SKILLEDTRADESBC

PROGRAM OUTLINE

Welder

The latest version of this document is available in PDF format on the SkilledTradesBC website
www.skilledtradesbc.ca

To order printed copies of Program Outlines
or learning resources (where available)
for BC trades contact:

Crown Publications, Queen's Printer
Web: www.crownpub.bc.ca
Email: crownpub@gov.bc.ca
Toll Free 1 800 663-6105

WELDER
PROGRAM OUTLINE

APPROVED BY INDUSTRY
AUGUST 2016

BASED ON
WELDER NOA 2013
AND
CCDA HARMONIZATION
RECOMMENDATIONS 2015

Developed by
SkilledTradesBC
Province of British Columbia

TABLE OF CONTENTS

Section 1

INTRODUCTION

Welder

Foreword

This Program Outline was developed to meet the needs of employers and other industry stakeholders.

It will be used as a guide for training providers delivering technical training for the Welder program and by apprentices and employers in planning the workplace training.

Safe working practices, though not always specified in each of the competencies and learning tasks, are an implied part of the program and should be stressed throughout the apprenticeship.

This document provides important information for a variety of audiences, including: training providers, employers/sponsors, apprentices and program challengers. Refer to "How to Use this Document" for information on how each section can be used by each intended audience.

Delivery of Technical Training:

The Welder Program has three levels of technical training. Practical demonstration and apprentice participation should be integrated with classroom sessions.

This program is competency-based with many options available for the delivery of technical training.

For example, the Welder Apprenticeship Program may be offered as a:

- Full-time day school program (including block release and continuous entry)
- Continuous entry competency-based model
- Some theory may be offered as interactive synchronistic “on-line” delivery

This program outline also includes:

- A list of recommended curriculum and reference textbooks
- Training Provider Requirements for Instructor Qualifications, Facilities (classroom and shop sizes), as well as the necessary Tools and Equipment
- Practical competencies as well as destructive and non-destructive testing
- Shop projects and weld destructive tests
- Pipe fabrication competencies
- Fabrication competencies

SAFETY ADVISORY

Be advised that references to the WorkSafeBC safety regulations contained within these materials do not/may not reflect the most recent Occupational Health and Safety Regulation (the current Standards and Regulation in BC can be obtained on the following website: http://www.worksafebc.com. Please note that it is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulation pertaining to his/her work.

Acknowledgements

Welder Program Review and Revision 2014 – 2016:

In 2014, Subject Matter Experts were convened to review and revise the BC Program Outline with reference to changes identified in the Welder 2013 National Occupational Analysis (NOA). The following are the Subject Matter Experts who participated in this review:

- Stan Boehm, SS Stainless Inc
- James Hillerby, Whistler Resorts
- Mike Zenowski, Weldco-Beales
- Merv Kube, UA Piping Industry College of BC (UAPIC BC)
- Jim Carson, University of the Fraser Valley (UFV)
- Mark Flynn, British Columbia Institute of Technoloy (BCIT)

In 2015, Subject Matter Experts were convened to review and re-sequence the Welder trade as part of the Pan-Canadian Harmonization Initiative. The following are the Subject Matter Experts who participated in this review:

- Stan Boehm, SS Stainless Inc
- James Hillerby, Whistler Resorts
- Merv Kube, UA Piping Industry College of BC (UAPIC BC)
- Jim Carson, University of the Fraser Valley (UFV)
- Mark Flynn, British Columbia Institute of Technoloy (BCIT)
- Al Sumal, Kwantlen Polytechnic University (KPU)

In 2016, Subject Matter Experts were convened to review the BC Program Outline with respect to the Pan-Canadian Harmonization Initiative changes. The following are the Subject Matter Experts who participated in this review:

- Willem Swint, Victoria Shipyards
- Mark Karpinski, Vancouver Shipyards
- Willy Manson, Stinger Welding
- Chris Meikle, ADAM Integrated Industries
- Jason Card, Macro Industries
- Brad Harder, Penticton Fabrication
- Matt Suddaby, Jewel Holdings
- Mike Longo, Ideal Welders
- Gord Weel, Boilermakers 359
- Palmer Allen, Boilermakers 359
- Gene Vonn Matt, Teck, Elk Valley Operations
- Jackie Lundman, Independent
- Ed Hurd, Technical Safety BC

SkilledTradesBC would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Welder occupation.

Committee members and consultation groups involved with prior editions of the BC Program Outline can be found in the Historical Program Review Participants in the appendix at the end of this document.

How to Use this Document

This Program Outline has been developed for the use of individuals from several different audiences. The table below describes how each section can be used by each intended audience.

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Program Credentialing Model	Communicate program length and structure, and all pathways to completion	Understand the length and structure of the program	Understand the length and structure of the program, and pathway to completion	Understand challenger pathway to Certificate of Qualification
OAC	Communicate the competencies that industry has defined as representing the scope of the occupation	Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification	View the competencies they will achieve as a result of program completion	Understand the competencies they must demonstrate in order to challenge the program
Training Topics and Suggested Time Allocation	Shows proportionate representation of general areas of competency (GACs) at each program level, the suggested proportion of time spent on each GAC, and percentage of time spent on theory versus practical application	Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application	Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application	Understand the relative weightings of various competencies of the occupation on which assessment is based
Program Content	Defines the objectives, learning tasks, high level content that must be covered for each competency, as well as defining observable, measureable achievement criteria for objectives with a practical component	Identifies detailed program content and performance expectations for competencies with a practical component; may be used as a checklist prior to signing a recommendation for certification (RFC) for an apprentice	Provides detailed information on program content and performance expectations for demonstrating competency	Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels
Training Provider Standards	Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program	Identifies the tools and equipment an apprentice is expected to have access to; which are supplied by the training provider and which the student is expected to own	Provides information on the training facility, tools and equipment provided by the school and the student, reference materials they may be expected to acquire, and minimum qualification levels of program instructors	Identifies the tools and equipment a tradesperson is expected to be competent in using or operating; which may be used or provided in a practical assessment

Section 2

PROGRAM OVERVIEW

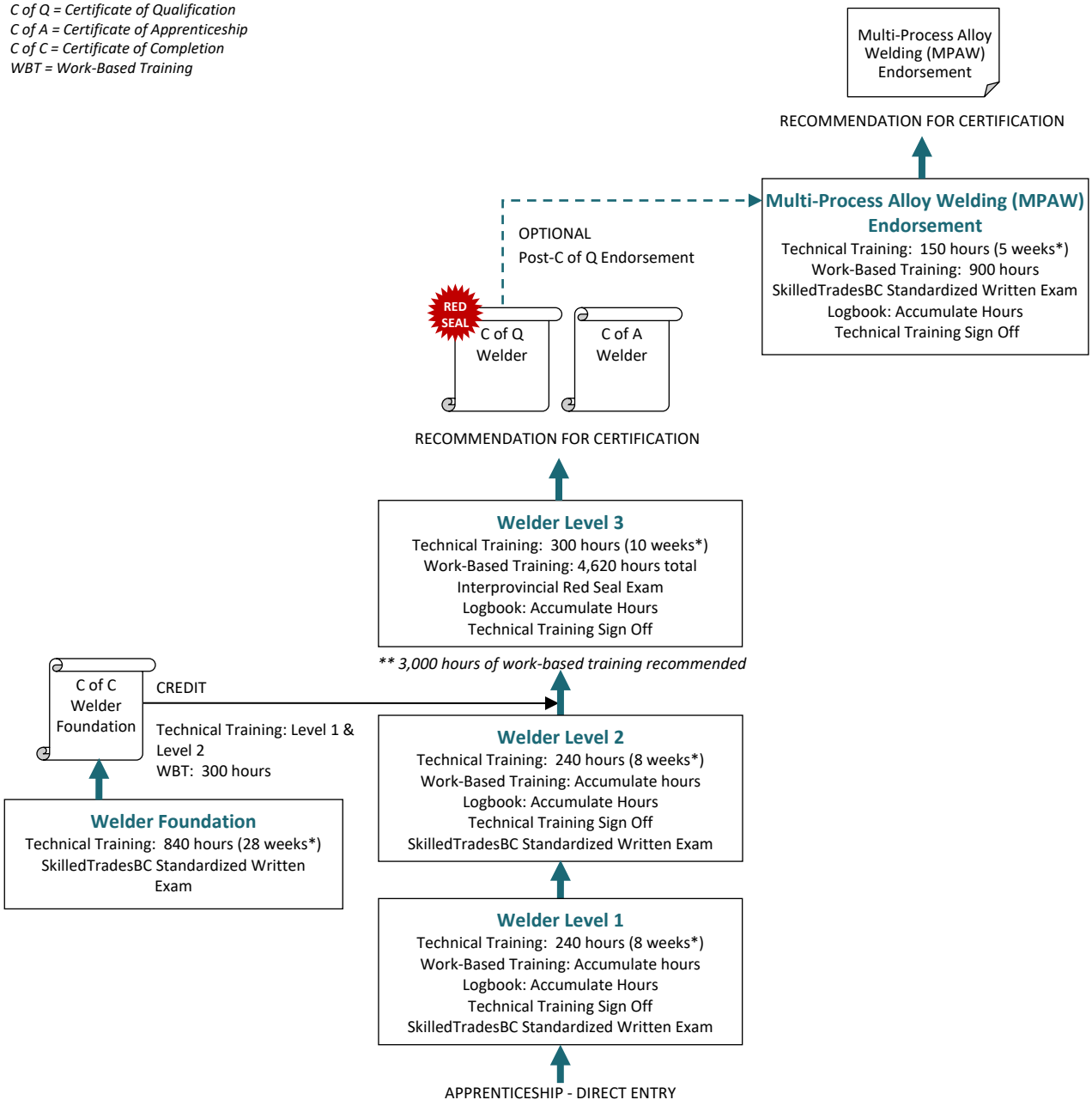
Welder

Program Credentialing Model

Apprenticeship Pathway

This graphic provides an overview of the Welder apprenticeship pathway.

C of Q = Certificate of Qualification
C of A = Certificate of Apprenticeship
C of C = Certificate of Completion
WBT = Work-Based Training



**Suggested duration based on 30-hour week*
*** 3,000 hours of work-based training recommended prior to entering Level 3 Technical Training (hours to be verified by Sponsor/Employer)*

CROSS-PROGRAM CREDITS
Individuals who hold the credentials listed below are entitled to receive partial credit toward the completion requirements of this program

None

Occupational Analysis Chart

WELDER

Occupation Description: "Welder" means a person who has training in and is capable of welding ferrous and non-ferrous metals in all positions, on both plate and/or pipe, using various welding processes. Certified welders qualify for testing with CSA, TSBC and for ASME procedures in British Columbia.

EN = Endorsement
F = Foundation, where Foundation is a stand-alone "pre-employment" pathway and encompasses Level 1 and/or 2 Apprenticeship Pathway competencies.
A1[1] The program content for this compentency is FOUNDATION only and can be found in the Program Outline Appendix.
C[2] The practical competencies for GAC C in the LEVEL 1 APPRENTICESHIP program are an optional component as recommended by industry.

Occupational Skills **A**	Describe welder apprenticeship and the scope of the trade in BC A1[1]	Describe safe working practices A2	Perform basic trade related mathematical calculations A3	Use and maintain measuring and layout tools A4	Use and maintain hand tools A5	Use and maintain power tools (electric and pneumatic) A6
	F	F 1	F 1	F 1	F 1	F 1
	Describe shop materials A7	Apply lifting, hoisting and rigging procedures A8				
	F 1	F 1 2				
Cutting and Gouging Processes **B**	Describe Oxy-Fuel Cutting (OFC) processes and their applications B1	Describe Oxy-Fuel Cutting (OFC) equipment and its operation B2	Perform freehand and guided cuts on low carbon steel (OFC) B3	Use automatic and semi-automatic cutting machines (OFC) B4	Describe CAC-A and PAC processes, equipment and their applications B5	Use CAC-A and PAC cutting and gouging processes and equipment B6
	F 1	F 1	F 1	F 1	F 1	F 1
Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process **C[2]**	Describe fusion welding, braze welding and brazing processes and their applications C1	Describe fusion welding, braze welding and brazing equipment and its operation C2	Describe filler metals, fluxes and tips used for fusion welding, braze welding and brazing C3	Describe joint design and weld positions for OFW C4	Fusion weld on low carbon steel sheet C5	Braze weld (TB) using the OFW process C6
	F 1	F 1	F 1	F 1	F 1	F 1
	Silver alloy braze on similar and dissimilar metals C7					
	F 1					

SKILLED TRADES BC

Program Overview

Shielded Metal Arc Welding (SMAW) **D**	Describe the SMAW process D1	Describe SMAW equipment and its operation D2	Select electrodes for SMAW D3	Describe basic joint design and weld positions for SMAW D4	Describe weld faults and distortion in fabrications in SMAW D5	Use the SMAW process on low carbon steel plate and pipe D6
	F 1	F 1	F 1 2 3 EN	F 1	F 1	F 1 2 3 EN
	Use the hardsurfacing process on low carbon steel D7	Describe the SMAW process on grey cast iron D8	Use the SMAW process on stainless steel and/or low carbon steel plate and pipe D9			
	F 1	F 2	F 1 EN			
Semi-Automatic and Automatic Welding **E**	Describe GMAW, GMAW-P, FCAW, MCAW and SAW processes and their applications E1	Describe semi-automatic and automatic welding equipment and its operation E2	Describe filler metal and shielding gases for semi-automatic and automatic processes E3	Use the GMAW and GMAW-P process E4	Use the FCAW process E5	Use the MCAW process E6
	F 1	F 1	F 1	F 1 2 3	F 1 2	F 2
	Use the SAW process E7	Use combined GMAW, MCAW and FCAW processes E8				
	F 2	3				
Gas Tungsten Arc Welding (GTAW) **F**	Describe the GTAW process and its application F1	Describe GTAW equipment and its operation F2	Describe the application of GTAW for ferrous metals F3	Use the GTAW process for ferrous metals F4	Use the GTAW process for stainless steel F5	Use the GTAW process for aluminum F6
	F 2	F 2	F 2	F 2 3	F 2 EN	3
Specialized Processes **G**	Describe specialized welding processes G1					
	EN					
Basic Metallurgy **H**	Describe production processes for manufacturing metals H1	Describe mechanical and physical properties of ferrous and non-ferrous metals H2	Describe common ferrous, non-ferrous and reactive metals and their weldability H3	Describe the grain structure of metals H4	Describe aluminum, aluminum alloys and their weldability H5	Describe die castings and their weldability H6
	F 2	F 2 3	F 2 3 EN	3	3	EN

Program Overview

Welding Drawings, Layout and Fabrication **I**	Identify common welding symbols and bolted connections I1	Read and interpret drawings I2	Perform basic drafting I3	Perform mathematical calculations I4	Interpret and apply mechanical drawings and layout components I5	Fabricate weldments I6
	F 1	F 2 3	F 2	F 2	F 2 3 EN	F 2 3 EN
	Costing and estimating I7					
	F 2 3					
Quality Control and Inspection **J**	Describe basic welding quality control and inspection requirements J1	Describe inspection and testing procedures J2	Describe the scope of the welding supervisor and inspector responsibilities J3			
	3	3	3			
Standards, Codes, Specifications and Welder Qualifications **K**	Identify applicable standards, codes, specifications and jurisdictional bodies K1	Describe compliance with weld procedure specifications (WPS) and data sheets K2				
	3	3				

Training Topics and Suggested Time Allocation: Foundation

Welder – Foundation

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**Occupational Skills**	**7%**	**50%**	**50%**	**100%**
A1	Describe welder apprenticeship and the scope of the trade in BC		✓		
A2	Describe safe working practices		✓		
A3	Perform basic trade related mathematical calculations		✓		
A4	Use and maintain measuring and layout tools		✓		
A5	Use and maintain hand tools		✓	✓	
A6	Use and maintain power tools (electric and pneumatic)		✓	✓	
A7	Describe shop materials		✓	✓	
A8	Apply lifting, hoisting and rigging procedures		✓	✓	
Line B	**Cutting and Gouging Processes**	**6%**	**20%**	**80%**	**100%**
B1	Describe Oxy-Fuel Cutting (OFC) processes and their applications		✓		
B2	Describe Oxy-Fuel Cutting (OFC) equipment and its operation		✓		
B3	Perform freehand and guided cuts on low carbon steel (OFC)			✓	
B4	Use automatic and semi-automatic cutting machines (OFC)			✓	
B5	Describe CAC-A and PAC processes, equipment and their applications		✓		
B6	Use CAC-A and PAC cutting and gouging processes and equipment		✓	✓	
Line C	**Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process**	**3%**	**20%**	**80%**	**100%**
C1	Describe fusion welding, braze welding and brazing processes and their applications		✓		
C2	Describe fusion welding, braze welding and brazing equipment and its operation		✓		
C3	Describe filler metals, fluxes and tips used for fusion welding, braze welding and brazing		✓		
C4	Describe joint design and weld positions for OFW		✓		
C5	Fusion weld on low carbon steel sheet			✓	
C6	Braze weld (TB) using the OFW process		✓	✓	
C7	Silver alloy braze on similar and dissimilar metals		✓		

Line D	**Shielded Metal Arc Welding (SMAW)**	**42%**	**20%**	**80%**	**100%**
D1	Describe the SMAW process		✓		
D2	Describe SMAW equipment and its operation		✓		
D3	Select electrodes for SMAW		✓		
D4	Describe basic joint design and weld positions for SMAW		✓		
D5	Describe weld faults and distortion in fabrications in SMAW		✓		
D6	Use the SMAW process on low carbon steel plate and pipe			✓	
D7	Use the hardsurfacing process on low carbon steel		✓		
D8	Describe the SMAW process on grey cast iron			✓	
D9	Use the SMAW process on stainless steel and/or low carbon steel plate and pipe		✓		
Line E	**Semi-Automatic and Automatic Welding**	**30%**	**25%**	**75%**	**100%**
E1	Describe GMAW, GMAW-P, FCAW, MCAW and SAW processes and their applications		✓		
E2	Describe semi-automatic and automatic welding equipment and its operation		✓		
E3	Describe filler metal and shielding gases for semi-automatic and automatic processes		✓		
E4	Use the GMAW and GMAW-P process			✓	
E5	Use the FCAW process			✓	
E6	Use the MCAW process			✓	
E7	Use the SAW process		✓		
Line F	**Gas Tungsten Arc Welding (GTAW)**	**4%**	**15%**	**85%**	**100%**
F1	Describe the GTAW process and its application		✓		
F2	Describe GTAW equipment and its operation		✓		
F3	Describe the application of GTAW for ferrous metals		✓		
F4	Use the GTAW process for ferrous metals		✓		
F5	Use the GTAW process for stainless steel			✓	
Line H	**Basic Metallurgy**	**1%**	**90%**	**10%**	**100%**
H1	Describe production processes for manufacturing metals		✓		
H2	Describe mechanical and physical properties of ferrous and non-ferrous metals		✓		
H3	Describe common ferrous, non-ferrous, reactive metals and their weldability		✓	✓	

Line I	**Welding Drawings, Layout and Fabrication**	**7%**	**15%**	**85%**	**100%**
I1	Identify common welding symbols and bolted connections		✓		
I2	Read and interpret drawings		✓		
I3	Perform basic drafting		✓	✓	
I4	Perform mathematical calculations		✓		
I5	Interpret and apply mechanical drawings and layout components		✓	✓	
I6	Fabricate weldments		✓	✓	
I7	Costing and estimating		✓	✓	
	Total Percentage for Welder Foundation	**100%**			

Training Topics and Suggested Time Allocation: Level 1

Welder – Level 1

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**Occupational Skills**	**10%**	**50%**	**50%**	**100%**
A2	Describe safe working practices				
A3	Perform basic trade related mathematical calculations				
A4	Use and maintain measuring and layout tools				
A5	Use and maintain hand tools				
A6	Use and maintain power tools (electric and pneumatic)				
A7	Describe shop materials				
A8	Apply lifting, hoisting and rigging procedures				
Line B	**Cutting and Gouging Processes**	**10%**	**20%**	**80%**	**100%**
B1	Describe Oxy-Fuel Cutting (OFC) processes and their applications				
B2	Describe Oxy-Fuel Cutting (OFC) and equipment and its operation				
B3	Perform freehand and guided cuts on low carbon steel (OFC)				
B4	Use automatic and semi-automatic cutting machines (OFC)				
B5	Describe CAC-A and PAC processes, equipment and their applications				
B6	Use CAC-A and PAC cutting and gouging processes and equipment				
Line C	**Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process**	**6%**	**20%**	**80%**	**100%**
C1	Describe fusion welding, braze welding and brazing processes and their applications				
C2	Describe fusion welding, braze welding and brazing equipment and its operation				
C3	Describe filler metals, fluxes and tips used for fusion welding, braze welding and brazing				
C4	Describe joint design and weld positions for OFW				
OPTIONAL					
C5	*Fusion weld on low carbon steel sheet*				
C6	*Braze weld (TB) using the OFW process*				
C7	*Silver alloy braze on similar and dissimilar metals*				

Line D	**Shielded Metal Arc Welding (SMAW)**	**40%**	**20%**	**80%**	**100%**
D1	Describe the SMAW process				
D2	Describe SMAW equipment and its operation				
D3	Select electrodes for SMAW				
D4	Describe basic joint design and weld positions for SMAW				
D5	Describe weld faults and distortion in fabrications in SMAW				
D6	Use the SMAW process on low carbon steel plate and pipe				
D7	Use the hardsurfacing process on low carbon steel				
D9	Use the SMAW process on stainless steel and/or low carbon steel plate and pipe				
Line E	**Semi-Automatic and Automatic Welding**	**30%**	**20%**	**80%**	**100%**
E1	Describe GMAW, GMAW-P, FCAW, MCAW and SAW processes and their applications				
E2	Describe semi-automatic and automatic welding equipment and its operation				
E3	Describe filler metal and shielding gases for semi-automatic and automatic processes				
E4	Use the GMAW and GMAW-P processes				
E5	Use the FCAW process				
Line I	**Welding Drawings, Layout and Fabrication**	**4%**	**100%**	**0%**	**100%**
I1	Identify common welding symbols and bolted connections				
	Total Percentage for Welder Level 1	**100%**			

Training Topics and Suggested Time Allocation: Level 2

Welder – Level 2

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**Occupational Skills**	**5%**	**65%**	**35%**	**100%**
A8	Apply lifting, hoisting and rigging procedures				
Line D	**Shielded Metal Arc Welding (SMAW)**	**35%**	**20%**	**80%**	**100%**
D3	Select electrodes for SMAW				
D6	Use the SMAW process on low carbon steel plate and pipe				
D8	Describe the SMAW process on grey cast iron				
Line E	**Semi-Automatic and Automatic Welding**	**37%**	**25%**	**75%**	**100%**
E4	Use the GMAW and GMAW-P process				
E5	Use the FCAW process				
E6	Use the MCAW process				
E7	Use the SAW process				
Line F	**Gas Tungsten Arc Welding (GTAW)**	**12%**	**15%**	**85%**	**100%**
F1	Describe the GTAW process and its application				
F2	Describe GTAW equipment and its operation				
F3	Describe the application of GTAW for ferrous metals				
F4	Use the GTAW process for ferrous metals				
F5	Use the GTAW process for stainless steel				
Line H	**Basic Metallurgy**	**2%**	**90%**	**10%**	**100%**
H1	Describe production processes for manufacturing metals				
H2	Describe mechanical and physical properties of ferrous and non-ferrous metals				
H3	Describe common ferrous, non-ferrous and reactive metals and their weldability				
Line I	**Welding Drawings, Layout and Fabrication**	**10%**	**50%**	**50%**	**100%**
I2	Read and interpret drawings				
I3	Perform basic drafting				
I4	Perform mathematical calculations				
I5	Interpret and apply mechanical drawings and layout components				
I6	Fabricate weldments				
I7	Costing and estimating				
	Total Percentage for Welder Level 2	**100%**			

