Content:

1.2.1 Define common fabrication equipment and their maintenance. [4/0]

- plate shears
- roll bending machines
- brake press
- drill presses
- band saws
- nibblers
- ironworkers
1.2.2 Describe the applications of common fabrication equipment.

- plate shears
  - capacity
  - rake angle
  - blade clearance
  - back gauge
- roll bending machines
  - capacity
  - metal thickness
  - rolling radii limits
- brake press
  - capacity
  - die sets
  - bending limits
- drill presses
- band saws
- nibblers
- ironworkers
  - punching
  - notching
  - cutting
1.3 – Practical Fitting Projects

Cross-Reference to Learning Outcomes:

6004.01, .02, .06, .09; 6005.02, .04; 6006.05; 6015.03

Duration: 39 Total Hours Theory: 6 hours Practical: 33 hours

General Learning Outcome:

Demonstrate a working knowledge of practical fitting techniques.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

1.3.1 Describe equipment set-up and use of common fabrication equipment.

[6/0]

- plate shears
- roll bending machines
- brake press
- drill presses
- band saws
- nibblers
- iron workers
1.3.2 Perform assigned practical fitting projects.

[0/33]

- plan and prepare worksite
- structural steel projects
  - channel or angle or beam
- cope and fit
  - 45° cope
    - layout
    - cut
    - fit parts
    - tack parts
  - 90° cope
    - layout
    - cut
    - fit parts
    - tack parts
- pipe projects
  - use wrap from layout and pattern development
  - form lateral branch
  - tee connection
    - layout
    - cut
    - fit parts
    - tack parts
- box construction project
  - layout parts
  - bend
  - fit box
  - tack parts

**Evaluation:**

The following evaluation structure is only a suggested format. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.

- **Theory Testing** 50%
- **Practical Application Exercises** 30%
- **Research Project** 10%
- **Notebook and Organizational Skills** 10%
Welder – Level III

Number: 2

Title: Quality

Duration: 39 Total Hours

Theory: 33 hours Practical: 6 hours

Prerequisites: Level II, Unit 3

Co-requisites: None

2.1 – Metallurgy II

15 Total Hours Theory: 15 hours Practical: 0 hours

2.2 – Distortion II

12 Total Hours Theory: 6 hours Practical: 6 hours

2.3 – Inspection and Codes

12 Total Hours Theory: 12 hours Practical: 0 hours
Welder – Level III

2.1 – Metallurgy II

Cross-Reference to Learning Outcomes:

6016.01; 6015.01

Duration: 15 Total Hours Theory: 15 hours Practical: 0 hours

General Learning Outcome:

Demonstrate a working knowledge of the principles of weldability and microstructures of metals.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

2.1.1 Explain the significance of different microstructures of common metals.

- interpretation of features and data from an iron – iron carbide equilibrium diagram
- definition of solidus and liquidus
- crystalline structures
- phase transformation
- carbon steel microstructures
  - ferrite
  - pearlite
  - martensite
  - austenite
- stainless steels
  - austenitic
  - martensitic
  - ferritic
  - duplex
  - precipitation hardening
- aluminum
- designation system
- mechanisms of strengthening
- basic heat treatment
2.1.2 Identify factors influencing the weldability of metals.

- carbon and low alloy steels
  - factors influencing weld cracking susceptibility
    - chemistry
    - thickness
    - joint geometry
    - restraint
  - carbon equivalent formulae
  - considerations for steel with limited weldability
    - filler metal selection
    - preheat
    - interpass
    - post heating
    - pass sequence
    - temperature indicating crayons
    - electro/mechanical temperature indicators
  - post weld heat treatment
- stainless steels
  - austenitic
  - martensitic
  - ferritic
  - duplex
  - precipitation hardening
    - thickness
  - joint geometry
  - restraint
  - corrosion
- aluminum and aluminum alloys
  - chemistry
  - thickness and thickness differences
  - preheating
  - shielding gas compositions
  - joint geometry
  - dissimilar alloys
  - filler metal selection
  - restraint
  - corrosion
  - cleaning and oxide thickness
- cast iron and non-ferrous metals
  - concepts of welding cast iron
  - concepts of welding copper and copper alloys
  - concepts of welding nickel alloys, inconel, monel, hastalloy
  - concepts of welding titanium and titanium alloys
- significance of microstructure
- factors influencing weldability
- high strength, low alloy steels (HSLA)
- thermo-mechanical controlled processing (TMCP)
2.2 – Distortion II