Training Topics and Suggested Time Allocation: Level 3

Welder – Level 3

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line D	**Shielded Metal Arc Welding (SMAW)**	**50%**	**10%**	**90%**	**100%**
D3	Select electrodes for SMAW				
D6	Use the SMAW process on low carbon steel plate and pipe				
Line E	**Semi-automatic and Automatic Welding**	**16%**	**10%**	**90%**	**100%**
E4	Use the GMAW and GMAW-P process				
E8	Use combined GMAW, MCAW and FCAW processes				
Line F	**Gas Tungsten Arc Welding (GTAW)**	**24%**	**15%**	**85%**	**100%**
F4	Use the GTAW process for ferrous metals				
F6	Use the GTAW process for aluminum				
Line H	**Basic Metallurgy**	**2%**	**90%**	**10%**	**100%**
H2	Describe mechanical and physical properties of ferrous and non-ferrous metals				
H3	Describe common ferrous, non-ferrous and reactive metals and their weldability				
H4	Describe the grain structure of metals				
H5	Describe aluminum, aluminum alloys and their weldability				
Line I	**Welding Drawings, Layout and Fabrication**	**4%**	**50%**	**50%**	**100%**
I2	Read and interpret drawings				
I5	Interpret and apply mechanical drawings and layout components				
I6	Fabricate weldments				
I7	Costing and estimating				
Line J	**Quality Control and Inspection**	**2%**	**100%**	**0%**	**100%**
J1	Describe basic welding quality control and inspection requirements				
J2	Describe inspection and testing procedures				
J3	Describe the scope of the welding supervisor and inspector responsibilities				
Line K	**Standards, Codes, Specifications and Welder Qualifications**	**2%**	**100%**	**0%**	**100%**
K1	Identify applicable standards, codes, specifications and jurisdictional bodies				
K2	Describe compliance with weld procedure specifications (WPS) and data sheets				
	Total Percentage for Welder Level 3	**100%**			

Training Topics and Suggested Time Allocation: MPAW

Multi-Process Alloy Welding (MPAW) Endorsement

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line D	**Shielded Metal Arc Welding (SMAW)**	**40%**	**15%**	**85%**	**100%**
D3	Select electrodes for SMAW				
D6	Use the SMAW process on low carbon steel plate and pipe				
D9	Use the SMAW process on stainless steel and/or low carbon steel plate and pipe				
Line F	**Gas Tungsten Arc Welding (GTAW)**	**44%**	**15%**	**85%**	**100%**
F5	Use the GTAW process for stainless steel				
Line G	**Specialized Processes**	**6%**	**100%**	**0%**	**100%**
G1	Describe specialized welding processes				
Line H	**Basic Metallurgy**	**4%**	**100%**	**0%**	**100%**
H3	Describe common ferrous, non-ferrous and reactive metals and their weldability				
H6	Describe die castings and their weldability				
Line I	**Welding Drawings, Layout and Fabrication**	**6%**	**10%**	**90%**	**100%**
I5	Interpret and apply mechanical drawings and layout components				
I6	Fabricate weldments				
	Total Percentage for Multi-Process Alloy Welding (MPAW) Endorsement	**100%**			

Section 3

PROGRAM CONTENT

Welder

Level 1

Welder

Line (GAC): A Occupational Skills

Competency: A2 Describe safe working practices

Objectives

To be competent in this area, the individual must be able to:

- Describe regulations for health and safety in a welding workplace.
- Describe fire safety precautions, confined space entry and H2S requirements.

LEARNING TASKS	CONTENT

1. Describe regulations for health and safety in a welding workplace	• WorkSafeBC
	  ○ Employer responsibility and eligibility
	  ○ Worker responsibility and eligibility
	  ○ WorkSafeBC coverage
	  ○ Standards, codes and regulations
	• Occupational Health and Safety (OH&S)
	• Workplace Hazardous Material Information System (WHMIS)
	  ○ Training
	  ○ Material Safety Data Sheets (MSDS)
	  ○ Labelling

2. Describe general safety precautions for welding	• Worksite safety
	  ○ Safety meetings
	  ○ Emergency procedures
	• Shop safety
	• Electrical safety
	• Safety requirements for welding processes

3. Describe fall protection requirements	• Personal fall protection requirements
	  ○ Ladders and scaffolds
	  ○ Handrails and guardrails
	  ○ Harnesses and tethers
	  ○ Fall restraint
	  ○ Fall arrest
	  ○ Access equipment

4. Describe physical hazards and select Personal Protective Equipment (PPE)

- Hazards
  - Radiation
  - Extreme temperatures
  - Noise
  - Bodily injury hazards
  - Chemical hazards
  - Respiratory
- Personal protective equipment
  - Protective clothing
  - Skin protection (leathers)
  - Head protection
  - Hand protection
  - Foot protection
  - Hearing protection
  - Welding screens and curtains
  - Eye protection for welding
    - Safety glasses and goggles
    - Face shields
    - Flash goggles
    - Welding helmets
    - Welding goggles
  - Respiratory protection

5. Identify fire hazards and describe methods for preventing and extinguishing fires

- WorkSafeBC requirements for fire watch
- Fire hazards
  - Sparks
  - Elements of a high hazard area
- Fire and explosion prevention
  - Clean area of combustible debris
  - Fire/water hose and/or fire extinguisher set up before and after work
  - Contain sparks by the use of fire-retardant blankets
  - Wet area down in high hazard area before starting hot work
  - Cover wall/floor openings with fire retardant blanket
- Extinguishing fires
  - Fire triangle
  - The four classes of fires
  - Types of fire extinguishers
- Toxic fumes/ventilation
  - Cadmium
  - Zinc
  - Lead
  - Beryllium
  - Other alloys
- Synthetic materials

6. Describe confined space entry	• Employer/employee responsibilities
	• Hazard assessment and work procedures
	• Identification and entry permits
	• Lockout and isolation
	  ○ Verification and testing
	  ○ Cleaning, purging, venting, inserting
	  ○ Standby persons
	  ○ Rescue
	  – Lifelines, harnesses and lifting equipment
	• Personal protective equipment and other precautions

7. Describe requirements for H2S training	• Properties, characteristics and locations of H2S
	• Health hazards
	• MSDS requirements
	  ○ Initial response strategy
	  ○ Ventilation, controls and PPE
	  – Respiratory protective equipment
	  – Self-Contained Breathing Apparatus (SCBA)
	  – Supplied Air Breathing Apparatus (SABA)
	• Detecting and monitoring for H2S
	  ○ Detector tube devices
	  ○ Electronic monitors
	• Rescue techniques
	  ○ Rescue breathing
	• Emergency response planning

Line (GAC): A Occupational Skills

Competency: A3 Perform basic trade related mathematical calculations

Objectives

To be competent in this area, the individual must be able to:

- Perform basic welder trade related mathematical calculations.

LEARNING TASKS	CONTENT

1. Solve trade related mathematical problems related to measurement	• Fractions
	  ○ Basic mathematical functions
	  ○ Calculate averages
	  ○ Key terms and concepts
	  ○ Convert to percentages and decimals
	• Decimals
	  ○ Basic mathematical functions
	  ○ Decimal fractions
	  ○ Convert decimals to common linear measurements (i.e. feet and inches)
	  ○ Convert to percentages
	• Whole numbers
	• Ratio and proportion
	• Metric and Imperial measurements
	• Convert between units of measurement
	  ○ Linear measurements
	  ○ Volumetric measurements

2. Solve problems involving geometric formulas	• Metric and Imperial measurements
	• Geometric formulas
	  ○ Perimeter
	  ○ Area
	  ○ Volume
	• Calculate the weight of a solid

Line (GAC): A Occupational Skills

Competency: A4 Use and maintain measuring and layout tools

Objectives

To be competent in this area, the individual must be able to:

- Describe and demonstrate the safe use and care of measuring and layout tools.

LEARNING TASKS	CONTENT

1. Identify, describe and select layout tools	• Combination squares
	  ○ Square head
	  ○ Center head
	  ○ Protractor head
	• Marking tools
	  ○ Soapstone
	  ○ Scriber or awl
	  ○ Chalkline
	  ○ Divider and trammel points
	  ○ Center punch
	  ○ Prick punch
	  ○ Spring loaded punch
	  ○ Transfer punch
	  ○ Number and letter stamps
	  ○ Pneumatic or electronic etching

2. Use and maintain layout tools	• Selecting correct tool for task • Proper usage • General maintenance and storage

3. Identify, describe and select measuring tools	• Systems of measuring
	  ○ Metric
	  ○ Imperial
	• Measuring tools
	  ○ Pocket measuring tape
	  ○ Steel rule
	  ○ Torpedo level
	  ○ Spirit level
	  ○ Laser level
	  ○ Plumb bob
	  ○ Framing square
	• Gauges
	  ○ Fillet weld
	  ○ Pipe internal alignment
	  ○ Single purpose weld
	  ○ Bridge cam

4. Use and maintain measuring tools	• Selecting correct tool for task

- Proper usage
- General maintenance and storage

Line (GAC): A Occupational Skills

Competency: A5 Use and maintain hand tools

Objectives

To be competent in this area, the individual must be able to:

- Describe and demonstrate the safe use and care of hand tools.

LEARNING TASKS	CONTENT

1. Identify, describe and select clamping tools	• Vises
	  ○ Bench vise
	  ○ Machine vise
	  ○ Pipe vise
	  ○ Top screw bench chain vise
	  ○ Tri-stand yolk vise
	• Clamps
	• Pliers
	  ○ Combination
	  ○ Interlocking slip-joint
	  ○ Needle-nose and round-nose
	  ○ GMAW

2. Use and maintain clamping tools	• Safety • Selecting correct tool for task • Proper usage • General maintenance and storage
3. Identify, describe and select alignment tools	• Drifts • Pinch line up bars • Pry bars • Dogs and wedges • External pipe alignment tools
4. Use and maintain alignment tools	• Safety • Selecting correct tool for task • Proper usage • General maintenance and storage
5. Identify, describe and select cutting tools	• Hacksaws • Files • Manual sheers • Cold chisels • Bolt cutters • Wire cutters
6. Use and maintain cutting tools	• Safety • Selecting correct tool for task

- Proper usage
- General maintenance and storage

7. Identify, describe and select other common hand tools
   - Wire brushes
   - Hammers
     - Ball-peen
     - Soft-faced
     - Chipping hammers
     - Sledge hammers
     - Dead blow hammers
     - Cross-peen
   - Anvils
   - Wrenches
     - Open-end
     - Box-end
     - Combination
     - Adjustable
     - Cylinder
     - Socket
     - Pipe
     - Hexagon key
   - Screwdrivers
     - Blade
     - Phillips
     - Robertson
     - Torx

8. Use and maintain other common hand tools
   - Safety
   - Selecting correct tool for task
   - Proper usage
   - General maintenance and storage

9. Identify, describe and select taps and dies
   - Taps
     - Tap wrenches
     - Dies
     - Tapping internal threads
     - Common tapping problems
   - Cutting external threads

10. Use and maintain taps and dies
    - Safety
    - Selecting correct tool for task
    - Proper usage
    - General maintenance and storage

11. Identify, describe and select alignment tools
    - Drifts
    - Pinch line up bars
    - Pry bars
    - Dogs and wedges

Achievement Criteria

Performance	The learner will be evaluated on the ability to: • Fabricate a welding bevel/drill bit point gauge. • Layout a full-size pan.
Conditions	As part of a practical shop project, given the required tools and materials.

Criteria	• Welding bevel/drill bit point gauge will be evaluated for:
	  ○ Squareness and accuracy of dimensions
	  ○ Correct angles and correct placement of holes, stamps, graduations, etchings
	  ○ Overall appearance
	• Pan layout will be evaluated for:
	  ○ Squareness and accuracy of measurement
	  ○ Accurate marking of break or cut lines
	  ○ Overall appearance
	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): A Occupational Skills

Competency: A6 Use and maintain power tools (electric and pneumatic)

Objectives

To be competent in this area, the individual must be able to:

- Describe and demonstrate the safe use and care of electric and pneumatic power tools.

LEARNING TASKS	CONTENT
1. Identify, describe and select power drilling tools	• Portable power drills • Rechargeable drills • Keyless chuck drills • Hammer drills • Magnetic base drills • Drill presses • Twist drill bits • Hollow bits • Hole saws • Carbide tipped masonry bits
2. Use and maintain power drilling tools	• Safety • Selecting correct tool for task • Set up and adjustment • Proper usage • General maintenance and storage
3. Identify, describe and select power grinding tools	• Stationary grinders • Portable grinders • Stationary belt sanders • Portable belt sanders • Abrasives and disks • Carbide burrs • Mini belt sanders
4. Use and maintain power grinding tools	• Safety • Selecting correct tool for task • Set up and adjustment • Proper usage • General maintenance and storage
5. Identify, describe and select power shearing tools	• Power squaring shears • Rotary throatless shears • Universal machines • Iron worker • Nibblers • Pipe cutters

6.	Use and maintain power shearing tools	• Safety • Selecting correct tool for task • Set up and adjustment • Proper usage • General maintenance and storage
7.	Identify, describe and select power sawing tools	• Abrasive cut-off saw • Power hacksaw • Metal-cutting band saws • Reciprocating saws • Sabre • Circular saws • Blades for metal-cutting saws
8.	Use and maintain power sawing tools	• Safety • Selecting correct tool for task • Set up and adjustment • Proper usage • General maintenance and storage
9.	Identify, describe and select specialty tools	• Scaler • Needle scaler
10.	Use and maintain specialty tools	• Safety • Selecting correct tool for task • Set up and adjustment • Proper usage • General maintenance and storage

Achievement Criteria

Performance — The learner will be evaluated on the use of power tools, including:

- Sharpen twist drill bits using freehand method.
- Grind, drill, tap and cut low carbon steel flat bar.

Conditions — As part of a practical shop project, given the required tools and materials.

Criteria

- Sharpening of twist drill bits will be evaluated for:
  - Accuracy of angles
  - Absence of distempering, chips, cracks
  - Cutting efficiency of sharpened drill bits
  - Overall appearance
- Grind, drill, tap and cut low carbon steel flat bar will be evaluated for:
  - Smooth surfaces/correct location of holes
  - Internal threads, alignment and fit
  - Correct location of cut
  - Clean cut (absence of burrs and sharp edges)
  - Accuracy of dimensions
  - Overall appearance

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): A Occupational Skills

Competency: A7 Describe shop materials

Objectives

To be competent in this area, the individual must be able to:

- Identify and describe common sheet, plate, pipe and structural shapes.

LEARNING TASKS	CONTENT

1. Identify and describe materials	• Plate and sheet
	  ○ Specifying sheet sizes
	  ○ Specifying plate sizes
	• Steel bars
	  ○ Rectangular bar, flat bar and strip stock
	  ○ Square bar
	  ○ Round bar
	  ○ Half oval bar
	  ○ Hexagon bar
	  ○ Octagon bar
	• Shapes
	  ○ W, S and M shapes
	• Angles
	  ○ Equal leg lengths
	  ○ Unequal leg angles
	  ○ Structural tees
	  ○ Channel
	• Structural tubing (hollow structural sections)
	  ○ Round tubing
	• Structural pipe

2. Select materials	• Read bill of materials • Resource materials
3. Describe correct procedures for manually handling and storing structural shapes	• Personal Protective Equipment (PPE) • Correct body position/posture for lifting • Center of gravity • Block and store ○ Location and environment

Line (GAC): A Occupational Skills

Competency: A8 Apply lifting, hoisting and rigging procedures

Objectives

To be competent in this area, the individual must be able to:

- Describe safety procedures for rigging and material handling.
- Perform safe working load (SWL) calculations involving geometric formulas, volumes and capacities.
- Perform safe manual-lifting procedures.
- Describe wire rope, slings and rigging hardware.
- Use hoisting equipment to perform lift.

LEARNING TASKS	CONTENT

1. Describe safety precautions for rigging and hoisting	• WorkSafeBC regulations
	• PPE
	• Hand signals
	• Manufacturers' specifications
	• Common safety hazards
	  ○ SWL not known
	  ○ Defective equipment and hardware
	  ○ Unrated lifting lugs
	  ○ Electrical contact
	  ○ Weather conditions

2. Describe the basic principles of lifting, hoisting and rigging	• Center of gravity
	• Safe working loads (SWL)
	  ○ Interpret safe working load charts
	  ○ WorkSafeBC regulations (part 15)

3. Describe and perform safe manual lifting	• Personal Protective Equipment (PPE) • Correct body position/posture for lifting • Center of gravity • Block and store

4. Identify common rigging hardware (below-the-hook lifting devices)	• Hooks
	  ○ Hoisting hooks
	  ○ Choker hooks
	• Clips
	  ○ Wire rope clips (number and spacing)
	  ○ Cable clips
	• Attachments
	  ○ Swivels
	  ○ Shackles
	  ○ Eye bolts
	  ○ Snatch blocks
	  ○ Turnbuckles

		○ Spreader and equalizer beams ○ Plate clamps • Magnets
5.	Describe the characteristics, applications and care of wire rope and slings	• Wire ropes ○ Diameter ○ SWL calculations ○ Rejection criteria • Sling types ○ Synthetic web slings ○ Wire rope slings ○ Alloy steel chain slings ○ Metal mesh slings • Mandatory rating tags on slings • Storage • Visual inspection • Rejection criteria • Safe working loads (SWL)
6.	Describe common sling configurations and their application	• Sling configurations ○ Single vertical hitch ○ Bridle hitch ○ Single basket hitch ○ Double basket hitch ○ Double-wrap basket hitches ○ Single choker hitch ○ Double choker hitch ○ Double-wrap chocker hitch • Sling angles • Adjust rated capacity for sling configurations
7.	Describe common types of hoisting equipment and their application	• Jacks (ratchet, hydraulic) • Jack stands • Rollers • Block and tackle • Chain blocks • Lever-operated hoists or come-a-longs • Hoists ○ Chain hoists ○ Grip action hoists (Tirfors) ○ Electric hoists and pendant cranes ○ Floor hoists • Winches • Forklifts • Crane types ○ Gantry cranes – Remote pendant control

  - Overhead runways
- Jib cranes
- Overhead travelling cranes
- Mobile cranes
- Tower cranes

8. Operate hoisting equipment

- Hoisting equipment
- Factors that reduce capacity
- Select proper rigging
- Attach proper rigging

Achievement Criteria

Performance
The learner will be evaluated on the ability to:
- Perform a manual lift.
- Identify and use the proper type of hoisting equipment to perform a lift.

Conditions
As part of a practical shop project, given the required materials, equipment and pre-calculated lift plan under supervision.

Criteria
- Under supervision, manual lifting will be evaluated for:
  - Personal Protective Equipment (PPE)
  - Correct body position/posture for lifting
  - Center of gravity
  - Block and store
- Under supervision, using hoisting equipment will be evaluated for:
  - Visual check of the lifting equipment before use
  - Checking capacity of equipment
  - Attaching correct rigging configuration
  - Attaching load correctly to lifting hook
  - Centering lifting hook above load before lifting
  - Hoisting load correctly
  - Lowering load correctly
  - Returning rigging to designated storage place
  - Using all equipment in a safe manner
  - Following all shop safety rules

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): B Cutting and Gouging Processes

Competency: B1 Describe Oxy-Fuel Cutting (OFC) processes and their applications

Objectives

To be competent in this area, the individual must be able to:

- Describe the Oxy-Fuel cutting and gouging (OFC) processes, components and applications.
- Describe techniques for cutting difficult-to-cut ferrous alloys.
- Describe thermal effects and safety precautions for Oxy-Fuel processes.

LEARNING TASKS	CONTENT
1. Describe the Oxy-Fuel processes and their components	• Principles of OFC process • Common components • Process specific components
2. Describe the applications of Oxy-Fuel processes	• Cutting plate, pipe and structural shapes • Washing bolts and rivets • Gouging and scarfing • Stack cutting • Cutting machines

3. Describe the cutting characteristics of ferrous and non-ferrous metals	• Ferrous alloys
	  ○ Techniques for cutting ferrous alloys
	  ○ Kindling point
	  ○ Preheating
	  ○ Waster plates
	• Non-ferrous alloys
	  ○ Aluminum
	  ○ Copper
	  ○ Brass
	  ○ Bronze
	  ○ Magnesium

4. Describe the thermal effects of Oxy-Fuel processes	• Distortion • Surface hardening

5. Describe safety requirements for Oxy-Fuel processes	• PPE
	• Fire and explosion prevention
	  ○ Refer to WorkSafeBC for fire watch regulations
	• Toxic fumes/ventilation
	  ○ Cadmium
	  ○ Zinc
	  ○ Lead
	  ○ Beryllium
	  ○ Other alloys
	  ○ Synthetic materials

Line (GAC): B Cutting and Gouging Processes

Competency: B2 Describe Oxy-Fuel Cutting (OFC) equipment and its operation

Objectives

To be competent in this area, the individual must be able to:

- Describe oxygen and fuel gases used in Oxy-Fuel processes.
- Describe gas cylinders and regulators, tips and attachments, and cutting machines used in Oxy-Fuel processes.

LEARNING TASKS	CONTENT

1. Describe the gases and their properties, used in Oxy-Fuel processes	• Oxygen
	• Acetylene
	• Other fuel gases
	  ○ Methylacetylene-propadiene
	  ○ Natural gas
	  ○ Propane gas

2. Describe oxygen and fuel gas cylinders	• Oxygen cylinders
	• Oxygen cylinder valve
	• Acetylene cylinders
	• Acetylene cylinder valves
	• Cylinder safety devices
	• Liquid fuel cylinders
	• Storage and handling of cylinders
	  ○ Storage
	  ○ Handling
	  ○ Safety precautions for using cylinders

3. Describe pressure regulators and their functions	• Oxygen and acetylene regulators
	• Single and two-stage regulators
	  ○ Single-stage regulator
	  ○ Two-stage regulator
	  ○ Safe use of regulators

4. Describe Oxy-Fuel hoses and fittings	• Oxy-Fuel hose
	  ○ Safe handling of hose
	  ○ Hose fitting
	• Torch line explosions – causes and prevention
	  ○ Backfire
	  ○ Flashbacks
	• Reverse flow check valves

5.	Describe torches and tips used in the Oxy-Fuel processes	• Injector torch
		• Equal pressure torch
		• Torch types
		  ○ One-piece cutting torch
		  ○ Two-piece cutting torch
		  ○ Machine torch
		• Cutting tips
		  ○ Cutting tip size
		  ○ Types of cutting tips
		  ○ Cutting tip maintenance
		• Tips for special purposes
		  ○ Rivet-cutting tips
		  ○ Gouging tips
		  ○ Heating tips

6.	Describe gas manifold systems	• Oxygen manifold systems • Acetylene manifold systems

7.	Describe Oxy-Fuel gas cutting accessories and machines	• Manual cutting guides
		• Straight-line cutting guide
		• Circle cutting guide
		• Templates
		• Cutting machines
		  ○ Straight-line cutting machines
		  ○ Shape-cutting machines
		• Electronic eye tracer
		• Magnetic tracer
		• Pipe-bevelling machines

Line (GAC): B Cutting and Gouging Processes

Competency: B3 Perform freehand and guided cuts on low carbon steel (OFC)

Objectives

To be competent in this area, the individual must be able to:

- Assemble the appropriate oxy-fuel cutting equipment, set pressures, light and adjust the cutting torch.
- Make freehand and guided cuts on low carbon steel plate.
- Make freehand cuts on round stock, structural shape and pipe.
- Pierce holes in low carbon steel plate.