Cross-Reference to Learning Outcomes:

6016.01, .03; 6015.03; 6004.10; 6005.01, .03, .05

Duration: 12 Total Hours Theory: 6 hours Practical: 6 hours

General Learning Outcome:

Demonstrate a working knowledge of fundamentals and correction of weld distortion.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

2.2.1 Define the fundamentals of distortion control.
   [6/0]
   - selection of preventative method
   - distortion allowances
   - preheating
   - back step
   - weld progression
     - vertical up vs. vertical down
   - continuous vs. intermittent welding
   - pre-setting joints
   - jigs and fixtures
   - effects of travel speed
   - effects of weld size
   - effects of bead size
   - effects of over welding
   - multiple pass v. single pass

2.2.2 Perform correction of weld distortion.
   [0/6]
   - selection of corrective method(s)
   - heat wedges
   - heat spots
   - back welding
   - mechanical straightening
2.3 – Inspection and Codes

Cross-Reference to Learning Outcomes:

6016.01; 6015.01

Duration: 12 Total Hours  Theory: 12 hours  Practical: 0 hours

General Learning Outcome:

Demonstrate a working knowledge of destructive inspection and testing methods. Demonstrate a working knowledge of welding performance and welding procedure qualification testing methods. Demonstrate a working knowledge of the common welding codes and standards.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

2.3.1 Explain destructive inspection and testing methods.

   [4/0]

   - hardness testing
     - Rockwell method
     - Brinell method
     - Vickers method
   - metallography
   - weld joint cross-sections
   - polishing
   - etching
   - analysing
   - macro-examination
   - micro-examination
   - hydrostatic testing
   - leak testing
   - vacuum testing
   - fracture testing
   - chemical analysis
2.3.2 Explain the requirements for welding performance qualification testing. [4/0]

- assessment of welding personnel
- format of tests
  - welding of test plates
  - witnessed by inspector
  - visual inspection of test plates
  - bend testing
  - radiographic testing
  - issuing of certification document
  - range of process variables qualified
  - need for re-qualification
  - duration of certification
  - reasons for loss of certification

2.3.3 Explain the requirements for welding procedure qualification testing. [1/0]

- Procedure Qualification Record (PQR)
- Welding Procedure Specification (WPS)
- assessment of welding procedure
  - essential variables
  - mechanical properties
  - qualification test
  - welding of plate vs. pipe
  - required tests
  - development of associated welding procedures

2.3.4 Identify production-welding requirements based on welding procedure documents. [1/0]

- need for access to welding procedures by production personnel
- purpose of welding procedure documents
- content of welding procedure documents
- material preparation and fit-up
- consumables selection
- recommended pass sequence
- electrical parameters
- technique parameters
2.3.5 Describe the requirements of welding codes and standards.
[2/0]

- pressure welding applications to the ASME Boiler and Pressure Vessel Code
- base and filler metal requirements to Sect II
- product design and manufacture requirements to Sect III or VIII
- welding procedure and performance qualification requirements to Section IX
- structural welding applications to the CSA Structural Welding Standards
- filler metal requirements to CSA W48
- company and personnel requirements to CSA W47.1
- product design and manufacture requirements to CSA W59
- material test reports
- other codes and standards

Evaluation:

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<td>Research Project</td>
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<tr>
<td>Notebook and Organizational Skills</td>
<td>10%</td>
</tr>
</tbody>
</table>
Welder – Level III

| Number: | 3 |
| Title: | Gas Tungsten Arc Welding (GTAW) II / Plasma Arc Welding (PAW) |
| Duration: | 42 Total Hours |
| Theory: | 24 hours |
| Practical: | 18 hours |
| Prerequisites: | Level II, Unit 6 |
| Co-requisites: | None |

3.1 – Gas Tungsten Arc Welding (GTAW) Theory II
9 Total Hours | Theory: 9 hours | Practical: 0 hours

3.2 – Fillet and Groove Welds with the Gas Tungsten Arc Welding (GTAW) Process
12 Total Hours | Theory: 6 hours | Practical: 6 hours

3.3 – Pipe Welding with the Gas Tungsten Arc Welding (GTAW) Process
9 Total Hours | Theory: 3 hours | Practical: 6 hours

3.4 – Fillets and Groove Welds on Aluminum with the Gas Tungsten Arc Welding (GTAW) Process
9 Total Hours | Theory: 3 hours | Practical: 6 hours

3.5 – Plasma Arc Welding (PAW)
3 Total Hours | Theory: 3 hours | Practical: 0 hours
3.1 – Gas Tungsten Arc Welding (GTAW) Theory II

Cross-Reference to Learning Outcomes:

6002.01, .02; 6009.01, .02

Duration: 9 Total Hours Theory: 9 hours Practical: 0 hours

General Learning Outcome:

Demonstrate a working knowledge of weldability issues, accessories and shielding gas requirements for the Gas Tungsten Arc Welding (GTAW) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

3.1.1 Describe the functions of Gas Tungsten Arc Welding (GTAW) power sources and their controls.
[2.5/0]
- power sources
- inverter technology
- types of currents
- polarity settings
- controls
- high frequency
- square wave controls
- AC amperage frequency control
- AC balance
- Pulse controls
- Up and down slope

3.1.2 Explain weldability issues with the Gas Tungsten Arc Welding (GTAW) process.
[2.5/0]
- oxide removal
- heat dissipation
- copper based alloys
  - brasses
  - bronzes
3.1.3 Explain shielding gas requirements for the Gas Tungsten Arc Welding (GTAW) process.

- specialty gases
  - blended gases
  - equipment
- flow rates
  - influencing factors
  - tables
  - units and conversions
- purging
  - requirements
  - gases used
  - methods
  - equipment

3.1.4 Describe the functions of Gas Tungsten Arc Welding (GTAW) accessories.

- torches
  - types
  - amperage capacities
  - size
  - flexible and rigid style
  - needle head
  - air cooled and liquid cooled
- remote controls
  - foot controls
  - torch mounted controls
- backing materials
  - consumables inserts
  - ceramic tape
  - flux paste
  - purging equipment
  - caps
  - dams
  - valves
Welder – Level III

3.2 – Fillets and Groove Welds in the Gas Tungsten Arc (GTAW) Process

Cross-Reference to Learning Outcomes:

6009.01, .02, .03, .04, .05, .06, .07

Duration: 9 Total Hours Theory: 9 hours Practical: 0 hours

General Learning Outcome:

Demonstrate a working knowledge of fillet and groove welding with the Gas Tungsten Arc Welding (GTAW) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

3.2.1 Describe equipment set-up and the process of Gas Tungsten Arc Welding (GTAW).

[3/0]

- power source
- equipment
- electrodes
- consumables
- shielding gas
- safety
- personal protection
- material
- technique
- type of welds
3.2.2 Set-up equipment for a variety of Gas Tungsten Arc Welding (GTAW) applications.
[3/0]
- material preparation and fit-up
  - pre-weld cleaning methods
  - position of welding
- equipment setup
  - current type and polarity
  - amperage
  - arc initiation method
- torch setup
  - collect and body
  - nozzle type and size
  - tungsten electrode type and size
- shielding gas
  - type
  - flow rate (imperial and metric)
  - purging
- filler material
  - type (alloy)
  - size