LEARNING TASKS

1. Assemble, ignite and shut down a portable oxyacetylene outfit

CONTENT

- Portable oxyacetylene outfit
  - Secure the cylinders
  - Remove the caps
  - Crack the valves
- Attach the regulators
- Install RFCV
  - Connect the hoses
  - Open the valves
  - Purge the hoses
- Flashback arrestors
- Connect the cutting attachment
  - Set working pressure
- Select and install the appropriate cutting tip
  - Set working pressure
- Test for leaks
  - Light and adjust flame
  - Ignite the torch
  - Add oxygen to the flame
- Shut down an oxyacetylene outfit
- Disassemble the oxyacetylene outfit

2.	Describe the characteristics of an acceptable cut	• Characteristics of an acceptable cut
		  ○ Top edge square
		  ○ Vertical draglines
		  ○ Bottom edge sharp
		• Factors that affect the quality of cut
		  ○ Speed of travel
		  ○ Surface condition of the metal
		  ○ Oxygen pressure
		  ○ Tip size
		  ○ Size of the preheat flames
		  ○ Thickness of the material
		  ○ Position of the cutting torch tip
		  ○ Position in relation to the work
		  ○ Starting cuts

3.	Perform freehand cuts on low carbon steel	• Low carbon steel sheet
		  ○ Freehand square cuts
		  ○ Freehand bevel cuts
		• Low carbon steel plate
		  ○ Freehand square cuts
		• Structural steel
		  ○ Freehand square cuts
		  ○ Freehand bevel cuts
		• Nuts and weldments
		  ○ Wash nuts
		  ○ Gouge weldments
		• Low carbon steel pipe
		  ○ Freehand square cuts
		  ○ Freehand bevel cuts

4.	Perform guided cuts on low carbon steel	• Low carbon steel plate
		  ○ Guided square cuts
		  ○ Guided bevel cuts
		  ○ Guided circular cuts
		• Low carbon steel sheet
		  ○ Guided square cuts
		• Steel pipe

5.	Pierce holes in low carbon steel plate	• Freehand piercing of miscellaneous shapes
6.	Wash nuts off bolts and gouge weldments	• Wash nuts off bolts • Gouge weldments

Achievement Criteria

Performance — The learner will be evaluated on the ability to:

- Assemble, ignite and shutdown Oxy-Fuel equipment.
- Perform freehand and guided cuts on low carbon steel plate, sheet round stock, structural shapes and pipe.

Conditions — As part of a practical shop project, given the required tools and materials.

Criteria

- Correct procedures followed for:
  - Assembly, setup and shutdown
  - Igniting and adjusting cutting and heating torches
  - Cleaning gas cutting tips
  - Repairing gas hose connection
- All cuts and holes pierced will be evaluated for:
  - Top and bottom edges are sharp (not rounded)
  - Slag is minimal and easily removed
  - Cut is consistently square (90º, not bevelled)
  - Draglines are perpendicular and not too pronounced
  - Cut surface is flat and not rounded or concave
  - Cut line is followed (cuts are straight - holes are desired size and round)
- Wash nuts off bolts will be evaluated for:
  - Cut quality
  - Slag is minimal and easily removed
  - No damage to the bolt
  - No damage to the plate surfaces

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): B Cutting and Gouging Processes

Competency: B4 Use automatic and semi-automatic cutting machines (OFC)

Objectives

To be competent in this area, the individual must be able to:

- Set up and operate automatic and semi-automatic cutting machines and produce high quality straight cuts, bevel cuts and pipe bevel cuts.

LEARNING TASKS	CONTENT
1. Perform cuts with a straight-line cutting machine using Oxy-Fuel gas	• Straight cuts
2. Perform cuts with a shape-cutting machine using Oxy-Fuel gas	• Bevel cuts
3. Perform cuts with a pipe-bevelling machine using Oxy-Fuel gas	• Pipe cuts • Pipe bevel cuts

4. Use automatic and semi-automatic cutting machines	• Set up
	  ○ Automatic cutting machines
	  ○ Semi-automatic cutting machines
	• Perform cuts
	  ○ Straight cuts
	  ○ Bevel cuts
	  ○ Pipe bevel cuts

Achievement Criteria

Performance: The learner will be evaluated on the ability to perform cuts with automatic and semi-automatic cutting machines.

Conditions: As part of a practical shop project, given the required tools and materials.

Criteria:

- Demonstrate correct setup and safe operation of straight line-cutting machine, shape-cutting machine and pipe-bevelling machine
- Cut and bevels will be evaluated for:
  - Top and bottom edges are sharp and square
  - Slag is minimal and easily removed
  - Cut is consistently square (90°) or bevelled (37.5° or 30°) as per directions
  - Draglines are vertical and not too pronounced
  - Cut surface is flat and not rounded or concave
  - The cut is straight (cut line was followed)
  - Preheat flame-to-work distance was the same all around the pipe
  - Correct cutting sequence was followed

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): B Cutting and Gouging Processes

Competency: B5 Describe CAC-A and PAC processes, equipment and their applications

Objectives

To be competent in this area, the individual must be able to:

- Describe CAC-A equipment and its cutting and gouging operations.
- Describe PAC equipment and its cutting and gouging operations.

LEARNING TASKS	CONTENT

1. Describe the CAC-A process and equipment	• Principles of CAC-A
	• Components
	  ○ Power sources
	  ○ Air supply
	  ○ Power rating
	  ○ DC power sources
	  ○ Connecting two DC power sources in parallel
	  ○ Power cables
	  ○ Electrode holder
	• Electrode types, shapes and size
	• Quality of cut surfaces
	• Effects on the base metal

2. Describe the applications of CAC-A	• Types of cuts
	  ○ Manual
	  ○ Machine
	  ○ Bevelling
	  ○ Washing
	• Elements affecting cut
	  ○ Polarity
	  ○ Torch angle
	  ○ Travel speed
	  ○ Correct positioning of electrode
	  ○ Electrode stickout
	  ○ Operator comfort
	  ○ Operating sequence
	  ○ Gouging in other positions
	  – Vertical
	  – Horizontal
	  – Overhead
	• Weld defects
	• Disassembly and repair

3. Describe the PAC process and equipment	• PAC process fundamentals
	  ○ Advantages
	  ○ Quality of cut

- Air quality control
- Oil
- Moisture
- Contaminants

- Metallurgical effects

- PAC cutting system and equipment
  - Electrodes
  - Ventilation
  - Power sources
  - Control unit
  - Torches
    - Consumables
    - Tip stand-off
    - Air-cooled
    - Water-cooled
  - Gases (plasma and secondary)
  - Water-table cutting
    - Electric shock
    - Ventilation
    - Arc radiation
    - Noise

4. Describe the applications of PAC

- Types of cuts
  - Machine
  - Manual
  - Stack
  - Gouging
- Elements affecting cut
  - Materials being cut
    - Hard-to-cut metals
    - Carbon steel
  - Operating variables
    - Air pressure
    - Travel speed
    - Double arcing
    - Tip-to-work distance
    - Travel direction
    - Torch maintenance

5. Describe procedures for gouging cast iron

- Polarity
- Pre and post heat

6. Describe safety requirements, precautions and procedures for cutting and gouging

- PPE
  - Eye protection for the electrical welding processes
  - Hearing protection
  - Welding helmets
  - Radiation protection
  - Respiratory protection

- Electric shock
  - Damp conditions
  - Treatment of electric shock victims
- Fire and explosion prevention
  - Refer to WorkSafeBC for fire watch regulations
- Safety requirements for operating electric welding equipment
  - Maintenance of equipment
  - Welding cables and connections
  - Electrode holder
  - Ground clamp
  - Electrode stub disposal
  - Slag
- Toxic fumes/ventilation

Line (GAC): B Cutting and Gouging Processes

Competency: B6 Use CAC-A and PAC cutting and gouging processes and equipment

Objectives

To be competent in this area, the individual must be able to:

- Set up CAC-A equipment and demonstrate its cutting and gouging operations.
- Set up PAC equipment and demonstrate its cutting and gouging operations.

LEARNING TASKS	CONTENT
1. Use CAC-A process on low carbon steel	• Set up equipment • Gouge in all positions • Bevel in the flat position • Remove back-up strip/backing material • Remove discontinuities and faults on groove and fillet welds • Prepare joints

2. Use PAC process on low carbon steel	• Set up equipment
	• Perform cuts
	  ○ Square cuts
	  – Ferrous and non-ferrous
	  ○ Bevel cuts
	  ○ Circular cuts
	• Gouge in all positions
	• Bevel in the flat position
	• Prepare joints

Achievement Criteria

Performance The learner will be evaluated on the ability to:

- Use CAC-A equipment to prepare weld joints and to remove weld faults on low carbon steel.
- Assemble PAC equipment and perform bevel cuts, square cuts and circular cuts on both ferrous and non-ferrous metals.

Conditions As part of a practical shop project, given the required tools and materials.

Criteria

- Weld joints will be evaluated for:
  - Uniform width and depth
  - Clean, smooth groove in a straight line
  - Absence of arc strikes
  - No traces of carbon deposit
  - Overall appearance
- Removal of weld faults will be evaluated for:
  - Complete removal of weld metal or weld defect
  - Absence of arc strikes
  - No traces of carbon deposit
  - No damage to base metal

  - Clean, smooth gouge surfaces
  - Shape of groove in respect to weld repair
  - Overall appearance
- PAC cuts will be evaluated for:
  - Top edge is sharp (not rounded)
  - Slag is minimal and easily removed
  - Square cuts are consistently square (90°, not bevelled)
  - Bevelled cuts have a consistent bevel angle of 30°
  - Draglines are consistent and not too pronounced
  - Cut surface is flat and not rounded or concave
  - Bottom edge is sharp
  - Cut edge is straight (cut line was followed)

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): C Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process

Competency: C1 Describe fusion welding, braze welding and brazing processes and their applications

Objectives

To be competent in this area, the individual must be able to:

- Describe fusion welding, braze welding, brazing processes, their applications and safety precautions.

LEARNING TASKS	CONTENT
1. Describe the fusion welding process and its application	• Principles of fusion welding • Filler rods • Applications of fusion welding • Maintenance or repair work • Fabrication • Safety requirements
2. Describe the braze welding process and its application	• Principles of braze welding • Filler rods • Applications • Maintenance or repair work • Light gauge metals • Dissimilar metals • Grey cast iron • Non-ferrous metals • Safety requirements
3. Describe the brazing process and its applications	• Principles of brazing • Filler rods • Applications • Safety requirements

Line (GAC): C Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process

Competency: C2 Describe fusion welding, braze welding and brazing equipment and its operation

Objectives

To be competent in this area, the individual must be able to:

- Describe fusion and braze welding equipment and its operation.

LEARNING TASKS	CONTENT

1. Describe OFW equipment and application	• Fundamentals of OFW process
	• Types of equipment
	  ○ Regulators
	  ○ Flashback arrestors
	  ○ Hoses
	  ○ Types of torch bodies
	  ○ Torch attachments
	• Match equipment to application

2. Describe fuel gas precautions and procedures	• Characteristics of fuel gases • Fuel gas delivery systems • Cylinder and gases handling procedures • Cylinder and gases storage requirements • Hazards associated with different fuel gases • Match fuel gas to type of equipment • Identify type of fuel gas from information on label
3. Describe the main factors to consider in gas fusion welding	• Correct tip sizes • Correct flame setting • Distance between work and flame • Types of welding technique • Torch angle • Speed and travel movement • Operator comfort and position
4. Describe tips and their application	• Type of base metal • Base metal thickness • Tip functions • Required weld • Types of tips • Match tip to base metal and required weld • Differentiate between tips

5.	Describe consumables and requirements	• Fluxes • Filler metals
6.	Describe operating parameters	• Base metal thickness • Welding tip sizes • Gas regulators • Manufacturers' recommendations • Other task specific guidelines • Reference information
7.	Describe setting up OFW equipment	• Set-up procedures • OFW safe practices • Equipment leak test procedures • Safety precautions • Reference manufacturers' instructions

8.	Describe operating OFW equipment	• Required task-specific PPE
		• Safe operating practices
		  ○ Prevent flashback
		  – Recognize flashback
		  – Flashback conditions
		  ○ Prevent backfire burnback
		  – Recognize backfire burnback
		  – Backfire burnback conditions
		• Welding techniques
		• Metallurgy
		• Types of flames
		• Braze welding techniques
		• Brazing fluxes
		• Flame temperatures
		• Metal fusion techniques
		• Light and adjust torch
		• Detecting defects in weld

9.	Describe process related weld discontinuities and their causes	• Weld defects • Lack of penetration • Lack of fusion • Undercut • Reinforcement on groove welds • Correct weld profile for fillet weld

Line (GAC): C Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process

Competency: C3 Describe filler metals, fluxes and tips used for fusion welding, braze welding and brazing

Objectives

To be competent in this area the individual must be able to:

- Identify filler metals, fluxes and tips used for fusion welding, braze welding and brazing.

LEARNING TASKS	CONTENT

1. Describe the filler rods for fusion welding, braze welding and brazing	• Filler rods for fusion welding
	• Low carbon steel rods
	  ○ RG 45
	  ○ RG 60
	  ○ RG 65
	• Filler rod size
	• Brazing and braze welding alloys
	  ○ Silver (BAg)
	  ○ Aluminum-silicon (BA 1Si)
	  ○ Precious-metals (BAu)
	  ○ Copper and copper-zinc (BCu and RBCuZn) brass
	  ○ Copper-phosphorous (BCuP)
	  ○ Magnesium (BMg)
	  ○ Nickel (BNi)
	  ○ Cobalt (BCo)
	• Choosing a brazing filler rod
	  ○ Braze welding filler rods

2. Describe the flux for fusion welding, braze welding and brazing	• Purpose of flux
	  ○ Welding flux
	  ○ Brazing flux
	• High temperature
	• Special purpose or low temperature
	• General purpose flux
	• Choosing the correct brazing flux
	  ○ Using flux
	  ○ Removing flux

3. Describe tips for fusion welding, braze welding and brazing	• Welding tips
	  ○ Selecting the correct welding tip
	  ○ Welding tip maintenance

Line (GAC): C Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process

Competency: C4 Describe joint design and weld positions for OFW

Objectives

To be competent in this area, the individual must be able to:

- Identify basic joint designs, weld positions and the associated abbreviations.

LEARNING TASKS	CONTENT
1. Describe the five basic joints	• Corner joint • Lap joint • Tee joint • Butt joint • Edge joint
2. Describe the four basic welding positions and abbreviations	• Flat position (1F, 1G) • Horizontal position (2F, 2G) • Vertical position (3F, 3G) • Overhead position (4F, 4G)

Line (GAC): C Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process

Competency: C5 Fusion weld on low carbon steel sheet *(optional for Level 1)*

Objectives

To be competent in this area, the individual must be able to:

- Use the OFW process to fusion weld stringer beads on low carbon steel sheet.
- Use the OFW process to fusion weld fillet welds on low carbon steel sheet.
- Use the OFW process to fusion weld groove welds on low carbon steel sheet.

LEARNING TASKS	CONTENT

1. Fusion weld stringer beads using the OFW process	• In the flat position
	  ○ Without a filler rod
	  ○ With a filler rod

2. Fusion weld fillet welds using the OFW process	• In the flat (1F) position
	  ○ Lap joint
	  ○ Corner joint
	• In the horizontal (2F) position
	  ○ Lap joint
	• In the vertical (3F) position
	  ○ Lap joint

3. Fusion weld groove welds using the OFW process	• In the flat (1G) position

Achievement Criteria

Performance — The learner will be evaluated on the ability to fusion weld on low carbon steel sheet:

- Stringer beads, with and without filler metal, in the flat position.
- Fillet welds in the 1F, 2F and 3F (uphill) positions.
- Groove welds in the 1G position.

Conditions — As part of a practical shop project, given the required tools and materials.

Criteria

- Stringer beads will be evaluated for:
  - Correct bead width
  - Convex weld bead profile (welds with filler metal rod)
  - Even ripples
  - Reasonable uniform straight beads
  - Complete fusion
  - Overall appearance
- Fillet welds and groove welds will be evaluated for:
  - Correct sheet alignment
  - Correct bead width
  - Slightly convex weld bead profile
  - Even ripples
  - Uniform, straight bead

- Absence of undercut
- Complete fusion
- Overall appearance

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): C Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process

Competency: C6 Braze weld (TB) using the OFW process *(optional for Level 1)*

Objectives

To be competent in this area, the individual must be able to:

- Braze weld fillet welds on low carbon steel sheet using OFW process.

LEARNING TASKS	CONTENT
1. Describe the procedures for braze welding low carbon steel sheet	• Pre-cleaning and edge preparation • Flame setting • Filler rods and flux • Number of passes • Determining the quality of work
2. Describe braze welding groove welds on grey cast iron using the OFW process	• Braze weld grey cast iron • Pre-cleaning • Pre-heating • Special factors in welding grey cast iron • Welding technique

3. Braze weld fillet welds using the OFW process	• On low carbon steel sheet
	  ○ In the flat (1F) position
	  – Tee joint
	  ○ In the horizontal (2F) position
	  – Lap joint

Achievement Criteria

Performance	The learner will be evaluated on the ability to braze weld: • Fillet welds on low carbon steel sheet.
Conditions	As part of a practical shop project and given the required tools and equipment.

Criteria	• Welds will be evaluated for:
	  ○ Correct sheet alignment
	  ○ Correct bead width
	  ○ Slightly convex weld bead profile
	  ○ Even ripples
	  ○ Uniform, straight bead
	  ○ Good adhesion
	  ○ Overall appearance
	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): C Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process

Competency: C7 Silver alloy braze on similar and dissimilar metals *(optional for Level 1)*

Objectives

To be competent in this area, the individual must be able to:

- Describe silver alloy brazing on similar and dissimilar metals using OFW processes.

LEARNING TASKS	CONTENT
1. Describe the materials, equipment and procedures for silver brazing	• Joint preparation and design • Flux selection • Filler alloys (rods) • Flame for brazing • Silver brazing procedure

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D1 Describe the SMAW process

Objectives

To be competent in this area, the individual must be able to:

- Describe the SMAW process.
- Describe SMAW safety requirements and precautions.

LEARNING TASKS	CONTENT
1. Describe the SMAW process and its applications	• Principles of SMAW • The arc welding circuit

2. Describe safety requirements, precautions and procedures for SMAW	• PPE
	  ○ Eye protection for the electrical welding processes
	  ○ Welding helmets
	  ○ Hearing protection
	  ○ Radiation protection
	  ○ Respiratory protection
	• Electric shock
	  ○ Damp conditions
	  ○ Treatment of electric shock victims
	• Fire and explosion prevention
	  ○ Refer to WorkSafeBC for fire watch regulations
	• Safety requirements for operating electric welding equipment
	  ○ Maintenance of equipment
	  ○ Welding cables and connections
	  ○ Electrode holder
	  ○ Ground clamp
	  ○ Electrode stub disposal
	  ○ Slag
	  ○ Toxic fumes/ventilation

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D2 Describe SMAW equipment and its operation

Objectives

To be competent in this area, the individual must be able to:

- Describe SMAW equipment and its operation.
- Describe the principles of electricity and types of current.
- Describe AC and DC welding power source, electrode holders, ground clamps and welding cables.

LEARNING TASKS	CONTENT
1. Explain basic principles of electricity	• Resistance • Effects of resistance • Electromagnetism • Transformers • Reactor
2. Describe types of current and their applications	• Alternating current • Direct current • Polarity • Arc blow • Dealing with arc blow
3. Describe the effects of a volt-ampere curve on the welding arc	• Volt-ampere curve • Interpreting the volt-ampere curve • Constant current welding power sources • Constant potential welding power sources • Adjusting the voltage • Adjusting the amperage

4. Describe AC and DC welding power sources	• Transformer type welding power sources
	  ○ AC transformers
	  – AC transformer control
	  ○ Transformer/rectifiers
	  – Transformer/rectifier control
	  ○ AC/DC transformers/rectifiers
	  ○ Advantages of transformer type welding power sources
	  ○ Disadvantages of transformer type welding power sources
	• Generator/alternator type welding power sources
	• Electric motor drive DC welding power sources
	  ○ Fuel engine driven AC, DC and AC/DC welding power sources
	  ○ Controls
	  ○ Advantages of generator/alternator type

	welding power sources ○ Disadvantages of generator/alternator type welding power sources • Multi-operator sets ○ Inverters ○ Advantages of inverter type welding power sources • Remote control devices • Ratings for welding power sources • Power requirements • Duty cycle • Choosing between AC and DC welding power sources • General maintenance of welding power sources
5. Describe and select electrode holders, ground clamps and welding cables	• Electrode holder ○ Jaw ○ Twist head • Ground clamps ○ Spring-loaded ○ C-clamp ○ Rotary ○ Magnetic • Welding cables ○ Size ○ Connections

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D3 Select electrodes for SMAW

Objectives

To be competent in this area, the individual must be able to:

- Describe low carbon steel electrodes for SMAW.
- Describe the selection and applications of electrodes.
- Describe basic care, handling and storage of electrodes.

LEARNING TASKS	CONTENT

1. Describe the operation of common electrodes for SMAW	• Functions of electrode coatings
	• Types of electrodes
	  ○ F1 (fast-fill)
	  ○ F2 (fill-freeze)
	  ○ F3 (fast-freeze)
	  ○ F4 (low hydrogen/basic electrode)
	• Electrode coating composition
	  ○ Cellulose
	  ○ Rutile
	  ○ China clay, silica and mica
	  ○ Potassium
	  ○ Ferro-magnanese
	  ○ Iron oxide (magnetite, hematite)
	  ○ Iron powder
	  ○ Sodium silicate
	• Metal transfer with SMAW electrodes
	• Gravity
	• Gas expansion
	• Electro-magnetic force
	• Electromotive force
	• Surface tension

2. Describe the classifications of low carbon steel electrodes	• Standards of coated electrode manufacture • CSA and AWS designations • Electrode length • Electrode diameter

3.	Describe the selection of electrodes for SMAW	• Principles of electrode selection
		• Properties of the base metal
		• Joint design and fit up
		• Welding position and thickness of weld deposit
		• Welding current
		• Service conditions
		• Production factors
		• Common low carbon steel electrodes
		  ○ E4310 (E6010)
		  ○ E4311 (E6011)
		  ○ E4313 (E6013)
		  ○ E4914 (E7014)
		  ○ E4924 (E7024)
		  ○ E4918 (E7018)
		  ○ E4928 (E7028)
		  ○ E309-15, -16 and -17
		• Common hardsurfacing electrodes

4.	Describe correct handling and storage of common electrodes	• Handling of electrodes before and after use • Storage of electrodes • Electrode ovens • Handling of electrodes in use

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D4 Describe basic joint design and weld positions for SMAW

Objectives

To be competent in this area, the individual must be able to:

- Describe basic joint design and weld positions for fillet welds using the SMAW process.
- Describe groove welds using the SMAW process.