3.2.3 Perform fillet and groove welds on mild steel plate with the Gas Tungsten Arc Welding (GTAW) process.
[0/6]
- set-up
  - welding parameters
  - equipment set-up
  - filler material
  - material surfaces
- fillet welds
  - 3F position
  - 4F position
- groove welds
  - 3G position (progression up)
  - 4G position
- post weld operations
  - clean and prepare welds to specification
  - visually inspect finished welds
3.3 – Pipe Welding With the Gas Tungsten Arc Welding (GTAW) Process

Cross-Reference to Learning Outcomes:

6009.01, .02, .03, .04, .05, .06, .07

Duration: 9 Total Hours Theory: 9 hours Practical: 0 hours

General Learning Outcome:

Demonstrate a working knowledge of pipe welding with the Gas Tungsten Arc Welding (GTAW) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

3.3.1 Explain the process of preparation for welding pipe using the Gas Tungsten Arc Welding (GTAW) process.

[3/0]

- joint geometry
  - edge preparations
  - bevelling methods
    - flame cut
    - mechanical
    - machining
  - electric grinder / nibbler
  - hydraulic beveller
  - pneumatic grinder
  - bevel and included angle
  - root gap
  - root face (landing)
- positions
  - 1G (rotated)
  - 2G
  - 5G
  - 6G
- fitup
  - pipe alignment
  - fittings
- clamps
- jigs
- spacers
- pipe to pipe and pipe to fittings
- tooling
- turntables
- rollers
- manual and mechanical positioners

3.3.2 Weld mild steel pipe using the Gas Tungsten Arc Welding (GTAW) process.

- preparation
- edge preparation
- pre-weld conditioning
  - chamfering
  - filing
  - grinding
- joint alignment
  - spacers
  - jigs
  - clamps
  - pipe vices
  - pipe to pipe and pipe to fittings
- welding pipe
  - set-up
    - welding parameters
    - equipment set-up
    - filler material
    - material surfaces
- pipe sizes
  - large diameter
  - small diameter
- sequence
  - Gas Tungsten Arc Welding (GTAW) root
  - fill and cap with Shielded Metal Arc Welding (SMAW) (E4918)
- positions
  - 2G
  - 5G
  - 6G
- post weld operations
  - clean and prepare welds to specification
  - visually inspect finished welds
3.4 – Fillets and Groove Welds on Aluminum with the Gas Tungsten Arc Welding (GTAW) Process

Cross-Reference to Learning Outcomes:

6009.01, .02, .03, .04, .05, .06, .07

Duration: 9 Total Hours  Theory: 9 hours  Practical: 0 hours

General Learning Outcome:

Demonstrate a working knowledge of fillet and groove welding on aluminum with the Gas Tungsten Arc Welding (GTAW) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

3.4.1 Describe equipment set-up and applications of aluminum welding with the Gas Tungsten Arc Welding (GTAW) process. [2/0]

- power source
- equipment
- electrodes
- material
- consumables
- shielding gas
- techniques
- types weld
- safety
- personal

3.4.2 Set-up equipment for aluminum welding using the Gas Tungsten Arc Welding (GTAW) process. [1/0]

- consumables
  - filler rod
    - type
    - size
3.4.3 Perform fillet and groove welds on aluminum with the Gas Tungsten Arc Welding (GTAW) process.

- set-up
  - welding parameters
  - equipment set-up
  - filler material
  - material surfaces
- fillet welds
  - 2F position
  - 3F position
- groove welds (plate or pipe)
  - 1G position
  - 2G position
  - 3G progression up position
- post weld operations
  - clean and prepare welds to specification
  - visually inspect finished welds
3.5 – Plasma Arc Welding (PAW)

Cross-Reference to Learning Outcomes:

6012.01, .02, .03, .04, .05, .06

Duration: 3 Total Hours  Theory: 3 hours  Practical: 0 hours

General Learning Outcome:

Demonstrate a working knowledge of the Plasma Arc Welding (PAW) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

3.5.1 Explain the Plasma Arc Welding (PAW) process.

[3/0]
- safety concerns specific to the Plasma Arc Welding (PAW) process
- arc characteristics
  - transferred and non-transferred arc
  - current parameters (amperage and voltage)
- melt-in and keyhole modes
- power source and controls
- torches, types and sizes
  - electrodes
  - nozzles
- gases
  - plasma and shielding (cooling)
  - gas flow meters
  - gas flow parameters
- manual and automated process
- filler materials

Evaluation:

The following evaluation structure is only a suggested format. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.

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</table>
Welder – Level III

Number: 4

Title: Automatic and Semi-Automatic Processes

Duration: 27 Total Hours

Theory: 12 hours  Practical: 15 hours

Prerequisites: Level II, Unit 5

Co-requisites: Unit 5

4.1 – Gas Metal Arc Welding (GMAW) III (Pulsed)

3 Total Hours  Theory: 3 hours  Practical: 0 hours

4.2 – Fillets and Groove Welds with the Gas Metal Arc Welding – Pulsed (GMAW-P) Process

12 Total Hours  Theory: 3 hours  Practical: 9 hours

4.3 – Metal Cored Arc Welding (MCAW)

6 Total Hours  Theory: 0 hours  Practical: 6 hours

4.4 – Submerged Arc Welding (SAW)

3 Total Hours  Theory: 3 hours  Practical: 0 hours

4.5 – Stud Welding

3 Total Hours  Theory: 3 hours  Practical: 0 hours
Welder – Level III

4.1 – Gas Metal Arc Welding (GMAW) III (Pulsed)

Cross-Reference to Learning Outcomes:

6008.03; 6015.01

Duration: 3 Total Hours  Theory: 3 hours  Practical: 0 hours

General Learning Outcome:

Demonstrate a working knowledge of the Gas Metal Arc Welding – Pulsed (GMAW-P) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

4.1.1 Describe the fundamentals of the pulsed-arc metal transfer mode of the Gas Metal Arc Welding – Pulsed (GMAW-P) process.

[3/0]

- advantages
- limitations
- applications
- additional GMAW-P variables
- peak current
- peak time
- background current
- background time
- power sources requirements
- wire feeder requirements
- control of variables
  - synergic controls
  - trim controls
4.2 – Fillets and Groove Welds with the Gas Metal Arc Welding – Pulsed (GMAW-P) Process

Cross-Reference to Learning Outcomes:

6008.01, .02, .03, .04, .05, .06, .07; 6015.01

Duration: 12 Total Hours Theory: 3 hours Practical: 9 hours

General Learning Outcome:

Demonstrate a working knowledge of fillets and groove welds with the Gas Metal Arc Welding-Pulsed (GMAW-P) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

4.2.1 Describe equipment set-up and the process of Gas Metal Arc Welding – Pulsed (GMAW-P). [3/0]

- power source
- equipment
- wire feeder
- pulsing variables
- shielding gas
- consumables
- technique
- material
- type of welds

4.2.2 Perform fillet and groove welds with the Gas Metal Arc Welding - Pulsed (GMAW-P) process on mild steel. [0/9]

- fillets
- flat (1F)
- horizontal (2F)
- vertical –up (3F)
  - flat (1G)
  - vertical-up (3G)
- material
- thin gauge
4.3 – Metal Cored Arc Welding (MCAW)

Cross-Reference to Learning Outcomes:

6011.01, 02, .03, .04, .05, .06; 6002.02, .03; 6015.02; 6016.01

Duration: 6 Total Hours  Theory: 0 hours  Practical: 6 hours

General Learning Outcome:

Demonstrate a working knowledge of fillet welding with the Metal Cored Arc Welding (MCAW) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

4.3.1 Fillet weld with the Metal Cored Arc Welding (MCAW) process. [0/6]

- material
  - mild steel
- positions
  - flat (1F)
  - horizontal (2F)
- joints
  - lap
  - tee
- consumables
  - type
  - size
- shielding gas
  - type
  - flow rate
  - clean and inspect
4.4 - Submerged Arc Welding (SAW)

Cross-Reference to Learning Outcomes:

6014.01, .02, .03, .04, .05

**Duration:** 3 Total Hours  
**Theory:** 3 hours  
**Practical:** 0 hours

**General Learning Outcome:**

Demonstrate a working knowledge of the fundamentals of the Submerged Arc Welding (SAW) process.