LEARNING TASKS	CONTENT
1. Describe the five basic joint types as they apply to SMAW processes	• Lap • Tee • Corner • Edge • Butt

2. Describe weld types, their sizes and profiles	• Bead welds
	• Tack welds
	• Fillet welds
	• Groove welds
	  ○ Square
	  ○ Single-v and double-v
	  ○ Single bevel and double bevel
	  ○ Single U and double U
	  ○ Single J and double J
	• Profiles, sizes, plate thickness transitions on butt joints
	• Plug and slot welds
	• Continuous and intermittent welding

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D5 Describe weld faults and distortion in fabrications in SMAW

Objectives

To be competent in this area, the individual must be able to:

- Describe weld faults and their causes.
- Describe distortions and methods of prevention.

LEARNING TASKS	CONTENT
1. Describe the process-related weld faults and their causes	• Dimensional defects • Incorrect weld size • Overlap • Structural discontinuities in the weld • Under cut • Incomplete penetration • Lack of fusion • Porosity • Slag inclusion • Cracking (internal/external) • Insufficient throat/underfill

2. Identify distortions and determine methods of prevention and control	• Types of distortion
	  ○ Longitudinal distortion
	  ○ Transverse distortion
	  ○ Angular distortion
	• Distortion control
	  ○ Use mechanical methods
	  ○ Design methods
	  ○ Procedural methods
	  ○ Rate of heat input/joules
	  ○ Distribute the heat input as uniformly as possible
	  ○ Pre-heat and post-heat when necessary

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D6 Use the SMAW process on low carbon steel plate and pipe

Objectives

To be competent in this area, the individual must be able to:

- Use the SMAW process to weld bead welds in the flat position.
- Use the SMAW process to perform single-pass fillet welds on low carbon steel sheet.
- Use the SMAW process to perform multi-pass fillet welds on low carbon steel plate, structural shape to plate and on pipe to plate.

LEARNING TASKS	CONTENT
1. Describe main factors of the SMAW process	• Operator comfort and position • Machine setting • Arc length • Electrode angle • Speed of travel • Electrode oscillation
2. Weld beads in the flat position	• Strike an arc using scratch and tap method • Weld stringer beads in the flat position • Weld beads in the flat position using the weave method

3. Weld single-pass fillet welds	• On low carbon steel sheet
	  ○ Horizontal (2F) position
	  – Lap joint
	  – Tee joint
	  ○ Vertical (3F) position - downhill
	  – Lap joint
	  – Tee joint

4. Weld multi-pass fillet welds	• On low carbon steel plate
	  ○ Flat (1F) position
	  – Lap joint
	  – Tee joint
	  – Corner joint
	  ○ Horizontal (2F) position
	  – Lap joint
	  – Tee joint
	  – Corner joint
	  ○ Vertical (3F) position
	  – Lap joint - uphill
	  – Tee joint - uphill
	  – Corner joint – uphill
	  ○ Vertical (4F) position
	  – Lap joint
	  – Tee joint

  - Corner joint
- On structural shape to plate
  - Horizontal (2F) position

Achievement Criteria

Performance	The learner will be evaluated on the ability to use the SMAW process to: • Strike an arc using the tap and scratch methods. • Weld stringer beads in the flat position and weave beads in the flat position. • Weld fillet welds in all positions on low carbon steel plate. • Weld fillet welds in the 2F and 3F positions on low carbon steel sheet.
Conditions	As part of a practical shop project, given the required tools and materials.

Criteria	• Strike and maintain arc smoothly
	• Stringer bead and weave bead welds will be evaluated for:
	  ○ Correct bead width
	  ○ Reasonable smooth straight beads
	  ○ Absence of arc strikes
	  ○ Overall appearance
	  ○ Weave bead welds will also be evaluated for crown-to-crown bead placement
	• Fillet welds will be evaluated for:
	  ○ Correct alignment
	  ○ Good penetration and fusion
	  ○ Reasonable smoothness
	  ○ Legs of equal length
	  ○ Slightly convex profile
	  ○ Absence of porosity, irregularities, undercut and arc strikes
	  ○ Overall appearance
	
	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D7 Use the hardsurfacing process on low carbon steel

Objectives

To be competent in this area, the individual must be able to:

- Describe hardsurfacing preparation.
- Describe problems encountered while hardsurfacing.
- Use hardsurfacing on low carbon steel plate.

LEARNING TASKS	CONTENT

1. Describe hardsurfacing preparation and procedures	• Welding polarity
	• Types of wear
	  ○ Abrasion
	  ○ Impact
	  ○ Erosion
	  ○ Corrosion
	  ○ Oxidation
	  ○ Compression
	  ○ Thermal shock
	• Electrodes
	  ○ High-speed steels
	  ○ Austenitic manganese steels
	  ○ Chromium carbides
	  ○ Tungsten carbides
	  ○ Copper alloys
	  ○ Nickel chromium alloys
	• Depositing filler metal
	• Surface preparations
	  ○ Buildup
	  ○ Preheating
	  ○ Cooling rate
	  ○ Types of patterns
	  ○ Stringer beads

2. Describe problems encountered in hardsurfacing	• Dilution • Spalling • Underbead cracking • Stress failure • Weld cracking • Transverse or cross cracking • Longitudinal or centre-line cracking • Distortion

3.	Demonstrate build-up and hardsurfacing on low carbon steel plate	• Build up
		  ○ Flat (1S) position
		• Hardsurface
		  ○ Flat (1S) position
		• Hardsurface buttons
		  ○ Flat (1S) position

Achievement Criteria

Performance	The learner will be evaluated on the ability to use the SMAW process to buildup and hard surface on low carbon steel plate in the flat position.
Conditions	As part of a practical shop project, given the required tools and materials.

Criteria	• Buildup and hardsurfacing a waffle pattern will be evaluated for:
	  ○ Correct alignment
	  ○ Good penetration
	  ○ Good fusion
	  ○ Slightly convex profile
	  ○ Reasonable smoothness
	  ○ Maximum and minimum buildup according to specifications
	  ○ Absence of irregularities, porosity, undercut and arc strikes
	  ○ Overall appearance
	• Hardsurfacing a button pattern will be evaluated for:
	  ○ Good fusion
	  ○ Reasonable smoothness
	  ○ Absence of irregularities, porosity and arc strikes
	  ○ Overall appearance
	
	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D9 Use the SMAW process on stainless steel and/or low carbon steel plate and pipe

Objectives

To be competent in this area, the individual must be able to:

- Describe proper handling of stainless steel plate and consumables.
- Use the SMAW process to apply stainless steel filler metal to low carbon steel plate.

LEARNING TASKS	CONTENT

1. Describe specific safety precautions when welding stainless steel	• PPE specific to stainless steel
	• Toxic fumes/ventilation
	• Electrode coatings
	  ○ Chromium
	  ○ Nickel
	• Reflective radiation

2. Describe proper handling and preparation procedures for materials and consumables	• Material handling contamination • Abrasives and hand brushes • Rigging and tooling • Work area • Chemical cleaners
3. Describe the principal considerations in the SMAW welding of stainless steel	• Machine settings • Heat input • Weld contamination • Surface oxidation of weld area • Distortion
4. Weld multi-pass fillet welds using stainless steel electrodes on low carbon steel plate	• Horizontal (2F) position

Achievement Criteria

Performance	The learner will be evaluated on the ability to weld multi-pass fillet welds on low carbon steel plate in the horizontal (2F) position using stainless steel filler metal electrodes.
Conditions	As part of a practical shop project, given the required tools and materials.

Criteria	• Multi-pass fillet welds will be evaluated for:
	  ○ Correct alignment
	  ○ Good penetration
	  ○ Reasonable smoothness
	  ○ Legs of equal length
	  ○ Slightly convex profile
	  ○ Absence of irregularities, porosity, undercut and arc strikes
	  ○ Overall appearance
	
	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E1 Describe GMAW, GMAW-P, FCAW, MCAW and SAW processes and their applications

Objectives

To be competent in this area, the individual must be able to:

- Describe semi-automatic processes and their applications.
- Describe modes of metal transfer.
- Describe safety precautions.
- Describe weld discontinuities.

LEARNING TASKS	CONTENT

1. Describe the safety considerations for semi-automatic welding processes	• PPE
	• Prevention of electric shock
	• Fire and explosion prevention
	• Maintenance of equipment
	• Toxic fumes/ventilation
	• Aluminum specific considerations
	  ○ Ozone
	  ○ Chemical cleaners
	• Stainless steel specific considerations
	  ○ Chromium
	  ○ Nickel
	  ○ Chemical cleaners

2. Describe the GMAW process and its application	• Principles of GMAW
	• Application
	  ○ Advantages and disadvantages
	• Components
	• Modes of metal transfer
	  ○ Pinch effect
	  ○ Short-circuit transfer
	  ○ Globular transfer
	  ○ Spray transfer
	  ○ Transition currents

3. Describe the GMAW-P process and its application	• Principles of GMAW-P
	• Application
	  ○ Advantages and disadvantages
	• Components
	• Modes of metal transfer
	  ○ Pinch effect
	  ○ Globular transfer
	  ○ Spray transfer
	  ○ Transition currents

		○ Pulsed spray transfer
4.	Describe the FCAW process and its application	• Principles of FCAW • Application ○ Advantages and disadvantages • Components • Modes of metal transfer ○ Globular transfer ○ Spray transfer
5.	Describe the MCAW process and its application	• Principles of MCAW • Application ○ Advantages and disadvantages • Components • Modes of metal transfer ○ Globular transfer ○ Spray transfer
7.	Describe the SAW process and its application	• Principles of SAW • Application ○ Advantages and disadvantages • Components • Filler metals • Fluxes
8.	Describe weld discontinuities in semi-automatic and automatic welding	• Dimensional defects • Incorrect weld size • Overlap • Structural discontinuities in the weld • Under cut • Incomplete penetration • Lack of fusion • Porosity • Slag inclusion • Cracking (internal/external) • Insufficient throat/underfill

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E2 Describe semi-automatic and automatic welding equipment and its operation

Objectives

To be competent in this area, the individual must be able to:

- Describe semi-automatic and automatic equipment and its operation.
- Describe weld discontinuities.

LEARNING TASKS	CONTENT

1. Identify power sources for semi-automatic and automatic welding	• Constant voltage/current power sources
	  ○ Arc voltage
	  ○ Slope
	  ○ Inductance
	• Inverter power sources
	• Types of controls on power sources
	  ○ Voltage controls
	  ○ Slope controls
	  ○ Inductance controls
	  ○ Current controls
	  ○ Voltmeters and ammeters
	  ○ Remote controls and dual schedules
	  ○ Pulsed power sources
	• Wire feed speed (WFS)

2. Identify the equipment for semi-automatic and automatic wire-feed systems	• Types of systems
	  ○ Push
	  ○ Pull
	  ○ Push-pull
	• Wire-feed controls
	• Drive roll types
	• Constant and variable speed wire-feeders
	• Aluminum specific considerations

3. Describe welding gun assemblies for semi-automatic and automatic processes	• Welding gun types
	  ○ Amperage rating
	  ○ Water cooled
	  ○ Gas cooled
	  ○ Spool
	• Welding gun consumables
	• Cable assembly – size and adaptors
	• Liners
	• Preventive maintenance
	• Aluminum specific considerations

4.	Describe equipment for semi-automatic and automatic welding processes	• Welding guns
		  ○ Amperage rating
		  ○ Water cooled
		  ○ Gas cooled
		  ○ Spool
		  ○ Welding gun consumables
		  ○ Welding cables
		• Aluminum specific considerations
		• Preventative maintenance
		• Filler metal
		• Shielding gases and flow devices
		• Troubleshooting
		  ○ Mechanical
		  ○ Electrical
		  ○ Shielding gases

5.	Describe process variables for semi-automatic and automatic welding	• Primary process variables
		  ○ Voltage
		  ○ Wire feed speed
		  ○ Welding current
		  ○ Trim or arc length (GMAW-P)
		• Secondary process variables
		  ○ Electrode extension (stickout)
		  ○ Arc length
		  ○ Contact tip to work distance
		  ○ Push/pull technique
		  ○ Gun to work angles
		  ○ Nozzle to work distance
		  ○ Travel speed

6.	Identify process related weld discontinuities and their causes	• Dimensional defects
		  ○ Incorrect weld size
		  ○ Insufficient throat/underfill
		• Structural discontinuities in the weld
		  ○ Undercut
		  ○ Incomplete penetration
		  ○ Lack of fusion
		  ○ Cold lap
		  ○ Porosity
		  ○ Cracking (internal/external)
		• Slag inclusions

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E3 Describe filler metal and shielding gases for semi-automatic and automatic processes

Objectives

To be competent in this area, the individual must be able to:

- Describe filler metal and shielding gases for semi-automatic and automatic processes.
- Describe the CSA and AWS filler metal classification systems and specifications for semi-automatic and automatic processes.
- Describe the application for commonly used semi-automatic and automatic processes.
- Describe the basic care, handling and storage procedures for filler metals used with semi-automatic and automatic processes.

LEARNING TASKS	CONTENT

1. Describe filler metal for GMAW	• Low carbon steel filler metal classification systems
	  ○ CSA
	  ○ AWS
	• Application of most common GMAW wires
	  ○ ER49S-1 to 7 (ER70S-1 to 7)
	  ○ ER49S-G (ER70S-G)
	• Handling and storage
	• Aluminum filler metal classification
	• Stainless steel filler metal classification

2. Describe low carbon steel filler metals for FCAW and MCAW	• Major classifications of FCAW low carbon steel filler metals
	  ○ Gas-shielded wire (T-1 and T-9)
	  ○ Self-shielded wire (T8 and T11)
	• Major classifications of MCAW low carbon steel filler metals
	• Filler metal handling procedures
	• Filler metal storage requirements

3. Describe low carbon steel filler metals for SAW	• Types • Classifications • Handling and storage requirements
4. Describe fluxes for SAW	• Types • Classifications • Handling and storage requirements

5. Describe the shielding gases for semi-automatic and automatic processes	• Types of shielding gases
	  ○ Single gas
	  – Carbon dioxide
	  – Inert (argon and helium)
	  ○ Mixed gas

    - Argon-oxygen mixtures
    - Helium-argon mixtures
    - Specific gas mixtures to suit applications
    - Quaternary mixtures
- Properties
  - Density
  - Thermal conductivity
  - Ionization potential
  - Flowrates for shielding gases
    - Solutions for regulator “freeze-up”
  - Cathode jet
- Components of shielding gas systems
  - Shielding gas cylinders
  - Carbon dioxide cylinders
  - Regulators
  - Flowmeters
  - Manifold systems
  - Gas mixers
- Safe handling

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E4 Use the GMAW and GMAW-P process

Objectives

To be competent in this area, the individual must be able to:

- Use the GMAW process to weld on low carbon steel plate.
- Use the GMAW process to weld on aluminum plate.
- Use spray transfer.

LEARNING TASKS	CONTENT
1. Set up GMAW equipment using a DC constant voltage power source	• CV power source • Wire feeder • Drive rolls • Welding gun • Cable • Wire • Cylinder gas • Flow meter • Ground clamp
2. Weld stringer beads using the GMAW process	• On low carbon steel plate ○ In the flat (1S) position

3. Weld single-pass fillet welds using the GMAW process	• On low carbon steel sheet
	  ○ In the horizontal (2F) position
	  – Lap
	  – Tee
	  ○ In the vertical (3F) position
	  – Lap (downhill)
	  – Tee (downhill)
	• On low carbon steel plate
	  ○ In the flat (1F) position
	  – Lap
	  – Tee
	  – Corner
	  ○ In the horizontal (2F) position
	  – Lap
	  – Tee
	  – Corner
	  ○ In the vertical (3F) position
	  – Lap (uphill and downhill)
	  – Tee (uphill and downhill)
	• On aluminum plate
	  ○ In the horizontal (2F) position
	  – Lap

4.	Weld multi-pass fillet welds using the GMAW short circuit transfer process	• On low carbon steel plate
		  ○ In the vertical (3F) position
		  – Tee (uphill and downhill)

5.	Weld multi-pass fillet welds using the GMAW spray transfer process	• On low carbon steel plate
		  ○ In the flat (1F) position
		  – Lap
		  – Tee
		  ○ In the horizontal (2F) position
		  – Lap
		  – Tee
		• On aluminum plate
		  ○ In the horizontal (2F) position
		  – Tee

6.	Describe the principal considerations for welding aluminum using the GMAW process	• Set welding variables • Heat input • Shielding gases • Weld contamination • Surface oxidation of weld area • Distortion

Achievement Criteria

Performance — The learner will be evaluated on the ability to use the GMAW process to:

- Set up GMAW equipment using a DC constant voltage welding power source.
- Weld beads in the 1S position and fillet welds in the 1F, 2F and 3F (uphill) positions on low carbon steel plate.
- Weld fillet welds in the 2F and 3F (downhill) positions and on low carbon steel sheet.
- Weld fillet welds in the 2F positions on alunimum plate.

Conditions — As part of a practical shop project, given the required tools and materials.

Criteria

- Beads will be evaluated for:
  - Correct bead width
  - Reasonable straight and uniform weld beads
  - Absence of irregularities and arc strikes
  - Overall appearance
- Fillet welds will be evaluated for:
  - Correct weld alignment
  - Correct fillet leg length
  - Slightly convex weld bead profile
  - Absence of irregularities, porosity, undercut and arc strikes
  - Good fusion
  - Overall appearance
  - In addition to the above, welds on alumimum will be evaluated for weld spatter

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E5 Use the FCAW process

Objectives

To be competent in this area, the individual must be able to:

- Use the FCAW gas-shielded process to weld fillet welds on low carbon steel plate.
- Use the FCAW self-shielded process to weld fillet welds on low carbon steel plate.
- Use the FCAW process to weld fillet welds using stainless steel filler on low carbon steel plate.
- Describe hardsurfacing for FCAW.

LEARNING TASKS	CONTENT

1. Identify welding variables for the FCAW process	• Pre-selected variables
	  ○ Equipment selection
	  ○ Filler metal selection
	  ○ Mode of metal transfer
	  ○ Primary adjustable variables
	  ○ Welding current
	  ○ Arc voltage
	• Secondary adjustable variables
	  ○ Pushing and pulling techniques
	  ○ Travel speed
	  ○ Stickout
	  ○ Gun angle

2. Weld stringer beads using the FCAW process	• On low carbon steel plate using self-shielding filler metal
	  ○ Flat (1S) position
	• On low carbon steel plate using gas-shielded filler metal
	  ○ Flat (1S) position

3. Weld single-pass fillet weld	• On low carbon steel sheet
	  ○ Horizontal (2F) position
	  – Lap joint

4. Weld multi-pass fillet weld using the FCAW process and self-shielding filler metal	• On low carbon steel plate
	  ○ Flat (1F) position
	  – Lap joint
	  ○ Horizontal (2F) position
	  – Tee joint
	  ○ Vertical (3F) position
	  – Tee joint - uphill
	• On structural shape to plate
	  ○ Overhead (4F) position

5. Weld multi-pass fillet weld using the FCAW process and gas-shielded filler metal	• On low carbon steel plate ○ Flat (1F) position

  - Tee joint
- Horizontal (2F) position
  - Lap joint
  - Tee joint
- Vertical (3F) position
  - Lap joint
  - Tee joint - uphill
- Overhead (4F) position
  - Tee joint

- On structural shape to plate
  - Horizontal (2F) position

6. Describe the principal considerations in the FCAW welding of stainless steel
   - Set welding variables
   - Heat input
   - Shielding gases
   - Weld contamination
   - Surface oxidation of weld area
   - Distortion

7. Weld multi-pass fillet weld using the FCAW process using stainless steel filler metal ***(optional)***
   - On low carbon steel plate
     - Horizontal (2F) position
       - Tee joint

8. Describe hardsurfacing for FCAW
   - Types of hardsurfacing materials
   - Application

Achievement Criteria

Performance — The learner will be evaluated on the ability to use the FCAW process to:

- Weld stringer beads in the flat position on low carbon steel plate.
- Weld fillet welds in a variety of positions on low carbon steel plate using self-shielded filler metal wire and using gas-shielded filler metal wire.
- Weld fillet welds using stainless steel filler metal on low carbon steel plate. ***(optional)***

Conditions — As part of a practical shop project, given the required tools and materials.

Criteria

- Stringer beads will be evaluated for:
  - Correct bead width
  - Reasonable straight and uniform weld beads
  - Absence of irregularities and arc strikes
  - Overall appearance
- Fillet welds will be evaluated for:
  - Correct weld alignment and fillet leg length
  - Slightly convex weld bead profile
  - Absence of irregularities, porosity, undercut and arc strikes
  - Good fusion
  - Overall appearance
  - In addition, fillet welds on alunimum will be evaluted for weld spatter

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): I Welding Drawings, Layout and Fabrication

Competency: I1 Identify common welding symbols and bolted connections

Objectives

To be competent in this area, the individual must be able to:

- Identify standard welding symbols and supplementary welding symbols.
- Describe the dimensioning of fillet and groove weld symbols.
- Describe other weld symbols and the dimensioning of threaded fasteners used in structural steel construction.

LEARNING TASKS	CONTENT

1. Describe standard welding symbols	• Welding symbols
	  ○ Arrows
	  ○ Supplementary weld symbols
	  ○ Weld-all-around symbol
	  ○ Field weld symbol
	  ○ Contour and finish symbols
	  ○ Location of weld symbol

2. Describe the dimensioning of fillet and groove welds	• Filet welds
	  ○ Size
	  ○ Length
	  ○ Intermittent fillet welds
	• Groove welds
	  ○ Groove size (depth of operation)
	  ○ Effective throat size (depth of penetration)
	  ○ Root opening
	  ○ Groove or included angle
	  ○ Backing or spacer material symbol
	• Complete penetration welds
	  ○ Back gouging and its application to groove welds
	  ○ Back welds and backing welds
	  ○ Melt-thru welds

3. Identify other basic weld symbols and their dimensions	• Plug welds
	  ○ Plug size
	  ○ Angle of countersink
	  ○ Depth of filling
	• Slot welds
	• Spot welds
	  ○ Size and strength of spot welds
	  ○ Pitch of spot welds
	  ○ Number of spot welds
	• Seam welds
	  ○ Size and strength of seam welds
	• Scarf for brazed joint
	• Flange welds
	• Surface welds

4. Identify the dimensioning of bolted connections	• Thread symbols on drawings • Designation of UNC and UNF threads • Metric thread designations

Level 2

Welder

Line (GAC): A Occupational Skills

Competency: A8 Apply lifting, hoisting and rigging procedures

Objectives

To be competent in this area, the individual must be able to:

- Apply safety procedures for rigging and material handling.
- Perform safe working load (SWL) calculations involving geometric formulas, volumes and capacities.
- Use fibre ropes to tie knots.
- Operate hoisting equipment to perform a lift.