**Learning Outcomes:**

Upon successful completion, the apprentice is able to:

**Learning Content:**

4.4.1 Describe the fundamentals of the Submerged Arc Welding (SAW) Process.  
[.5/0]

- process fundamentals
- applications
- power sources
- wire feeders
- consumables
- process variations
- advantages
- limitations
4.4.2 State the equipment requirements for the Submerged Arc Welding (SAW) process.
[1/0]

- welding equipment
  - power sources
  - AC machines
  - DC machines
- controls
  - tandem arc
  - twin arc
- contact tips / contact tubes
- wire drive rolls
  - single wire
  - multi wire
- wire guides
- welding cables
  - cable size
  - condition
  - capacity
- work leads
  - clamps in good repair
  - clamping locations
- operational equipment
  - welding manipulators
  - drive rolls
  - positioners

4.4.3 Identify submerged arc welding consumables.
[.5/0]

- filler wire
  - classification
  - filler wire delivery
    - spool
    - drum
  - filler wire diameters
- flux
  - functions of flux
  - chemical properties
  - alloying elements
  - shielding
  - flux classification system
    - imperial version
4.4.4 Explain Submerged Arc Welding (SAW) parameter selection.
[.5/0]
- travel speed
  - carriage travel
  - boom travel
- electrical variables
  - amperage
  - voltage
- pre-heat
- post heat
- filler wire
  - stick out
  - drive roll tension
- travel angle
- work angle

4.4.5 Explain the Submerged Arc Welding (SAW) process on low carbon and stainless steel to CSA and ASME codes.
[.5/0]
- fillet welds
  - single and multi-pass sequencing
- groove welds
  - with backing
  - sequencing
- post cleaning
- inspect and measure weld size with appropriate (necessary) tools to meet specified requirements or standards
4.5 – Stud Welding

Cross-Reference to Learning Outcomes:
6014.01, .02, .03, .04, .05

Duration: 3 Total Hours Theory: 3 hours Practical: 0 hours

General Learning Outcome:
Demonstrate a working knowledge of the fundamentals of the Stud Welding (SW) process.

Learning Outcomes:
Upon successful completion, the apprentice is able to:

Learning Content:

4.5.1 Describe the fundamentals of the Stud Welding (SW) process.
[1.5/0]
- process fundamentals
- power sources and equipment
- applications
- consumables
  - studs
  - ferrules

4.5.2 Explain the Stud Welding (SW) process.
[1.5/0]
- equipment set-up
- adjustment and verification of variables
- corrective actions and repairs to defective stud welds and parent materials

Evaluation:
The following evaluation structure is only a suggested format. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.

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</table>
Welding – Level III

Number: 5
Title: Shielded Metal Arc Welding (SMAW) Practical III
Duration: 45 Total Hours

Theory: 3 hours  Practical: 42 hours

Prerequisites: Level II, Unit 4
Co-requisites: Unit 4

5.1 – Groove Welds on Plate with the Shielded Metal Arc Welding (SMAW) Process.