LEARNING TASKS	CONTENT

1. Describe and apply safety precautions for rigging and hoisting	• WorkSafeBC regulations
	• PPE
	• Hand signals
	• Manufacturers' specifications
	• Common safety hazards
	  ○ SWL not known
	  ○ Defective equipment and hardware
	  ○ Unrated lifting lugs
	  ○ Electrical contact
	• Weather conditions

2. Determine weight, center of gravity and safe working loads (SWL)	• Calculating the weight of a load
	  ○ Plate
	  ○ Structural steel shape
	  ○ Pipe
	• Center of gravity
	• Safe working loads (SWL)
	  ○ Explain safe working load ratios
	  ○ WorkSafeBC regulations (part 15)
	• Material and personnel

3. Describe proper care and inspection of fibre rope	• Storage
	• Visual inspection
	  ○ Cuts
	  ○ Abrasions
	  ○ Dirt
	  ○ Rot
	  ○ Fatigue
	  ○ Heat damage
	  ○ Dry-testing
	  ○ Cleanliness
	  ○ Kinks
	• Chemical damage

4. Recognize and name common knots, bends and hitches used with fibre rope	• Parts of a rope

- Basic knots
  - Figure 8
  - Square (reef) knot
  - Clove hitch
  - Sheetbend
  - Round turn and two half hitches
  - Bowline
  - Half hitch
- Single Dutchman (chain knot)

5. Describe and demonstrate applications of knots, bends and hitches
   - Tag lines (rigging)
   - Load lines (tie-down)
   - Hoisting lines (materials)
   - Safety harness
   - Joining ropes
   - Stopper knot

6. Operate hoisting equipment
   - Hoisting equipment
   - Plan a lift
   - Estimate weight of load
   - Factors that reduce capacity
   - Select proper rigging
   - Attach proper rigging

7. Lift, hoist and move loads
   - Use a hoist (chain fall)
   - Use come-alongs
   - Use a tirfor jack

Achievement Criteria

Performance — The learner will be evaluated on the ability to:
- Identify and use the proper type of hoisting equipment to perform a lift
- Perform a manual lift

Conditions — As part of a practical shop project, given the required materials, equipment and pre-calculated lift plan under supervision.

Criteria
- Under supervision, manual lifting will be evaluated for:
  - Personal Protective Equipment (PPE)
  - Correct body position/posture for lifting
  - Center of gravity
  - Block and store
- Under supervision, using hoisting equipment will be evaluated for:
  - Visual check of the lifting equipment before use
  - Checking capacity of equipment
  - Attaching correct rigging configuration
  - Attaching load correctly to lifting hook
  - Centering lifting hook above load before lifting
  - Hoisting load correctly

- Lowering load correctly
- Returning rigging to designated storage place
- Using all equipment in a safe manner
- Following all shop safety rules

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D3 Select electrodes for SMAW

Objectives

To be competent in this area, the individual must be able to:

- Describe low carbon steel filler metal electrodes.
- Describe hardsurfacing filler metal electrodes.
- Describe stainless steel filler metal electrodes.
- Describe the selection and applications of filler metal electrodes.
- Describe basic care, handling and storage of filler metal electrodes.

LEARNING TASKS	CONTENT

1. Describe the operation of common electrodes for SMAW	• Functions of electrode coatings
	• Types of electrodes
	  ○ F1 (fast-fill)
	  ○ F2 (fill-freeze)
	  ○ F3 (fast-freeze)
	  ○ F4 (low hydrogen/basic electrode)
	• Electrode coating composition
	  ○ Cellulose
	  ○ Rutile
	  ○ China clay, silica and mica
	  ○ Potassium
	  ○ Ferro-magnanese
	  ○ Iron oxide (magnetite, hematite)
	  ○ Iron powder
	  ○ Sodium silicate
	• Metal transfer with SMAW electrodes
	• Gravity
	• Gas expansion
	• Electro-magnetic force
	• Electromotive force
	• Surface tension

2. Describe the classifications of low carbon steel electrodes	• Standards of coated electrode manufacture • CSA and AWS designations • Electrode length • Electrode diameter

3.	Describe the selection of filler metal electrodes for SMAW	• Principles of electrode selection
		• Properties of the base metal
		• Joint design and fit up
		• Welding position and thickness of weld deposit
		• Welding current
		• Service conditions
		• Production factors
		• Common low carbon steel filler metal electrodes
		  ○ E4310 (E6010)
		  ○ E4311 (E6011)
		  ○ E4313 (E6013)
		  ○ E4914 (E7014)
		  ○ E4924 (E7024)
		  ○ E4918 (E7018)
		  ○ E4928 (E7028)
		• Common hardsurfacing filler metal electrodes
		• Stainless steel filler metal electrodes
		  ○ E309-15, -16 and -17
		• Common filler metal electodes for grey cast iron

4.	Describe correct handling and storage of common filler metal electrodes	• Handling of electrodes before and after use • Storage of electrodes • Electrode ovens • Handling of electrodes in use

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D6 Use the SMAW process on low carbon steel plate and pipe

Objectives

To be competent in this area, the individual must be able to:

- Describe primary adjustable variables.
- Use the SMAW process to perform multi-pass groove welds on low carbon steel plate.
- Use the SMAW process to perform multi-pass fillet welds on low carbon steel plate, structural shape to plate and on pipe to plate.
- Perform multi-pass groove welds without backing on low carbon steel plate.
- Perform guided bend tests.

LEARNING TASKS	CONTENT

1. Describe primary adjustable variables	• Arc blow
	• Dealing with arc blow
	• Volt-ampere curve
	• Interpreting the volt-ampere curve
	• Constant current welding power sources
	• Adjusting the voltage
	• Adjusting the amperage
	• Transformer type welding power sources
	• Generator/alternator type welding power sources
	• Multi-process welding power sources
	  ○ Inverters
	  ○ Advantages of inverter type welding power sources
	• Remote control devices
	• Ratings for welding power sources
	• Power requirements
	• Duty cycle
	• Choosing between AC and DC welding power sources
	• General maintenance of welding power sources

2. Weld multi-pass fillet welds	• On pipe to plate
	  ○ Horizontal (2F) position
	  ○ Fixed vertical (5F) position

3. Weld multi-pass fillet groove welds on single bevel butt joints (with backing) using the SMAW process	• On low carbon steel plate
	  ○ Flat (1GF) position
	  ○ Horizontal (2GF) position
	  ○ Vertical (3GF) position - uphill
	  ○ Overhead (4GF)

4.	Weld multi-pass groove welds on single-v butt joints (without backing) using the SMAW process	• On low carbon steel plate ○ Flat (1G) position
5.	Perform guided bend tests	• Guided bend test equipment • Types of guided bend tests • Face bend tests • Root bend tests • Side bend tests • Causes of failure

Achievement Criteria

Performance — The learner will be evaluated on the ability to weld using the SMAW process, including:

- Multi-pass fillet welds on pipe to plate in the 2F and 5F positions.
- Groove welds on low carbon steel plate in the 1G, 1GF, 2GF, 3GF and 4GF positions.

Conditions — As part of a practical shop project and given the required tools and equipment.

Criteria

- Fillet welds will be evaluated for:
  - Correct alignment
  - Good penetration and fusion
  - Reasonable smoothness
  - Legs of equal length
  - Slightly convex profile
  - Absence of porosity, irregularities, undercut and arc strikes
  - Overall appearance
- Groove welds will be evaluated for:
  - Correct alignment
  - Acceptable smoothness and uniformity
  - Absence of irregularitites, distortion, undercutting at weld edge and stray strike marks
  - Good fusion (wetting) of the deposit (or cover pass) to base metal
  - Maximum face reinforcement of 3.2 mm (1/8”).
  - Maximum root reinforcement of 2.5 mm (3/32”).
- Coupons will be evaluated in accordance with CSA W47.1 and/or Section IX ASME code
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8”) in any direction on the convex surface of the specimen after bending
  - Cracks occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from slag inclusions on other external defects.

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D8 Describe the SMAW process on grey cast iron

Objectives

To be competent in this area, the individual must be able to:

- Describe the SMAW process to prepare and apply filler metal to grey cast iron.

LEARNING TASKS

1. Describe the procedure for SMAW on grey cast iron

CONTENT

- Welding techniques
  - Hot welding
  - Cold welding
  - Peening to control bead shrinkage
  - Patching with low carbon steel
- Electrodes
  - ECI group
  - EST group
  - ENI group
- Joint preparation
- Problems welding grey cast iron
  - Contamination
  - Porosity
  - Cracking
  - Lack of fusion

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E4 Use the GMAW and GMAW-P process

Objectives

To be competent in this area, the individual must be able to:

- Use the GMAW and GMAW-P processes to weld fillet welds on aluminum and stainless steel plate.
- Use the GMAW-P processes to weld fillet welds on aluminum and stainless steel plate.
- Use the GMAW processes to weld groove welds on low carbon steel plate and sheet.
- Perform troubleshooting and maintenance of GMAW equipment.

LEARNING TASKS	CONTENT

1. Identify welding variables for GMAW-P	• Pre-selected variables
	  ○ Equipment selection
	  ○ Filler metal selection
	  ○ Mode of metal transfer and shielding gas
	• Primary adjustable variables
	  ○ Welding current
	  ○ Trim
	• Secondary adjustable variables
	  ○ Pushing and pulling techniques
	  ○ Travel speed
	  ○ Stickout
	  ○ Gun angle
	• Troubleshooting
	  ○ Dimensional defects
	  ○ Incorrect weld size
	  ○ Overlap
	  ○ Excessive reinforcement
	  ○ Structural discontinuities in the weld
	  ○ Under cut
	  ○ Incomplete penetration
	  ○ Lack of fusion
	  ○ Porosity
	  ○ Cracking (internal/external)
	• Insufficient throat/underfill

2. Set up GMAW-P equipment	• Assemble GMAW-P equipment ○ Wire feeder requriements • Power source requirements
3. Describe the principle considerations for welding different types of metals using the GMAW and GMAW-P processes	• Set welding variables • Heat input • Types of metals • Low carbon steel sheet and plate • Stainless steel • Aluminum

4.	Weld single-pass fillet welds using the GMAW-P process	• On low carbon steel sheet
		  ○ Horizontal (2F) position
		  – Lap joint
		  – Tee joint
		  ○ Vertical (3F) position - downhill
		  – Lap joint
		  – Tee joint

5.	Weld multi-pass fillet welds using the GMAW-P process	• On low carbon steel plate
		  ○ Horizontal (2F) position
		  – Lap joint
		  ○ Vertical (3F) position - uphill
		  – Lap joint
		  – Tee joint
		  ○ Overhead (4F) position
		  – Lap joint

6.	Weld multi-pass fillet welds using the GMAW spray transfer process	• On low carbon steel sheet or plate
		  ○ Horizontal (2F) position
		  – Tee joint

7.	Weld single-pass square groove welds using the GMAW short circuit transfer process	• On low carbon steel sheet
		  ○ Flat (1G) position
		  ○ Vertical (3G) position - downhill

8.	Weld single-pass square groove welds using the GMAW-P process	• On low carbon steel sheet ○ Horizontal (2G) position
9.	Weld multi-pass groove welds using the GMAW spray transfer process	• On low carbon steel plate with single bevel butt joint (with backing) ○ Flat (1GF) position

10.	Weld multi-pass groove welds using the GMAW short circuit transfer process	• On low carbon steel plate with single-v butt joint
		  ○ Flat (1G) position
		  ○ Vertical (3G) position - downhill

11.	Weld multi-pass fillet welds using the GMAW and GMAW-P processes on aluminum plate	• On aluminum plate
		  ○ Horizontal (2F) position
		  – Lap joint
		  – Tee joint
		  ○ Vertical (3F) position – uphill
		  – Lap joint
		  – Tee joint
		  ○ Overhead (4F) position
		  – Tee joint

12.	Weld single-pass fillet welds using the GMAW and GMAW-P processes on stainless steel plate	• On stainless steel plate
		  ○ Horizontal (2F) position
		  – Lap joint
		  – Tee joint

Achievement Criteria

Performance — The learner will be evaluated on the ability to use GMAW and GMAW-P to weld:

- Fillet welds on aluminum and stainless steel plate
- Groove and fillet welds on low carbon steel plate and sheet.

Conditions — As part of a practical shop project, using the GMAW and GMAW-P processes and materials

Criteria

- Groove welds will be evaluated for:
  - Correct alignment
  - Acceptable smoothness and uniformity
  - Absence of irregularitites, distortion, undercutting at weld edge and stray strike marks
  - Good fusion (wetting) of the deposit (or cover pass) to base metal
  - Maximum face reinforcement of 3.2 mm (1/8”).
  - Maximum root reinforcement of 2.5 mm (3/32”).
- Coupons will be evaluated in accordance with CSA W47.1 and/or Section IX ASME code
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8”) in any direction on the convex surface of the specimen after bending
  - Cracks occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from slag inclusions on other external defects.

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E5 Use the FCAW process

Objectives

To be competent in this area, the individual must be able to:

- Select filler metals and shielding gases for FCAW.
- Use the FCAW gas-shielded process to weld fillet welds on low carbon steel plate.
- Use the FCAW gas-shielded process to weld groove welds on low carbon steel plate.

LEARNING TASKS	CONTENT

1. Weld multi-pass fillet welds	• On low carbon steel plate on tee joint
	  ○ Vertical (3F) position - uphill
	  ○ Overhead (4F) position

2. Weld multi-pass groove welds	• On low carbon steel plate
	  ○ Flat (1G) position
	  – Butt joint (both sides)
	  – Gouge to Sound Metal (GTSM)
	  ○ Side bend tests
	• On low carbon steel plate with single bevel butt joint with backing
	  ○ Flat (1GF) position
	  ○ Horizontal (2GF) position
	  ○ Vertical (3GF) position - uphill
	  ○ Overhead (4GF) position

Achievement Criteria

Performance — The learner will be evaluated on the ability to use the FCAW process to:

- Weld fillet welds in the 3F and 4F positions on tee joints.
- Weld multi-pass groove welds 1GF, 2GF, 3GF, 4GF on low carbon steel plate.
- Weld a square groove butt joint in the flat (1G) position.

Conditions — As part of a practical shop project, using the FCAW process and materials.

Criteria

- Fillet welds will be evaluated for:
  - Correct alignment
  - Equal leg length
  - Slightly convex profile
  - Acceptable smoothness, uniformity and straightness of weld passes
  - Absence of porosity
  - Absence of undercut
  - Absence of stray arc strikes
- Groove welds will be evaluated for:
  - Correct alignment
  - Acceptable smoothness and uniformity
  - Absence of irregularitites, distortion, undercutting at weld edge and stray strike marks
  - Good fusion (wetting) of the deposit (or cover pass) to base metal
  - Maximum face reinforcement of 3.2 mm (1/8")
  - Maximum root reinforcement of 2.5 mm (3/32")
- Coupons will be evaluated in accordance with CSA W47.1 and/or Section IX ASME code
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8") in any direction on the convex surface of the specimen after bending
  - Cracks occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from slag inclusions on other external defects.

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E6 Use the MCAW process

Objectives

To be competent in this area, the individual must be able to:

- Select filler metals and shielding gases for MCAW.
- Describe the welding variables for using the MCAW process on low carbon steel plate.
- Use the MCAW process to weld fillet welds and groove welds on low carbon steel plate.

LEARNING TASKS	CONTENT

1. Identify welding variables for MCAW on low carbon steel plate	• Pre-selected variables
	  ○ Equipment selection
	  ○ Filler metal selection
	  ○ Mode of metal transfer
	  ○ Primary adjustable variables
	  ○ Welding current
	  ○ Arc voltage
	• Secondary adjustable variables
	  ○ Pushing and pulling techniques
	  ○ Travel speed
	  ○ Stickout
	  ○ Gun angle

2. Weld multi-pass fillet welds using the MCAW process	• On low carbon steel plate
	  ○ Flat (1F) position
	  – Lap joint
	  – Tee joint
	  ○ Horizontal (2F) position
	  – Lap joint
	  – Tee joint

3. Weld multi-pass square groove welds using the MCAW process	• On low carbon steel plate
	  ○ Flat (1G) position
	  – Butt joint (both sides)
	  – Gouge to Sound Metal (GTSM)
	  ○ Side bend tests

4. Weld multi-pass groove welds using the MCAW process	• On low carbon steel plate with single bevel butt joint (with backing) ○ Flat (1GF) position • Face and root bend tests

Achievement Criteria

Performance	The learner will be evaluated on the ability to use the MCAW process to: • Weld fillet welds in the 1F and 2F positions on low carbon steel plate. • Weld groove welds in the 1G position on low carbon steel plate. • Successful face, root and side bent tests.
Conditions	As part of a practical shop project, given the required tools and materials.

Criteria	• Fillet welds will be evaluated for:
	  ○ Correct alignment
	  ○ Equal leg length
	  ○ Slightly convex profile
	  ○ Acceptable smoothness, uniformity and straightness of weld passes
	  ○ Absence of porosity
	  ○ Absence of undercut
	  ○ Absence of stray arc strikes
	• Groove welds will be evaluated for:
	  ○ Correct alignment
	  ○ Straightness of cover pass
	  ○ Good fusion (wetting) of cover pass to base metal
	  ○ Acceptable smoothness and uniformity
	  ○ Absence of undercut and stray arc strikes
	  ○ Maximum reinforcement of 3.2 mm (1/8”)
	• Coupons will be evaluated for successful completion of guided bend tests on face and root or side bends will be evaluated to CSA W47.1
	
	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E7 Use the SAW process

Objectives

To be competent in this area, the individual must be able to:

- Describe the welding variables for using the SAW process on low carbon steel plate.
- Use the SAW process to weld fillet welds on low carbon steel plate.

LEARNING TASKS	CONTENT

1. Identify welding variables for SAW on low carbon steel plate	• Pre-selected variables
	  ○ Equipment selection
	  ○ Filler metal selection
	  ○ Mode of metal transfer
	  ○ Primary adjustable variables
	  ○ Welding current
	  ○ Arc voltage
	• Secondary adjustable variables
	  ○ Pushing and pulling techniques
	  ○ Travel speed
	  ○ Stickout
	  ○ Gun angle

2. Weld multi-pass fillet welds using the SAW process	• On low carbon steel plate
	  ○ Flat (1F) position
	  – Tee joint

Achievement Criteria

Performance	The learner will be evaluated on the ability to use the SAW process to: • Weld fillet welds in the 1F position on low carbon steel plate.
Conditions	As part of a practical shop project, given the required tools and materials.

Criteria	• Fillet welds will be evaluated for:
	  ○ Correct alignment
	  ○ Equal leg length
	  ○ Slightly convex profile
	  ○ Acceptable smoothness, uniformity and straightness of weld passes
	  ○ Absence of porosity
	  ○ Absence of undercut
	  ○ Absence of stray arc strikes
	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): F Gas Tungsten Arc Welding (GTAW)

Competency: F1 Describe the GTAW process and its application

Objectives

To be competent in this area, the individual must be able to:

- Describe the GTAW process.
- Describe the function of electrodes and shielding gases.
- Describe the basic components of a GTAW work station.
- Identify the applications of GTAW and the safety requirements.

LEARNING TASKS	CONTENT

1. Describe the GTAW process, equipment and applications	• Components of a GTAW workstation
	  ○ Electrodes
	  ○ Filler rods
	  ○ Shielding gases
	• GTAW process
	  ○ Applications
	  ○ Advantages
	  ○ Disadvantages

2. Identify safety requirements for GTAW	• Safe working practices • Special PPE requirements • Ozone

3. Describe purging requirements and techniques	• Purging
	  ○ Purpose
	  ○ Types of purging gas
	  – Argon
	  – Nitrogen
	  ○ Equipment
	  – Dams
	  – Flow regulators
	• Purging calculation charts
	• Techniques

Line (GAC): F Gas Tungsten Arc Welding (GTAW)

Competency: F2 Describe GTAW equipment and its operation

Objectives

To be competent in this area, the individual must be able to:

- Identify types of GTAW power sources.
- Describe shielding gases and systems.
- Describe torches and their components.
- Describe tungsten electrodes used for GTAW.
- Correctly assemble GTAW equipment.

LEARNING TASKS	CONTENT

1. Describe GTAW power sources and their operation	• Welding current for GTAW
	• Controls on GTAW power source
	  ○ Current controls
	  ○ High-frequency controls
	  ○ Shielding gas controls
	  ○ Water flow controls
	  ○ Remote controls and contact switches

2. Describe shielding gases and equipment used in GTAW	• Types of shielding gases
	  ○ Argon
	  ○ Helium
	• Gas regulators
	• Flowmeters
	• Hoses

3. Describe GTAW torches and their components	• Types of torches
	  ○ Air-cooled
	  ○ Water-cooled
	• Torch components
	  ○ Torch body
	  ○ Collet body
	  ○ Gas lens
	  ○ Collet
	  ○ Back cap
	  ○ Gas nozzles or cups
	  – Ceramic gas cups
	  – Alumina cups
	  – Fused-quartz cups
	• Water radiator

4. Describe tungsten electrodes used for GTAW	• Types of electrodes
	  ○ Pure tungsten electrodes
	  ○ Thoriated tungsten
	  – Non-radioactive (Ceriated, Lanthanated)

- Zirconium alloyed tungsten
- Electrode finishes

- Electrode selection
  - Size
  - Current
- Profile preparation of tungsten electrodes
  - Balled or rounded ends
  - Tapered or pointed ends
- Proper use
  - Preventing contamination
  - Avoiding heat build up

5. Select and assemble GTAW welding equipment

- Torches
- Tungsten electrodes
- Maintenance, care and storage

Achievement Criteria

Performance	The learner will be evaluated on the ability to select and assemble gas tungsten arc welding equipment and correctly prepare tungsten electrodes for the GTAW process.
Conditions	As part of a practical shop project and given the required tools and equipment.
Criteria	Equipment must be assembled correctly, within specifications, safety standards and time frames acceptable to industry.

Line (GAC): F Gas Tungsten Arc Welding (GTAW)

Competency: F3 Describe the application of GTAW for ferrous metals

Objectives

To be competent in this area, the individual must be able to:

- Describe the GTAW process on low carbon steel.
- Identify discontinuities.
- Identify the main factors of GTAW.

LEARNING TASKS	CONTENT

1. Describe the GTAW process	• Low carbon steel
	  ○ Filler metals
	  – Deoxidized filler rod
	  – Handling and storing filler rod
	  ○ Welding low carbon steel

2. Identify discontinuities in the GTAW process	• Incomplete and insufficient penetration • Excessive penetration • Undercut • Porosity and dark appearance • Burn-through • Root side concavity (suck-back) • Tungsten inclusion • Weld cracking

2. Identify the main factors of GTAW	• Power source setting
	• Welding torch, electrode and filler rod variables
	• Electrode stickout
	• Arc length
	• Torch angle and filler metal angle
	  ○ Butt joints
	  ○ Lap joints
	  ○ Tee joints
	  ○ Corner joints
	• Shielding gas flow
	• Speed of travel
	• Operator comfort and position

Line (GAC): F Gas Tungsten Arc Welding (GTAW)

Competency: F4 Use the GTAW process for ferrous metals

Objectives

To be competent in this area, the individual must be able to:

- Use the GTAW process to strike an arc using three methods.
- Use the GTAW process to weld stringer beads and fillet welds on low carbon steel sheet.
- Use the GTAW process to weld groove welds on low carbon steel sheet.

LEARNING TASKS	CONTENT

1 Strike an arc using three methods	• Methods
	  ○ Scratch start
	  ○ Lift arc
	  ○ High frequency

2. Weld stringer beads	• Flat (1S) position

3. Weld single-pass fillet welds	• On low carbon steel sheet:
	  ○ Flat (1F) position
	  – Corner joints
	  ○ Horizontal (2F) position
	  – Lap joints
	  – Tee joints
	  ○ Vertical (3F) position - uphill
	  – Lap joints
	  – Tee joints

4. Weld single-pass groove welds	• On low carbon steel sheet ○ Flat (1G) position

Achievement Criteria

Performance — The learner will be evaluated on the ability to:

- Strike an arc using the touch start methods and high frequency start method.
- Weld stringer beads in the 1S flat position on low carbon steel sheet.
- Weld fillet welds in the 1F, 2F and 3F (uphill) positions on lap and tee joints on low carbon steel sheet.
- Weld single-pass groove weld in the 1G position on low carbon steel sheet.

Conditions — As part of a practical shop project and given the required tools and equipment.

Criteria

- Striking an arc must follow correct procedure and establish a weld pool of desirable size.
- Stringer beads will be evaluated for:
  - Good fusion
  - Smooth, slightly convex beads
  - Absence of stray strike marks
  - Absence of irregularities, porosity and undercut
- Fillet welds will be evaluated for each of the criteria above, plus they must have legs of equal length
- Groove welds will be evaluated for each of the criteria above, plus they must have complete root penetration

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): F Gas Tungsten Arc Welding (GTAW)

Competency: F5 Use the GTAW process for stainless steel

Objectives

To be competent in this area the individual must be able to:

- Describe the GTAW process and procedures on stainless steel.
- Use the GTAW process to weld fillet welds on stainless steel sheet.
- Use the GTAW process to weld groove welds on stainless steel sheet.

LEARNING TASKS	CONTENT

1. Describe the GTAW process and procedures on stainless steel	• Stainless steel filler metal
	• Welding stainless steel
	• Joint design for stainless steel
	• Preparation of stainless steel:
	  ○ Pre-cleaning
	  ○ Post-cleaning
	• Recognize weld defects

2. Describe purging and fluxing requirements and techniques	• Purging
	  ○ Purpose
	  ○ Types of purging gas
	  – Argon
	  – Nitrogen
	  ○ Equipment
	  – Dams
	  – Flow regulators
	• Purging calculation charts
	• Techniques
	• Solar flux

3. Weld single-pass fillet welds	• On stainless steel sheet
	  ○ Horizontal (2F) position
	  – Lap joints
	  – Tee joints
	  ○ Vertical (3F) position - uphill
	  – Lap joints
	  – Tee joints

4. Weld single-pass groove welds	• On stainless steel sheet ○ Flat (1G) position

Achievement Criteria

Performance	The learner will be evaluated on the ability to use the GTAW process to: • Weld fillet welds in the 2F, 3F uphill position on lap and tee joints on stainless steel sheet. • Weld groove welds in the 1G position on stainless steel sheet.
Conditions	As part of a practical shop project and given the required tools and equipment.

Criteria	• All welds will be evaluated for:
	  ○ Good fusion
	  ○ Smooth, slightly convex beads
	  ○ Absence of irregularities, porosity, undercut and stray strike marks
	• Fillet welds will be evaluated for each of the criteria above, and they must have legs of equal length
	• Groove welds will be evaluated for each of the criteria above, and they must have complete joint penetration
	
	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): H Basic Metallurgy

Competency: H1 Describe production processes for manufacturing metals

Objectives

To be competent in this area, the individual must be able to:

- Describe the production processes for manufacturing metals.

LEARNING TASKS	CONTENT
1. Describe types of iron and current production methods	• Blast furnace – pig iron • Cast irons • Grey cast iron • White cast iron • Malleable cast iron • Nodular iron (ductile iron)

2. Describe current steel production and forming methods	• Open hearth furnace
	• Basic oxygen furnace
	• Electric furnace
	• Bessemer converter
	• Ingots
	• Rimmed, killed and semi-killed steel
	• Continuous casting process
	• Blooms, billets and slabs
	• Hot and cold-rolled sheet products
	• Galvanized sheet steel products
	• Tin mill products
	• Structural shapes and bars
	• Steel plate and large diameter pipe
	  ○ Pipe and tubing
	  ○ ERW
	  ○ Seamless
	• Forging process
	  ○ Open-die forging
	  ○ Closed-die forging
	• Casting process
	  ○ Sand casting
	  ○ Centrifugal casting
	  ○ Die casting

3. Describe types of steel and steel classifications	• Main elements of carbon steels
	• Types of steel
	  ○ Low carbon
	  ○ Medium carbon
	  ○ High carbon (tool)
	• Alloying elements
	  ○ Chromium
	  ○ Cobalt
	  ○ Copper
	  ○ Magnesium
	  ○ Nickel
	  ○ Titanium
	  ○ Tungsten
	  ○ Vandium
	• Steel classification
	  ○ CSA standards
	  ○ UNS numbering system
	• SAE and AISI systems
	  ○ First digit
	  ○ Second digit
	  ○ Third and fourth digits
	• ASTM classification
	• Manufacturer's certification and identification markings
	  ○ Colour coding
	  ○ Numbering systems
	  ○ Heat numbers
	• Mill certification

Line (GAC): H Basic Metallurgy

Competency: H2 Describe mechanical and physical properties of ferrous and non-ferrous metals

Objectives

To be competent in this area, the individual must be able to:

- Identify the mechanical and physical properties of metals.

LEARNING TASKS	CONTENT

1. Define the terms relating to mechanical and physical properties of metals	• Metallurgy
	• Alloys
	• Ferrous metals
	• Wrought iron
	• Cast iron
	• Carbon steels
	• Low alloy steels
	• Alloy steels
	• Non-ferrous metals
	  ○ Aluminum
	  ○ Copper
	  ○ Lead
	  ○ Magnesium
	  ○ Nickel
	  ○ Silver
	  ○ Tin
	  ○ Zinc

2. Describe the mechanical properties of metals	• Tensile strength • Elasticity, yield point, ultimate tensile strength • Elongation • Impact strength • Compressive strength • Fatigue strength • Toughness • Hardness • Ductility • Malleability • Brittleness
3. Describe the physical properties of metals	• Density • Resistance to corrosion • Electrical conductivity • Thermal conductivity • Thermal expansion • Melting point

Line (GAC): H Basic Metallurgy

Competency: H3 Describe common ferrous, non-ferrous and reactive metals and their weldability

Objectives

To be competent in this area, the individual must be able to:

- Identify metals by their visual appearance, relative weight, typical shape and texture.
- Describe tests for identifying metals.

LEARNING TASKS	CONTENT
1. Describe types of metals by their physical characteristics (visual appearance, colour, relative weight, typical shape and texture)	• Steel • Cast steel • Cast irons • Copper • Brass and bronze • Aluminum • Stainless steel • Lead • Magnesium • Zinc • Titanium
2. Describe mechanical and thermal tests for identifying metals	• Chip • Spark • Hardness • Files • Center punch • Chisel • Flame • Magnetic • Non-magnetic • Slightly magnetic • Melting point
3. Describe weldability and pre and post heat treatment	• Low carbon steel • Cast iron • Aluminum • Stainless steel

Achievement Criteria

Performance	The learner will be evaluated on the ability to inspect metals for identification.
Conditions	As part of a practical shop project, given the required tools and materials.
Criteria	• Identify metals by visual inspection • Perform flame, chip, spark and file tests *Completed within specifications, safety standards and time frames acceptable to industry.*

Line (GAC): I Welding Drawings Layout and Fabrication

Competency: I2 Read and interpret drawings

Objectives

To be competent in this area, the individual must be able to:

- Read structural drawings.

LEARNING TASKS	CONTENT
1. Identify types of structural drawings	• Engineering drawings • Site plans • Foundation plans • Framing plans • Elevation plans • Sections • Connection detail drawings • Shop drawings • Detail drawings • Assembly drawings • Detail assembly drawings
2. Identify bills of material and other information found on structural drawings	• Title block • Revisions block • Notes and specifications • Material list • Item number • Quantity • Description • Length • Specifications • Material • Remarks

Line (GAC): I Welding Drawings Layout and Fabrication

Competency: I3 Perform basic drafting

Objectives

To be competent in this area, the individual must be able to:

- Describe types of drawings, basic lines used on drawings, and auxiliary and sectional views.
- Sketch orthographic projections of basic objects.
- Sketch isometric and dimensioned drawings of basic objects.

LEARNING TASKS	CONTENT
1. Describe types of drawings	• Orthographic • Pictorial • Isometric
2. Identify basic lines used in drawings	• Object lines • Hidden lines • Centre lines • Dimension and extension lines • Leader lines • Phantom lines • Cutting plane lines • Section lines • Break lines
3. Draw orthographic projections	• Freehand sketching to approximate scale • Graph paper • Sketching orthographic views • Scale rule

4. Describe and draw auxiliary and sectional views	• Auxiliary views
	• Sectional views
	• Locating sectional views
	• Showing sectional views
	• Types of sectional views
	  ○ Full sections
	  ○ Half-sections
	  ○ Broken sections
	  ○ Revolved sections

5. Identify systems of measurements used on drawings	• SI metric units of measurement • Imperial system of measurement • Dual dimensioning • Position method • Bracket method • Conversion chart method

6.	Describe methods of dimensioning	• Types of dimensions • Rules for placing dimensions • Dimensioning curved surfaces • Angular dimensioning • Tolerance dimensions • Dimensioning external chamfers and bevels
7.	Sketch isometric drawings of basic objects	• Simple rectangular objects • Figures using isometric lines • Objects with circular features
8.	Sketch a dimensioned drawing of a simple object	• Dimensioned drawing

Achievement Criteria

Performance	The learner will be evaluated on the ability to reproduce drawings with proper dimensioned parts made to scale.
Conditions	As part of a practical shop project, given the required tools and materials.
Criteria	*Completed within specifications, safety standards and time frames acceptable to industry.*

Line (GAC): I Welding Drawings, Layout and Fabrication

Competency: I4 Perform mathematical calculations

Objectives

To be competent in this area, the individual must be able to:

- Perform mathematical calculations involving angles, triangles and geometric construction.

LEARNING TASKS	CONTENT
1. Solve problems involving angles, triangles and geometric construction	• Basic terms • Lines and points • Angles and angle terms • Basic theorems • Apply the principles of angles • Read protractor • Calculate angles • Right angle triangles • Apply geometric constructions • Exponents

Line (GAC): I Welding Drawings, Layout and Fabrication

Competency: I5 Interpret and apply mechanical drawings and layout components

Objectives

To be competent in this area, the individual must be able to:

- Source required information and materials.
- Prepare work area and layout materials.

LEARNING TASKS	CONTENT

1. Source required information for selecting materials and equipment	• Material information sources
	  ○ Location of information
	  ○ Identify unique or special information
	  ○ Type of materials
	  ○ Material selection
	• Documentation and markings
	  ○ Mill test reports
	  ○ Traceability methods
	  ○ Traceability requirements
	• Equipment information sources
	  ○ Equipment selection

2. Describe work area requirements	• Good housekeeping practices • Access and egress • Material and equipment • Identify safety hazards
3. Plan sequence of operation	• Assembly requirements • Codes • Weld procedure specifications (WPS) • Final product • Welding sequence • Possible distortion • Organize sequence of work • Visualize final components
4. Gather work materials and equipment	• Work plan • Finished component • Assembly of requirements

5. Develop templates and transfer drawings to materials	• Construct template
	  ○ Template materials
	  ○ Measuring tools
	  ○ Conform to dimensional tolerances
	• Transfer methods
	  ○ Layout tools
	• Checking layout

6.	Select cutting equipment and cut materials to dimensions	• Cutting equipment • Materials • Tolerances • Cutting sequence
7.	Identify preparation and marking requirements for specialty processes	• Galvanizing • Heat treatment • Paint and/or finishing • Annodizing

8.	Describe the preparation of materials for assembly	• Grinding of materials
		  ○ Type of base metal
		  ○ Abrasive selection
		• Application of identification markings
		  ○ Paint mark
		  ○ Stamp

Line (GAC): I Welding Drawings, Layout and Fabrication

Competency: I6 Fabricate weldments

Objectives

To be competent in this area, the individual must be able to:

- Fabricate weldments using selected processes and materials.

LEARNING TASKS	CONTENT

1. Fit and tack structural components	• Select fitting equipment
	  ○ Dogs and wedges
	  ○ Clamps
	  ○ Jigs and fixtures
	  ○ Hydraulic porta-power
	  ○ Hand tools
	• Welding process and consumables
	• Organize work in sequential order
	• Fitting
	  ○ Techniques
	  ○ Equipment
	  ○ Distortion control
	  ○ Specifications

2. Weld weldments	• Preheating procedures • Welding procedures
3. Finish final product	• Conforms to dimensions • Conforms to specifications

Achievement Criteria

Performance	The learner will demonstrate the ability to fabricate weldments.
Conditions	Given a practical project using a selected process and materials. A minimum of two shop projects is recommended.
Criteria	*Completed within specifications, safety standards and time frames acceptable to industry.*

Line (GAC): I Welding Drawings Layout and Fabrication

Competency: I7 Costing and estimating

Objectives

To be competent in this area, the individual must be able to:

- Identify project costs.
- Calculate project cost for simple fabrication.

LEARNING TASKS	CONTENT

1. Identify project costs	• Materials
	  ○ Weight
	  ○ Wastage
	• Labour
	• Consumables
	• Transportation
	  ○ Shipping
	  ○ Material handling
	• Lead time

2. Calculate project cost for simple fabrication	• Weight • Estimate labour and consumables

Achievement Criteria

Performance	The learner will be evaluated on the ability to cost a simple fabrication project consisting of 3 structural columns complete with base plates.
Conditions	Given project specifications and fixed costs.
Criteria	*Completed within specifications, safety standards and time frames acceptable to industry.*

Level 3

Welder

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D3 Select electrodes for SMAW

Objectives

To be competent in this area, the individual must be able to:

- Identify stainless steel electrodes for SMAW.
- Identify low-alloy filler metal for SMAW.

LEARNING TASKS	CONTENT

1. Identify stainless steel electrodes for SMAW	• Stainless steel electrodes classification
	• Standard AISI stainless steels
	  ○ Austenitic
	  ○ Ferritic
	  ○ Martensitic
	  ○ Duplex
	• Common stainless steel electrodes
	  ○ E308
	  ○ E309
	  ○ E310
	  ○ E315
	  ○ E316
	  ○ E318
	  ○ Exxx-15
	  ○ Exxx-16
	  ○ Exxx-17

2. Identify low-alloy filler metal for SMAW	• Low alloy electrodes composition and designation:
	  ○ Carbon-molybdenum
	  ○ Chromium-molybdenum
	  ○ Nickel
	  ○ Copper-nickel
	  ○ Manganese-molybdenum
	• Special military grades

3. Describe correct handling and storage of common filler metal electrodes	• Handling of electrodes before and after use • Storage of electrodes • Electrode ovens • Handling of electrodes in use

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D6 Use the SMAW process on low carbon steel plate and pipe

Objectives

To be competent in this area, the individual must be able to:

- Use the SMAW process to weld groove welds on low carbon steel plate and pipe.

LEARNING TASKS	CONTENT

1. Weld multi-pass groove welds on single-v open root butt joint using the SMAW process	• On low carbon steel plate
	  ○ Flat (1G) position
	  ○ Horizontal (2G) position
	  ○ Vertical (3G) position- uphill
	  ○ Overhead (4G)
	• On low carbon steel pipe
	  ○ Flat rolled (1G) position
	  ○ Vertical fixed (2G) position
	  ○ Horizontal fixed (5G) position – uphill
	  ○ Inclined fixed 45° (6G) position – uphill
	  ○ Face and root bend tests

Achievement Criteria

Performance — The learner will be evaluated on the ability to use the SMAW process to:

- Weld open root groove welds on low carbon steel plate in the 1G, 2G, 3G uphill and 4G positions.
- Weld open root groove welds on low carbon steel pipe, in the 1G, 2G, 5G uphill and 6G uphill.
- Successfully complete face and root bend tests.

Conditions — As part of a practical shop project, given the required tools and materials.

Criteria

- Groove welds will be evaluated for:
  - Correct alignment
  - Acceptable smoothness and uniformity
  - Absence of irregularitites, distortion, undercutting at weld edge and stray strike marks
  - Good fusion (wetting) of the deposit (or cover pass) to base metal
  - Maximum face reinforcement of 3.2 mm (1/8”).
  - Maximum root reinforcement of 2.5 mm (3/32”).
- Coupons will be evaluated in accordance with Section IX ASME code.
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8”) in any direction on the convex surface of the specimen after bending
  - Cracks occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from slag inclusions on other external defects.

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E4 Use the GMAW and GMAW-P Process

Objectives

To be competent in this area, the individual must be able to:

- Use the GMAW process to weld groove welds on aluminum plate.

LEARNING TASKS	CONTENT

1. Weld groove welds using the GMAW process	• On aluminum plate with backing
	  ○ Flat (1G) position
	  ○ Horizontal (2G) position
	  ○ Vertical (3G) position – uphill
	  ○ Overhead (4G) position

Achievement Criteria

Performance The learner will be evaluated on the ability to:

- Weld groove joints on aluminum plate with backing in 1G, 2G, 3G and 4G positions.

Conditions As part of a practical shop project and given the required tools and equipment.

Criteria

- Groove welds will be evaluated for:
  - Correct alignment
  - Acceptable smoothness and uniformity
  - Absence of irregularitites, distortion, undercutting at weld edge and stray strike marks
  - Good fusion (wetting) of the deposit (or cover pass) to base metal
  - Maximum face reinforcement of 3.2 mm (1/8”).
  - Maximum root reinforcement of 2.5 mm (3/32”).
- Coupons will be evaluated in accordance with Section IX ASME code.
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8”) in any direction on the convex surface of the specimen after bending
  - Cracks occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from slag inclusions on other external defects.

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): E Semi-Automatic and Automatic Welding

Competency: E8 Use combined GMAW, MCAW and FCAW processes

Objectives

To be competent in this area, the individual must be able to:

- Use the GMAW process to weld groove welds on open root, single-v butt joints on low carbon steel plate.
- Use the GMAW process to weld groove welds on low carbon steel pipe.
- Use the FCAW and/or MCAW process to weld groove welds on low carbon steel pipe.

LEARNING TASKS	CONTENT

1. Weld multi-pass groove welds using the GMAW process for the open root pass and the FCAW and/or MCAW process for the fill and cap pass	• On low carbon steel plate:
	  ○ Flat (1G) position
	  ○ Horizontal (2G) position
	  ○ Vertical (3G) position – downhill root, uphill fill and cap
	  ○ Overhead (4G) position
	• On low carbon steel pipe:
	  ○ Flat rolled (1G) position
	  ○ Vertical fixed (2G) position
	  ○ Horizontal fixed (5G) position – downhill root, uphill fill and cap
	  ○ Face and root bend tests

Achievement Criteria

Performance The learner will be evaluated on the ability to:

- Weld open root groove welds on single-v low carbon steel plate in the 1G, 2G, 3G downhill and 4G positions.
- Weld open root groove welds on single-v butt joints on low carbon steel schedule 40 pipe in the ***1G (assessment optional)***, 2G and 5G position, downhill root, uphill fill and cap.
- Successfully complete face and root bend tests.

Conditions As part of a practical shop project and given the required tools and equipment.

Criteria

- Groove welds will be evaluated for:
  - Correct alignment
  - Acceptable smoothness and uniformity
  - Absence of irregularitites, distortion, undercutting at weld edge and stray strike marks
  - Good fusion (wetting) of the deposit (or cover pass) to base metal
  - Maximum face reinforcement of 3.2 mm (1/8”).
  - Maximum root reinforcement of 2.5 mm (3/32”).
- Coupons will be evaluated in accordance with Section IX ASME code.
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8”) in any direction on the convex surface of the specimen after bending
  - Cracks occurring on the corners of the specimen during testing shall not be

considered unless there is definite evidence that they result from slag inclusions on other external defects.

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): F Gas Tungsten Arc Welding (GTAW)

Competency: F4 Use the GTAW process for ferrous metals

Objectives

To be competent in this area, the individual must be able to:

- Use the GTAW process to weld groove welds using low carbon steel filler metal on low carbon steel pipe.
- Use the GTAW process to weld groove welds in the 1G, 2G and 3G positions using free-hand and cup-contact method.

LEARNING TASKS	CONTENT

1. Describe the preparation of plate and pipe for GTAW	• Edge preparation
	• Pipe alignment
	• Tacking
	• Consumable inserts:
	  ○ EB weld insert
	  ○ Type Y insert
	  ○ The Grinnel insert

2. Weld multi-pass groove welds using free-hand and cup-contact methods	• On low carbon steel plate:
	  ○ Flat (1G) position
	  ○ Horizontal (2G) position
	  ○ Vertical (3G) position - uphill

3. Weld multi-pass groove welds	• On low carbon steel pipe
	  ○ Vertical fixed (2G) position
	  ○ Horizontal fixed (5G) position – uphill
	• Face and root bend tests

Achievement Criteria

Performance The learner will be evaluated on the ability to:

- Use the GTAW process to weld groove welds using low carbon steel filler metal on low carbon steel pipe in the 2G and 5G uphill positions.
- Successfully complete face and root bend tests.

Conditions As part of a practical shop project and given the required tools and equipment.

Criteria

- Welds will be evaluated for:
  - Good fusion and penetration
  - Smooth, slightly convex weld
  - Absence of irregularities, undercut, porosity and stray arc strikes
- Coupons will be evaluated in accordance with Section IX ASME code
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8") in any direction on the convex surface of the specimen after bending
- Cracks occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from slag inclusions on other external defects

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): F Gas Tungsten Arc Welding (GTAW)

Competency: F6 Use the GTAW process for aluminum

Objectives

To be competent in this area, the individual must be able to:

- Use the GTAW process to weld stringer beads, fillet and groove welds on aluminum sheet.

LEARNING TASKS	CONTENT

1. Describe the GTAW process and procedures on aluminum	• Aluminum filler metal
	• Welding aluminum
	• Joint design for aluminum
	• Preparation of aluminum
	  ○ Pre-cleaning
	  ○ Post-cleaning
	  ○ Recognize weld defects

2. Weld stringer beads on aluminum sheet	• On aluminum sheet: ○ Flat (1S) position

3. Weld single-pass fillet welds	• On aluminum sheet
	  ○ Flat (1F) position
	  – Tee joints
	  – Corner joints
	  ○ Horizontal (2F) position
	  – Tee joints
	  – Corner joints
	  ○ Vertical (3F) position - uphill
	  – Tee joints

4. Weld single-pass groove welds	• On aluminum sheet ○ Flat (1G) position

Achievement Criteria

Performance — The learner will be evaluated on the ability to:

- Weld stringer beads on aluminum sheet.
- Weld fillet welds in the 1F, 2F and 3F uphill positions on aluminum sheet.
- Weld groove welds in the 1G position on aluminum sheet.

Conditions — As part of a practical shop project and given the required tools and equipment.

Criteria

- Stringer beads will be evaluated for:
  - Good fusion
  - Smooth, slightly convex beads
  - Absence of irregularities, porosity, undercut and stray strike marks
- Fillet welds will be evaluated for each of the criteria above, plus they must have legs of equal length
- Groove welds will be evaluated for each of the criteria above, and they must have complete joint penetration

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): H Basic Metallurgy

Competency: H2 Describe mechanical and physical properties of ferrous and non-ferrous metals

Objectives

To be competent in this area, the individual must be able to:

- Describe the effects of the welding process with regard to the mechanical properties of low carbon steel.