21 Total Hours  Theory: 3 hours  Practical: 18 hours

5.2 – Groove Welds on Pipe with the Shielded Metal Arc Welding (SMAW) Process

21 Total Hours  Theory: 0 hours  Practical: 21 hours

5.3 – Fillets and Groove Welds with Stainless Steel Electrodes Using the Shielded Metal Arc Welding (SMAW) Process

3 Total Hours  Theory: 0 hours  Practical: 3 hours
5.1 – Groove Welds on Plate with the Shielded Metal Arc Welding (SMAW) Process

Cross-Reference to Learning Outcomes:

6015.01; 6007.01, .02, .03, .04, .06, .07; 6004.01, .03; 6016.05;
6001.01, .02, .03, .04, .05, .06

Duration: 21 Total Hours  Theory: 3 hours  Practical: 18 hours

General Learning Outcome:

Demonstrate a working knowledge of groove welding on plate with the Shielded Metal Arc Welding (SMAW) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

5.1.1 Describe the equipment set-up and the process of Shielded Metal Arc Welding (SMAW).

[3/0]

- power source
- equipment
- consumables
- safety
- personal protection
- material
- technique
- type of welds

5.1.2 Set-up equipment for Shielded Metal Arc Welding (SMAW) applications.

[0/1]

- power sources
  - transformers
  - rectifiers
  - inverters
  - engine driven
- power source controls
  - amperage
5.1.3 Groove weld on plate using the Shielded Metal Arc Welding (SMAW) process.

- groove welds
  - open root
- positions
  - flat (1G)
  - horizontal (2G)
  - vertical (3G)
    - progression up
  - overhead (4G)
- material
  - mild steel plate
- joints
  - single vee-groove, open root
- consumables
  - cellulose
  - basic
Welder – Level III

5.2 – Groove Welds on Pipe with the Shielded Metal Arc Welding (SMAW) Process

Cross-Reference to Learning Outcomes:

6007.01, .02, .03, .05, .06, .07; 6016.05

Duration: 21 Total Hours Theory: 0 hours Practical: 21 hours

General Learning Outcome:

Demonstrate a working knowledge of groove welding on pipe with the Shielded Metal Arc Welding (SMAW) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

5.2.1 Perform groove welds on pipe for destructive testing using the Shielded Metal Arc Welding (SMAW) Process.

[0/18]

- groove welds
  - open root
- positions
  - horizontal / vertical, (2G) / (5G)
  - all (6G)
- material
  - mild steel pipe
- joints
  - single vee-groove, open root
- consumables
  - cellulose
  - basic

5.2.2 Perform preparations for destructive testing.

[0/2]

- layout coupons
- cut coupons
- grind surfaces
- grind coupons
5.2.3 Perform destructive testing.
[0/1]

- destructive test welds
  - root bend
  - face bend
Weld – Level III

5.3 – Fillets and Groove Welds with Stainless Steel Electrodes Using the Shielded Metal Arc Welding (SMAW) Process

Cross-Reference to Learning Outcomes:

6007.01, .02, .03, .04, .05, .06, .07

Duration: 3 Total Hours  Theory: 0 hours  Practical: 3 hours

General Learning Outcome:

Demonstrate a working knowledge of fillet and groove welding with stainless electrodes using the Shielded Metal Arc Welding (SMAW) process.

Learning Outcomes:

Upon successful completion, the apprentice is able to:

Learning Content:

5.3.1 Perform fillet and groove welds on plate using the Shielded Metal Arc Welding (SMAW) process with Stainless Steel Electrodes. [0/3]

- fillet welds
- flat (1F)
- horizontal (2F)
- groove welds with backing
- flat (1G)
- horizontal (2G)
- consumable – any one of
  - E308(L)
  - E316(L)
  - E309(L)

Evaluation:

The following evaluation structure is only a suggested format. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.

<table>
<thead>
<tr>
<th>Evaluation Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Theory Testing</td>
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</tr>
<tr>
<td>Practical Application Exercises</td>
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<tr>
<td>Research Project</td>
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</tr>
<tr>
<td>Notebook and Organizational Skills</td>
<td>0%</td>
</tr>
</tbody>
</table>
Reference Material:


**GCIL Learning Modules** 1 to 23, Gooderham Centre for Industrial Learning

**Blueprint Reading for Welders**, A. E. Bennett

**Layout and Patterns**, John Kroisenbrunner, Conestoga College

**Pipe Welding Procedures**, Hoobasar Rampaul


**ILM Alberta Learning Modules**