LEARNING TASKS	CONTENT
1. Describe the precautions and weldability of low carbon steel	• Factors affecting the weldability of low carbon steel • Contamination • Thickness • Temperature • Moisture

2 Describe the effects of welding on low carbon steel	• Heat affected zones in welds
	• Heat transfer
	• Effects of expansion and contraction
	• The purpose and effects of:
	  ○ Preheating
	  ○ Post heating
	  ○ Quenching
	  ○ Temperature indicating devices
	  – Temperature sticks/crayon
	  – Pyrometer

Line (GAC): H Basic Metallurgy

Competency: H3 Describe common ferrous, non-ferrous and reactive metals and their weldability

Objectives

To be competent in this area, the individual must be able to:

- Identify low alloy and their weldability.
- Identify stainless steels and their weldability.
- Describe heat treatment of steels.

LEARNING TASKS	CONTENT
1. Identify low alloy steels and their weldability	• Low alloy steels • Weldability of low alloy steels • High strength low alloy steels (HSLA) • Weldability of HSLA steels

2. Identify stainless steels and their weldability	• Weldability of stainless steels
	  ○ Welding process
	  ○ Preparation of base metal
	• Duplex stainless
	  ○ 2205 (SMO, HMO)

2. Describe heat treatment of steels	• Full annealing • Normalizing • Spheroidizing • Stress-relief annealing • Process annealing • Quench hardening • Tempering or drawing stress relief • Vibratory stress relief • Peening

Line (GAC): H Basic Metallurgy

Competency: H4 Describe the grain structure of metals

Objectives

To be competent in this area, the individual must be able to:

- Describe the microstructure of metals.
- Identify changes in grain structure that result from welding.

LEARNING TASKS	CONTENT
1. Describe the microstructure of metals	• Crystalline or grain structure • Grain size in metal • Grain structure in pure iron • Grain structure of carbon steels
2. Identify changes in grain structure that result from welding	• Heat zones in welds • Grain characteristics in welds • Preheating • Postheating

Line (GAC): H Basic Metallurgy

Competency: H5 Describe aluminum, aluminum alloys and their weldability

Objectives

To be competent in this area, the individual must be able to:

- Describe aluminum, aluminum alloys and their weldability.

LEARNING TASKS	CONTENT
1. Identify aluminum, aluminum alloys and their designations	• Production of aluminum • Properties of aluminum and aluminum alloys • Casting alloys
2. Identify the effects of alloy content on the weldability of aluminum	• Properties of major wrought alloys • Hot shortness • Filler metal for wrought alloys • Properties of major casting alloys • Weldability of aluminum casting alloys
3. Identify heat treatments for aluminum and its alloys	• Annealing • Stress-relieving • Solution heat treatments • Precipitation-hardening (aging)

Line (GAC): I Welding Drawings Layout and Fabrication

Competency: I2 Read and interpret drawings

Objectives

To be competent in this area, the individual must be able to:

- Read and interpret piping drawings.
- Perform basic pipe layout.

LEARNING TASKS	CONTENT

1. Identify pipe and pipe fittings and their symbols	• Pipe
	• Pipe specifications
	• Pipe fittings
	  ○ Butt-weld fittings
	  ○ Butt-weld elbows
	  – 180º return elbow
	  – 90º elbow
	  – 45º elbow
	  – Mitre-cut elbows
	  – Reducing weld elbow
	  ○ Butt-weld tee
	  ○ Lateral
	  ○ Butt-weld cross
	  ○ Butt-weld reducer
	  ○ Welding cap
	  ○ Welding outlet (weldolet)
	• Butt-weld fitting symbols
	• Welding fitting specifications
	• Threaded fittings
	• Socket-welded fittings
	• Flanged fittings

2. Identify valves, their symbols and specifications	• Types of valves
	  ○ Gate
	  ○ Globe
	  ○ Check
	  ○ Safety (relief)
	  ○ Pressure reducing
	  ○ Control
	• Valve specifications

3.	Identify flanges, their symbols and specifications	• Screwed flange (Scr'd Flg.)
		• Weld-neck flange (W.N.flg.)
		• Slip-on flanges (S.O.Mg.)
		• Socket-weld flange (S.W.Flg.)
		• Lap-joint flange (L.J.Flg.)
		• Special purpose flanges:
		  ○ Blind flange (B.F.)
		  ○ Spectacle blind (Fig. 8 Blind)
		  ○ Reducing flanges (Red. Flg.)
		• Flange facings
		• Flange specifications

4.	Interpret basic piping drawings	• Types of piping drawings
		  ○ Process flow drawings and P&ID
		  ○ Site plans
		  ○ Plan views, elevations and sections
		  ○ Single-line isometrics
		  ○ Spool drawings
		  ○ Drawing views

5.	Perform a pipe layout	• Pipe bending
		• Bend allowance
		• Templates
		• Fundamental parallel-line development theory
		  ○ Principles of parallel-line development
		  ○ Placement and number of views
		  ○ Number of elements
		  ○ Calculating the length of the stretch-out
		• Pipe dimensions
		  ○ Angles of cut
		• Tools for pipe layout
		  ○ Centering head
		  ○ Pipefitter's level
		  ○ Contour marker

6.	Use parallel line development to layout templates for K-6 pipe fabrication	• Two-piece 45º elbow on 4" pipe

Achievement Criteria

Performance	The learner will be evaluated on the ability to layout and assemble a two-piece 45° elbow on 4" pipe.
Conditions	As part of a practical shop project and given the required tools and equipment.
Criteria	A two-piece elbow will be evaluated during layout, cutting and assembly. The final product will be evaluated for*:* • Correct alignment • 45 degree angle of fit • Neat and feathered tack welds • Correct root gap *Completed within specifications, safety standards and time frames acceptable to industry.*

Line (GAC): I Welding Drawings Layout and Fabrication

Competency: I5 Interpret and apply mechanical drawings and layout components

Objectives

To be competent in this area, the individual must be able to:

- Interpret and apply mechanical drawings.
- Layout and prepare materials.

LEARNING TASKS	CONTENT
1. Describe types of mechanical drawings	• Orthographic • Isometric • Oblique • Detail drawings • Spool sheets
2. Describe mechanical drawing applications	• Industrial • Commercial • Oil and gas • Marine

3. Explain why applicable standards and codes must be followed when interpreting mechanical drawings	• CSA standards
	• ASME standards
	  ○ B31.3
	  ○ B31.1
	• API standards

4. Explain the use of drawing notes and their applications	• Reference points • Details • Tolerances • Specifications • Working from centerlines
5. Describe the use of drawing scales	• Interpreting dimensions • Metric or imperial • Use of AutoCad

6. Describe views used in assemblies	• Types of views:
	  ○ Multiple views
	  ○ Detail views
	  ○ Assembly views
	  ○ Detail/assembly views
	• Procedures

7. Identify and explain the purpose of key numbers on drawings	• Drawing number • Part number • Spooling number

		• Revision number
8.	Prepare pipe for cutting	• Check templates to verify accuracy • Apply to pipe • Mark accordingly
9.	Cut materials to dimensions	• Cutting sequence • Tolerances and bevel • Select cutting equipment • Safety
10.	Prepare materials for assembly	• Check joint preparation and geometry • Select abrasives • Perform grinding • Safety

Achievement Criteria

Performance	The learner will be evaluated on the ability to layout, assemble and weld a two-piece elbow and a two-piece tee connection.
Conditions	As part of a practical shop project and given the required tools and equipment.

Criteria	• Two-piece elbow will be evaluated during layout, cutting and assembly.
	The final product will be evaluated for:
	  ○ Correct alignment
	  ○ 45 degree angle of fit
	  ○ Neat and feathered tack welds
	  ○ Correct root gap
	• Two-piece 90 degree tee connection will be evaluated during layout, cutting and assembly.
	The final product will be evaluated for:
	  ○ Correct alignment of header and branch
	  ○ Correct root gap
	• Tack welds neat and feathered
	
	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): I Welding Drawings Layout and Fabrication

Competency: I6 Fabricate weldments

Objectives

To be competent in this area, the individual must be able to:

- Fit and weld a pipe assembly project.

LEARNING TASKS	CONTENT

1. Fit and tack pipe and miscellaneous components	• Select fitting equipment
	  ○ Wedges
	  ○ Clamps
	  ○ Hand tools
	  ○ Pipe stands
	• Welding process and consumables
	• Organize work in sequential order
	• Fitting
	  ○ Techniques
	  ○ Equipment
	  ○ Distortion control
	  ○ Specifications

2. Weld weldments	• Check tacks and alignment • Welding procedures

Achievement Criteria

Performance	The learner will be evaluated on the ability to: • Layout, fit and weld a pipe assembly.
Conditions	Given a practical fitting and welding pipe assembly project, the required tools and materials.
Criteria	The learner will be assessed using criterion reference standard (pass/fail), as per the guidelines for practical examinations. *Completed within specifications, safety standards and time frames acceptable to industry.*

Line (GAC): I Welding Drawings Layout and Fabrication

Competency: I7 Costing and estimating

Objectives

To be competent in this area, the individual must be able to:

- Calculate project costs for complex fabrication.

LEARNING TASKS	CONTENT

1. Identify project costs	• Materials
	  ○ Weight
	  ○ Wastage
	• Labour
	• Consumables
	• Transportation
	  ○ Shipping
	  ○ Material handling
	  ○ Lead time

2. Calculate cost for a complex fabrication project	• Weight
	• Estimate labour and consumables
	• Transportation
	  ○ Shipping
	  ○ Material handling
	  ○ Lead time

Achievement Criteria

Performance	The learner will be evaluated on the ability to cost a complex fabrication project consisting of a 3 structural columns complete with base plates.
Conditions	Given project specifications and fixed costs.
Criteria	Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): J Quality Control and Inspection

Competency: J1 Describe basic welding quality control and inspection requirements

Objectives

To be competent in this area, the individual must be able to:

- Describe welding quality control and inspection requirements.

LEARNING TASKS	CONTENT
1. Describe quality control and inspection requirements	• Fit-up and preparation (prior to assembly) • Examine completed welds • Measure final product for compliance to blueprints and drawings • Standards, specifications and codes

2. Describe welding procedure qualification tests	• Types of tests
	  ○ Guided bend tests
	  ○ Tensile tests
	  ○ Impact tests
	  ○ Etching
	  ○ Radiography
	• CSA reguations
	• ASME regulations
	• Welder performance qualification tests

Line (GAC): J Quality Control and Inspection

Competency: J2 Describe inspection and testing procedures

Objectives

To be competent in this area, the individual must be able to:

- Describe types and uses of destructive testing methods.
- Describe types and uses of non-destructive testing methods.
- Identify surface and sub-surface discontinuities.
- Identify testing symbols.

LEARNING TASKS	CONTENT
1. Describe destructive testing methods	• Destructive testing • Guided bend tests • Nick-break tests • Impact test ○ Charpy and izod tests • Tensile tests • Fillet weld break tests • Etching

2. Describe non-destructive testing methods and their use	• Non-destructive testing
	• Visual inspection
	• Radiographic tests
	• Magnetic-particle testing
	• Ultrasonic testing
	• Eddy current testing
	• Dye penetrant testing
	• Ultrasound thickness test
	• Hydrostatic
	• Light oil
	• Acoustic
	• Emission
	• Vacuum box tests
	• Hardness testing
	  ○ File test
	  ○ Brinnell hardness test
	  ○ Rockwell hardness testing
	  ○ Vickers hardness test

3. Identify surface and sub-surface discontinuities	• Relevant indications • Non-relevant indications
4. Identify non-destructive testing symbols	• Side significance • Multiple tests • Dimensions • Test all-around and field test symbols • Combining welding and testing symbols

Line (GAC): J Quality Control and Inspection

Competency: J3 Describe the scope of the welding supervisor and inspector responsibilities

Objectives

To be competent in this area, the individual must be able to:

- Describe the welding supervisor's responsibilities.
- Describe the welding inspector's responsibilities.

LEARNING TASKS	CONTENT
1. Examine levels of supervision	• Journeyperson • Leadhand • Supervisor • Superintendent • Manager
2. Describe the scope of the Welding Supervisor	• Ensuring safe work practices • Coordinating work • Quality control • Project start up • Material and time estimations • Inventory control • Purchasing • Record and time keeping • Documentation use/control • Effective communications/conflict resolution • Meeting deadlines • Training workers • Progress reports

3. Describe the scope of the Welding Inspector	• Adherence to job specifications, codes and standards
	• Adherence to acceptable welding practices
	  ○ Material preparation
	  ○ Filler metal handling and storage
	• Visual inspections
	• Weld procedures specifications (WPS)
	• Verifies weld acceptability through destructive and non-destructive testing methods
	• Welder performance qualification tests
	• Material and consumables documented:
	  ○ Mill certification
	• Filler metal certification

Line (GAC): K Standards, Codes, Specifications and Welder Qualifications

Competency: K1 Identify applicable standards, codes, specifications and jurisdictional bodies

Objectives

To be competent in this area, the individual must be able to:

- Identify welding codes, standards and specifications, the governing agencies and qualification testing.
- Describe the scope of welding codes, standards and specifications.
- Describe the services and responsibilities of the Technical Safety BC (TSBC).

LEARNING TASKS	CONTENT

1. Describe the scope of welding codes, standards and specifications	• Codes
	  ○ Welding of steel structures
	  ○ Welding of boilers and pressure vessels
	• Specifications
	• Standards
	  ○ Standardization
	  ○ Relationship of terms
	• Agencies that set codes and standards
	  ○ Canadian Standards Association (CSA)
	  ○ American Society of Mechanical Engineers (ASME)
	  ○ American Welding Society (AWS)
	  ○ International Standards Organization (ISO)
	  ○ American Bureau of Shipping (ABS) and Lloyds of London
	  ○ American Petroleum Institute (API)

2. Describe the services performed by TSBC	• Issuing permits • Inspecting technical work and equipment • Certifying individuals and licensing contractors to meet regulatory requirements • Educating the public about safety issues • Oversee regulations for industry sectors • Investigating incidents • Registering new equipment designs

3.	Describe the responsibilities of the TSBC	• Amusement rides and recreational railways • Boilers, pressure vessels and refrigeration systems • Electrical equipment and systems • Elevating devices (i.e. elevators and escalators) • Gas appliances and systems, including hydrogen • Passenger ropeways such as ski lifts • Railways

4.	Describe CWB jurisdiction	• Accreditation covers welding certification programs for companies engaged in
		  ○ Fusion welding
		  ○ Welding consumables
		  ○ Welding inspection organizations

5.	Describe CWB certification programs	• CSA W 47.1 Steel • CSA W 47.2 Aluminum • CSA W 55.3 Resistance Welding • CSA A 660 Steel Building • CSA W 186 Reinforcing Bar
6.	Describe piping codes	• Power piping code (B31-1) • Process piping code (B31-3) • ASME section IX • CSA standard W59 • CSA standard Z662

Line (GAC): K Standards, Codes, Specifications and Welder Qualifications

Competency: K2 Describe compliance with weld procedure specifications (WPS) and data sheets

Objectives

To be competent in this area, the individual must be able to:

- Describe compliance with weld procedure specifications (WPS) and data sheets.

LEARNING TASKS

1. Describe weld procedure specifications (WPS) and data sheets.

CONTENT

- Requirements as outlined in the WPS
  - QW482
  - QW483
  - QW484
- Certified testing agencies
- Complete documentation
- Engineer approval

Multi-Process Alloy Welding (MPAW) Endorsement (Optional)

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D3 Select electrodes for SMAW

Objectives

To be competent in this area, the individual must be able to:

- Describe low-alloy electrodes for SMAW.
- Describe the selection, applications, basic care, handling and storage of electrodes.

LEARNING TASKS	CONTENT
1. Describe correct handling and storage of common electrodes	• Handling of electrodes before and after use • Storage of electrodes • Electrode ovens • Handling of electrodes in use

2. Identify low-alloy electrodes for SMAW	• Composition and designation
	  ○ Carbon-molybdenum
	  ○ Chromium-molybdenum
	  ○ Nickel
	  ○ Manganese-molybdenum
	  ○ Special military grades

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D6 Use the SMAW process on low carbon steel plate and pipe

Objectives:

To be competent in this area, the individual must be able to:

- Use the SMAW process to weld groove welds using low-alloy electrodes on steel plate and pipe.

LEARNING TASKS	CONTENT

1. Weld multi-pass groove welds using the SMAW process	• On low carbon steel plate on single-v butt joint using low-alloy filler metal electrodes
	  ○ Horizontal (2G) position
	  ○ Vertical (3G) position – uphill
	  ○ Overhead (4G) position

2. Weld multi-pass groove welds using (GTAW root) and SMAW fill and cap	• On low carbon steel pipe using low-alloy filler metal electrodes ○ Inclined fixed 45º (6G) position – uphill • Face and root bend tests

Achievement Criteria

Performance

The learner will be evaluated on the ability to use the SMAW process to:

- Weld groove welds with low-alloy filler metal electrodes:
  - On steel plate in the 2G, 3G (uphill) and 4G position.
  - On steel pipe in the 6G position (uphill, fill and cap passes).
- Successfully complete face and root bend tests.

Conditions

As part of a practical shop project and given the required tools and equipment.

Criteria

- Groove welds will be evaluated for:
  - Correct alignment
  - Smoothness and uniformity
  - Absence of distortion, irregularities and stray arc strikes
  - Maximum face reinforcement of 3.2 mm (1/8")
  - Maximum root reinforcement of 2.5 mm (3/32")
- Coupons will be evaluated in accordance with Section IX ASME code:
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8") in any direction on the convex surface of the specimen after bending
  - Cracks occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from slag inclusions on other external defects.

*Completed within specifications, safety standards a*nd time frames acceptable to industry.

Line (GAC): D Shielded Metal Arc Welding (SMAW)

Competency: D9 Use the SMAW process on stainless steel and/or low carbon steel plate and pipe

Objectives:

To be competent in this area, the individual must be able to:

- Use the SMAW process to weld fillet and groove welds using stainless steel filler metal electrodes on steel plate and pipe.

LEARNING TASKS	CONTENT

1. Weld multi-pass fillet welds using the SMAW process	• On low carbon steel plate
	  ○ Vertical (3F) position – uphill with E309 stainless steel filler metal electrodes
	  – Tee joint
	  ○ Overhead (4F) position
	  – Tee joint

2. Weld multi-pass groove welds using (GTAW root) and SMAW fill and cap	• On low carbon steel pipe
	  ○ Vertical fixed (2G) position with E309 stainless steel filler metal electrodes
	  ○ Horizontal fixed (5G) position - uphill with E309 stainless steel filler metal electrodes
	• Face and root bend tests

Achievement Criteria

Performance

The learner will be evaluated on the ability to use the SMAW process to:

- Fillet weld on low carbon steel plate with stainless steel filler metal electrodes
- Weld groove welds with stainless steel filler metal electrodes (fill and cap passes):
  - On steel pipe in the 2G position
  - On steel pipe in the 5G position (uphill)
- Successfully complete face and root bend tests.

Conditions

As part of a practical shop project and given the required tools and equipment.

Criteria

- Fillet welds will be evaluated for:
  - Correct alignment
  - Good penetration and fusion
  - Reasonable smoothness
  - Legs of equal length
  - Slightly convex profile
  - Absence of porosity, irregularities, undercut and arc strikes
  - Overall appearance
- Groove welds will be evaluated for:
  - Correct alignment
  - Smoothness and uniformity
  - Absence of distortion, irregularities and stray arc strikes
  - Maximum face reinforcement of 3.2 mm (1/8”)
  - Maximum root reinforcement of 2.5 mm (3/32”)

- Coupons will be evaluated in accordance with Section IX ASME code:
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8") in any direction on the convex surface of the specimen after bending
  - Cracks occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from slag inclusions on other external defects.

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): F Gas Tungsten Arc Welding (GTAW)

Competency: F5 Use the GTAW process for stainless steel

Objectives

To be competent in this area, the individual must be able to:

- Use the GTAW process to groove weld using stainless steel filler metal on stainless steel pipe (or low carbon steel) and stainless steel tubing.

LEARNING TASKS	CONTENT
1. Assemble and purge equipment for GTAW on pipe	• Purge pipe to appropriate CFM prior to welding

2. Weld multi-pass groove welds using the GTAW process	• On stainless steel pipe *(low carbon steel optional)*
	  ○ Vertical fixed (2G) position
	  ○ Horizontal fixed (5G) position – uphill
	  ○ 45° fixed (6G) position - uphill
	• Stainless steel filler metal
	• Face and root bend tests

3. Weld single-pass groove welds using the GTAW process	• On stainless steel tubing
	  ○ Vertical fixed (2G) position
	  ○ Horizontal fixed (5G) position – uphill

Achievement Criteria

Performance — The learner will be evaluated on the ability to:

- Use the GTAW process to weld groove welds on stainless steel pipe in the 2G, 5G and 6G positions.
- Weld single-pass groove welds on stainless steel tubing.
- Successfully complete face and root bend tests.

Conditions — As part of a practical shop project and given the required tools and equipment.

Criteria

- Groove welds will be evaluated for:
  - Correct alignment
  - Smoothness and uniformity
  - Absence of distortion, irregularities and stray arc strikes
  - Maximum face reinforcement of 3.2 mm (1/8")
  - Maximum root reinforcement of 2.5 mm (3/32")
- Coupons will be evaluated in accordance with Section IX ASME code:
  - Weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion specimen after testing
  - Guided-bend specimens shall have no open defects in the weld or heat-affected zone exceeding 3.2 mm (1/8") in any direction on the convex surface of the specimen after bending
  - Cracks occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from slag inclusions on other external defects.

Completed within specifications, safety standards and time frames acceptable to industry.

Line (GAC): G Specialized Processes

Competency: G1 Describe specialized welding processes

Objectives

To be competent in this area, the individual must be able to:

- Describe specialized welding processes.

LEARNING TASKS	CONTENT
1. Describe orbital welding and its applications	• Definition • History • Process types • Industry applications • Advantages and disadvantages • Equipment
2. Describe specialized welding processes, equipment and their applications	• Plastic welding • Thermal spray process welding • Thermit welding • Electro-gas welding • Electro-slag welding • Laser welding • Plasma welding • Flash butt welding • Electron beam welding • Friction and friction stir welding • Stud arc welding • Resistance welding

Line (GAC): H Basic Metallurgy

Competency: H3 Describe common ferrous, non-ferrous and reactive metals and their weldability

Objectives

To be competent in this area, the individual must be able to:

- Describe non-ferrous alloys, their uses and the methods for welding.
- Describe reactive metals and their weldability.

LEARNING TASKS	CONTENT

1. Describe nickel and nickel alloys and their weldability	• Nickel alloys
	  ○ Monel
	  ○ Inconel
	  ○ Nichrome
	  ○ Nimonic alloys
	  ○ Hastelloys
	• Basic considerations in welding
	• Thermal conductivity
	• Electrical resistance and heat input
	• Porosity
	• Filler metals
	• Hot cracking
	• Iron dilution

2. Describe copper and copper alloys and their weldability	• Copper alloys
	  ○ Brass
	  ○ Bronze
	  ○ Copper-silicon alloys (silicon bronze)
	  ○ Copper-aluminum (aluminum bronze)
	  ○ Copper-beryllium
	  ○ Copper-nickel alloys
	• Welding copper and copper alloys
	  ○ Preheating
	  ○ Shielding
	  ○ Joint geometry
	  ○ Deoxidization
	  ○ Filler metals
	  ○ Post-weld heat treatment
	  ○ Vaporization
	  ○ Hot cracking

3. Describe magnesium and magnesium alloys and their weldability	• Pure magnesium
	• Magnesium alloys
	• Welding magnesium and its alloys:
	  ○ Joint preparation
	  ○ Cleaning
	  ○ Shielding
	  ○ Cracking
	  ○ Filler metals

4. Describe lead and lead alloys and their weldability	• Lead alloys • Weldability

5. Describe titanium and titanium alloys and their weldability	• Characteristics of reactive metals
	• Titanium
	  ○ Grain structure
	  – Alpha alloys
	  – Beta alloys
	  – Alpha-beta alloys
	• Welding titanium
	  ○ Shielding
	  ○ Porosity
	  ○ Heat affected zone (HAZ)
	  ○ Filler metals

6. Describe zirconium and zirconium alloys and their weldability	• Zirconium alloys
	  ○ Alpha alloys
	  ○ Beta alloys
	  ○ Commercial zirconium alloys
	• Weldability
	  ○ Zirconium filler metals

7. Describe tantalum and tantalum alloys and their weldability	• Tantalum • Weldability
8. Describe columbium and columbium alloys and their weldability	• Columbium alloys • Weldability

Line (GAC): H Basic Metallurgy

Competency: H6 Describe die castings and their weldability

Objectives

To be competent in this area, the individual must be able to:

- Describe aluminum, magnesium and zinc die castings and the processes for welding each type.

LEARNING TASKS	CONTENT
1. Describe die castings and their weldability	• Magnesium • Aluminum • Zinc

Line (GAC): I Welding Drawings Layout and Fabrication

Competency: I5 Interpret and apply mechanical drawings and layout components

Objectives

To be competent in this area, the individual must be able to:

- Layout and prepare materials.
- Interpret detail drawings of a rolling offset and transition pieces.
- Develop template drawings of transition pieces.

LEARNING TASKS	CONTENT
1. Construct an assembly consisting of square to round transition	• Template materials • Measuring tools • Conform to dimensional tolerances
2. Interpret and transfer dimensions from drawings to materials	• Transfer methods • Measuring tools • Layout tools • Conform to dimensional tolerances
3. Layout materials	• Check templates to verify accuracy • Mark accordingly
4. Layout cuts on materials to dimensions	• Cutting sequence • Tolerances and bevel • Select cutting equipment • Safety

5. Read a detail drawing of a rolling offset	• Offset terminology
	  ○ Piping offset
	  ○ Travel
	  ○ Advance
	  ○ Angle fit
	• Types of offset
	• Offset piping problems

6.	Calculate simple and rolling offset dimensions	• Trigonometric terms and functions
		• Triangles
		• Triangle part labels
		• Trigonometric functions
		• Calculating trigonometric functions:
		  ○ Table of trigonometric functions
		  ○ Scientific calculator
		• Apply trigonometry to simple offsets
		• Apply the Pythagorean theorem to simple piping offsets
		• Apply trigonometry and the Pythagorean theorem to rolling offsets

7.	Develop template drawings of transition pieces	• Methods of developing templates • True length elements • Radial-line development • Triangulation • Principles of triangulation

Line (GAC): I Welding Drawings Layout and Fabrication

Competency: I6 Fabricate weldments

Objectives

To be competent in this area, the individual must be able to:

- Layout, assemble and weld a square-to-square transition.
- Layout, assemble and weld a square-to-round transition.
- Layout, assemble and weld a rolling offset.

LEARNING TASKS	CONTENT

1. Layout square-to-square transition	• Fitting techniques
	  ○ Use of fitting equipment
	  ○ Tack techniques
	  ○ Distortion control
	• Follow specifications

2. Assemble and weld a square-to-square transition	• Set up work area, tools and equipment • Gather material • Cut to specifications • Prep edges as per drawings • Fit pieces as per drawings • Tack pieces in place • Complete weldments

3. Layout square-to-round transition	• Layout and break components
	• Fitting techniques:
	  ○ Use of fitting equipment
	  ○ Tack techniques
	  ○ Distortion control
	• Follow specifications

4. Assemble and weld a square-to-round transition	• Set up work area, tools and equipment • Gather material • Cut to specifications • Prep edges as per drawings • Fit pieces as per drawings • Tack pieces in place • Complete weldments

5.	Layout rolling offset	• Select required fitting equipment
		  ○ Wedges
		  ○ Clamps
		  ○ Hand tools
		  ○ Pipe stands
		• Welding process and consumables
		• Organize work in sequential order
		• Fitting techniques
		  ○ Use of fitting equipment
		  ○ Tack techniques
		  ○ Distortion control
		• Follow specifications

6.	Assemble and weld components for a rolling offset	• Set up work area, tools and equipment • Gather material • Cut to specifications • Prep edges as per drawings • Fit pieces as per drawings • Tack pieces in place • Complete weldments

Achievement Criteria

Performance — The learner will be evaluated on the ability to:

- Layout and assemble a square-to-square and square-to-round transition.
- Layout, assemble and weld a rolling offset.

Conditions — As part of a practical shop project and given the required tools and equipment.

Criteria

- Transition layout will be evaluated on:
  - Height of truncated cone is correct
  - Base dimensions are correct
  - Dimensions of top opening are correct
- Rolling offset layout will be evaluated on:
  - Angle of cut calculated correctly
  - Semi-circle correctly divided
  - Stretch-out is correct length
  - Correct number of elements in stretch-out and elements in stretch-out are equally spaced
- Final welds will be evalutated on:
  - Correct alignment
  - Smoothness
  - Absence of distortion and irregularities

Completed within specifications, safety standards and time frames acceptable to industry.

Section 4

TRAINING PROVIDER STANDARDS

Facility Requirements

Classroom Area

All levels

- Comfortable seating and tables suitable for training, teaching, lecturing
- Compliance with all local and national fire code and occupational safety requirements
- Lighting controls to allow easy visibility of projection screen while also allowing students to take notes
- Windows must have shades or blinds to adjust sunlight
- Heating/Air conditioning for comfort all year round
- In-room temperature regulation to ensure comfortable room temperature
- In-room ventilation sufficient to control training room temperature
- Acoustics in the room must allow audibility of the Instructor
- White marking board with pens and eraser (optional: flipchart in similar size)
- Projection screen or projection area at front of classroom
- Overhead projector and/or multi-media projector

Shop Area (fixed properties)

All levels

- One welding booth per student (minimum booth size must be 6' x 6') fully equipped with:
    - Welding table (minimum recommended size 18" x 20")
    - One 115 volt receptacle or pneumatic air supply for grinders
    - Ventilation as per WorkSafeBC standards
    - Task lighting
    - Suitable demonstration area of approximately 7' x 14'
    - Aisles size must be a minimum of 6' wide
    - The grinding and test coupon preparation area must be a minimum 300 square feet
    - Material storage area (including a separate, secured cylinder storage area)
    - Ceiling shall be a minimum height of 16' or as varied by good engineering practices and code

Level 1

- One welding booth per student (minimum booth size must be 6' x 6') fully equipped with:
    - Industrial grade multi-process welding power source or equipment suitable for all Level 1 required welding processes
    - One height adjustable positioning arm

Level 2

- One welding booth per student (minimum booth size must be 6' x 6') fully equipped with:
    - Industrial grade multi-process welding power source or equipment suitable for all Level 2 required welding processes
    - One height adjustable positioning arm for pipe

Level 3

- One welding booth per student (minimum booth size must be 6' x 6') fully equipped with:
    - Industrial grade multi-process welding power source or equipment suitable for all Level 3 required welding processes
    - One height adjustable positioning arm for pipe

Endorsement

- One welding booth per student (minimum booth size must be 6' x 6') fully equipped with:
    - Industrial grade multi-process welding power source or equipment suitable for all Level 4 required welding processes
    - One height adjustable positioning arm for pipe

Lab Requirements

- N/A

Student Facilities

- Adequate lunch room as per WorkSafeBC requirements
- Adequate washroom facilities as per WorkSafeBC requirements
- Personal storage lockers

Instructor's Office Space

- As required

Tools and Equipment

Shop Equipment

For all Levels

- One floor model drill press, 1/2 hp minimum, 1/2" x 8"
- One 3' x 6' work bench with two vices
- One pedestal grinder, 12" x 2" stone
- One pedestal belt sander with a minimum 3" belt
- One floor model vertical band saw
- One horizontal band saw
- One abrasive chop saw
- Two track cutters
- Four 7" grinders (electric or pneumatic) for general shop use
- Electrode stabilizing oven (minimum 250 lbs)
- One semi-automatic or automatic submerged arc welder

Level 1 and Level 2

- One guided bend test jig as per CSA W47.1 dimensional specifications
- One 5" grinders per student (one grinding, one bead brush)

Level 3 and Endorsement

- One guided bend test jig as per ASME Section IX dimensional specifications
- Two 5" grinders per student (one grinding, one bead brush)
- Six pipe stands
- Two pipe positioners
- Two pipe bevelling machines
- Pipe layout hand tools (one set for every two students)
- Purging equipment (plugs, backing bars, caps, flow meters, hose)

Hoisting, Rigging and Lifting Equipment – *for all levels*

- One ton overhead jib crane or overhead crane
- Overhead hoist
- Rigging hardware - shackles, swivels, eyebolts, turn buckles, snatch blocks, etc.
- Plate clamps
- Cable clamps
- Chain, wire rope and synthetic slings
- Chains
- Chain fall
- Rope
- Slings
- Come-alongs (chain and cable)
- Connectors
- Tirfor jacks
- Chain block hoist
- Chokers
- Forklift
- Portable boom
- Spreader bars
- Stands
- Supports
- Tuggers

Optional Equipment – *for all levels*

- One 1/4" x 4' hydraulic shear
- One iron worker
- One press brake (minimum 4' x 12 gauge mechanical pan brake)

Basic Tools and Equipment – *for all levels*

- Adjustable wrenches (various sizes)
- Allen wrenches (metric and imperial)
- Ammeter
- Bench vise
- Broom
- Brushes (various bristle brushes for cleaning and scrubbing)
- "C" clamps
- Center head
- Centering pins
- Chain hoists
- Chalk line
- Chokers
- Cold chisels (various sizes)
- Combination wrenches (metric and imperial)
- Come-alongs
- Contour marker
- Cylinder carts
- Cylinder cradles
- Dollies
- Electric cords
- Files (flat, half-round, rat-tail, bastard)
- Flange pins
- Flashlight
- Friction lighter
- Funnels
- Hack saw
- Hammers (chipping, ball peen, claw, sledge, various sizes)
- Hand shears
- Jacks
- Knives
- Ladders
- Magnets
- Metal markers
- Mop
- Oil can
- Pails (plastic and metal)
- Paint brushes
- Pipe cutters
- Pipe stands
- Pipe wrenches
- Pliers (needle nose, slip joint)
- Positioners
- Pry bars
- Punches
- Rollers
- Scaffolding (safety)
- Scrapers (various sizes)
- Screwdrivers (flat, Phillips, Robertson, various sizes)
- Shovels (flat mouthed)
- Slings
- Snips (heavy duty sheet metal cutting)
- Soapstone markers
- Socket sets (metric and imperial)
- Soldering iron
- Stamping tools
- Temperature sticks
- Tip cleaners
- Tool boxes
- Vice grips
- Vices (chain vice, pipe vice)
- Water hose
- Wrap arounds
- Wire brush
- Wire cutter
- Wrench sets (open and closed ends, both metric and imperial)

Measuring Tools – *for all levels*

- Calculator
- Calipers
- Depth gauge
- Feeler gauges
- Fillet gauges
- Laser level
- Torpedo level
- Micrometer
- Plumb bob
- Protractor
- Scribers
- Spirit level
- Squares
- Stop watch
- Straight edges
- Tape measure
- Tri squares
- Vernier calipers
- Welding gauges

Testing Equipment – *for all levels*

- Adapter fittings
- Ammeter
- Calibrating gauges
- Infrared pyrometer
- Pressure difference gauges
- Pressure gauge kit
- Temperature gauges
- Temperature sticks

Safety Equipment – *for all levels*

- Air hoods
- Aprons
- Body harness
- Boots
- Coveralls
- Ear-plugs and muffs
- Eye wash station
- Face shields
- Fire blankets
- Fire extinguishers
- Fire hoses
- Gloves
- Goggles
- Masks (particle, vapour)
- Respirators
- Safety glasses
- Safety helmet
- Welding shield

Power Tools and Equipment – *for all levels*

- Air hose and nozzle
- Air monitoring device
- Arc welder
- Oxy-fuel cutting equipment
- Band saw
- Buffers
- Chop saw (cut-off saw)
- Circular saw
- Coil heating equipment
- Compressors
- Cranes (overhead, gantry-type, monorail, boom)
- Drills (portable, magnetic base, drill press)
- Electric drills
- Electronic measuring device (hand-held "electronic tape measure" type)
- Feeders-wire
- Fork lifts
- Gas detector
- Grinders (wire brush, angle grinders)
- Guns-welding
- Hammer drill
- Hand-held and stationary radios
- Headphones
- Heated hoppers
- Heaters (electric, natural gas, oil, propane)
- Heating torch
- Hydraulic press brake
- Hydraulic shear
- Hydrostatic equipment
- Impact wrenches (electric or pneumatic)
- Nibblers
- Ovens
- Oxyacetylene brazing torch
- Oxyacetylene cutting torch
- Pipe-bevelling machine
- Pipe cutters
- Plasma console
- Pneumatic equipment
- Power hack saw
- Power vice
- Propane torch
- Reamer (hand held or mounted on power threader)
- Reciprocating saw
- Routers
- Sand-blast equipment
- Sanders
- Scissor lift
- Testing pump
- Torches
- Vacuum (wet/dry)
- Winches
- Wire wheel (body grinder or angle grinder with wire brush)

Resource Material – *for all levels*

- Code books
- Drawings
- Engineering specifications
- Job schedules
- Manufacturers' specifications, manuals and charts
- Material Safety Data Sheets
- Packing slips
- Pamphlets
- Prints
- Regulatory information
- Safety manuals
- Service bulletins
- Shop manuals
- Specifications
- Waybills
- Written informational or instructional material

Reference Materials

THIS SECTION IS CURRENTLY UNDER REVIEW, PLEASE SEE YOUR TRAINING PROVIDER FOR A LIST OF REQUIRED MATERIALS

Required Reference Materials

Level 1, 2, 3 and Endorsement

- **WELDER TRAINING PROGRAM LEVEL C PACKAGE** (CPUB230M) (7960000058) ISBN 0-7719-1783-X
  This package contains the following modules:
  - P01 Introduction and Program Orientation (MN1807) (7960002678)
  - P02 Oxy-fuel Cutting (MN1808) (7960002679)
  - P03 Gas Welding and Braze Welding (MN1809) (7960002680)
  - P04 Shielded Metal Arc Welding (SMAW I) (MN1810) (7960002681)
  - P05 Air Carbon Arc Gouging (MN1811) (7960002682)
  - P06 Gas Metal Arc Welding (GMAW I) & Flux Cored Arc Welding (FCAW I) (MN1812)(7960002683)
  - RK01 Material Handling (MN1813) (7960002684)
  - RK02A Blueprint Reading I (MN1814) (7960002685)
  - RK02B Mathematics (MN1815) (7960002686)
  - RK03 Welding Metallurgy I (MN1816) (7960002687)

Level 2, 3 and Endorsement

WELDER TRAINING PROGRAM LEVEL B

- P07 Shielded Metal Arc Welding (SMAW II)
  Goal/Competency P07-P01 to 02 (MN1927)(7850002773)..... ISBN 0-7719-1670-1
- P07 Shielded Metal Arc Welding (SMAW II)
  Goal/Competency P07-P01 to 02 (MN1927) (7850002591)..... ISBN 0-7719-1670-1
- P08 Gas Metal Arc Welding (GMAW II)
  Goal/Competency P08-01 to 05 (MN1927) (7960002787)..... ISBN 0-7719-1671-X
- P09 Flux Cored Arc Welding (FCAW II)
  Goal/Competency P09-01 to 04 (MN1929) (7960002788)..... ISBN 0-7719-1672-8
- P10 Gas Tungsten Arc Welding (GTAW I)
  Goal/Competency P10-01 to 08 (MN1930) (7960002789)..... ISBN 0-7719-1673-6
- RK04 Welding Quality Control and Inspection Procedures
  Goal/Competency RK04 (MN1931) (7960002790)..... ISBN 0-7719-1674-4
- RK05 Welding Quality Codes, Standards and Specifications
  Goal/Competency RK (MN1932) (7960002791) ..... ISBN 0-7719-1675-2
- RK06 Blueprint Reading II
  Goal/Competency RK06-01 to 02 Perform Basic Pipe (MN1933) (7960002792)..... ISBN 0-7719-1676-0
- RK07 Welding Metallurgy II
  Goal/Competency RK07-01 to 03 (MN1934) (7960002793) ..... ISBN 0-7719-1676-0

Level 3 and Endorsement

WELDER TRAINING PROGRAM LEVEL A

- P11 Shielded Metal Arc Welding (SMAW III)
  Goal/Competency P11-01 To 02 (MN1923) (79600027830) ..... ISBN 0-7719-1666-3
- P12 Gas Tungsten Arc Welding (GTAW II)
  Goal/Competency P12-01 To 04 (MN1924) (7960002784) ..... ISBN 0-7719-1667-1
- RK08 Welding Metallurgy III
  Goal/Competency RK08-01 to 04 (MN1925) (7960002785) ..... ISBN 0-7719-1668-X
- RK09 Blueprint Reading III
  Goal/Competency Rk09-01 To 02 (MN1926) (7960002786) ..... ISBN 0-7719-1669-8

WELDER TRAINING PROGRAM LEVEL B

- P10 Gas Tungsten Arc Welding (GTAW I)
  Goal/Competency P10-01 to 08 (MN1930) (7960002787) ..... ISBN 0-7719-1673-6
- RK04 Welding Quality Control and Inspection Procedures
  Goal/Competency RK04 (MN1931) (7960002788) ..... ISBN 0-7719-1674-4
- RK05 Welding Codes, Standards and Specifications
  Goal/Competency RK (MN1932) (7960002789) ..... ISBN 0-7719-1675-2

WELDER TRAINING PROGRAM LEVEL C

- P04 Shielded Metal Arc Welding (SMAW I)
  (MN1810) (7960002790) ..... ISBN 0-7719-1551-9
- P06 Gas Metal Arc Welding (GMAW I) & Flux Cored Arc Welding (FCAW I)
  (MN1812) (7960002791) ..... ISBN 0-7719-1553-5

WELDER TRAINING PROGRAM: PACKAGE LEVEL A (CPUB241M) (7960002792) ..... ISBN 0-7719-1781-3

Recommended Resources

Level 1, 2, 3 and Endorsement

- Welding Principles and Applications, Fifth edition, by Larry Jeffus
  Delmar Learning ..... ISBN 1-4018-1046-2
- GMAW-P: Pulsed Spray Transfer
  Miller Electric Mfg. Co ..... ©1994, Revised 11/95
- Procedure Handbook of Arc Welding Design and Practics
  Lincoln Electric Company
- Pipefitters and Welder's Pocket Manual, all new 2nd edition
  Audel ..... ISBN 0-7645-4205-2 LB
- The Procedure Handbook of Arc Welding, 14th edition
  The James F. Lincoln Welding Foundation
- Modern Welding, 10th edition, by Andrew Daniel Althouse
  Goodheart-Willcox Company ..... ISBN 0-87006-210-7
- Alberta Individual Learning Modules
  Available through Queens Printer/Crown Publications ..... ISBN not available
- Welding Skills, 5th edition, by B. J. Moniz
  American Technical Publishers ..... ISBN 978-0-8269-3084-2

Level 2, 3 and Endorsement

- Measurement and Calculations for the Trades
  Sue Grecki..... ISBN 0-9685027-9-2
- Formulas at Work: Tradesworkers on the Job
  Sue Grecki..... ISBN 978-0-9739-6-1
- ASME Boiler and Pressure Vessel Code – Section IX
- ASME Power Piping (B31.1) Process Piping (B31.3)
- CSA Standards W59, W47.1, Z662
- Metal Trades Training Manual (Steel Fabrication)
  IPT Publishing & Training LTD.
- Pipe Trades Training Manual (Pipefitting)
  IPT Publishing & Training LTD.
- Safety First Training Manual
  IPT Publishing & Training Ltd.

Websites

For all levels

- Lincoln Electric: www.lincolnelectric.com
- Hobart Welders: www.hobartwelders.com
- Miller Welding Equipment: www.millerwelds.com
- WorkSafeBC – publications: www.worksafebc.com/publications/default.asp

Level 2, 3 and Endorsement

- Queens Printers: http://www.publications.gov.bc.ca
- Canadian Welding Bureau (CWB) Group: http://www.cwbgroup.org/
- American Welding Society (AWS): http://www.aws.org/w/a/
- Skill Plan: http://www.skillplan.ca
- IPT List of Publications: http://www.iptbooks.com/

NOTE:

This list of Reference Materials is for training providers. Apprentices should contact their preferred training provider for a list of recommended or required texts for this program.

Instructor Requirements

Occupation Qualification

The instructor must possess for all levels:

- Welder – Certificate of Qualification with Interprovincial Red Seal endorsement
- BC PWP7 and PWP10 pressure tickets

Work Experience

- A minimum of 5 years' experience working in the industry as a journeyperson
- Must have diverse industry experience including code work such as shop fabrication, heavy construction and maintenance/repair (ASME or CSA W59)

Instructional Experience and Education

It is preferred that the instructor also possesses one of the following:

- Instructors Certificate (minimum 30 hr course)
- Instructor's Diploma or be registered in an Instructor's Diploma Program to be completed within a 5 year period;
  OR
- Bachelors or Masters degree in Education

Appendices

Appendix A: Foundation Competencies

Line (GAC): A Occupational Skills

Competency: A1 Describe welder apprenticeship and the scope of the trade in BC

Objectives

To be competent in this area, the individual must be able to:

- Describe the scope of the welder trade in BC.
- Describe the requirements and structure of the BC Welder Apprenticeship program.

LEARNING TASKS	CONTENT

1. Describe the four levels of training in the BC welder program	• Historical structure
	• Current apprenticeship
	  ○ Foundation
	  ○ Level 1, Level 2, Level 3
	  ○ Level 4 (Endorsement)

2. Describe the requirements and procedure for registration at each level	• Skills and qualities of a welder
	• Specific job knowledge
	  ○ Equipment knowledge
	  ○ Metal identification
	  ○ Personal qualities
	• Roles and responsibilities
	  ○ Employer responsibilities
	  ○ Apprentice responsibilities
	• Logbook requirements
	  ○ Identification of the welder
	  ○ Registration seals
	  ○ Training endorsements
	  ○ Qualifications tests, general section
	  ○ Employment record
	  ○ W.P.Q.R.

3. Describe the Welder Learning Resource modules	• The training program • Training requirements • P lines • RK lines

4. Describe employment opportunities for each level of the training program and more advanced training opportunities	• High school, college or technical training institute
	  ○ Tacker
	  ○ Welding operator
	  ○ Welder
	  ○ Welder fabricator/fitter
	• College, technical institute or university:

- Welding inspector level 1, 2 and 3
- Welding technician
- Welder technologist
- Mechanical engineer
- Welding engineer

5. Identify industrial and construction fields that provide employment opportunities for welders

- Metal fabricating
- Ship building
- Pulp and paper mills
- Wood products manufacture
- Machinery manufacture
- Equipment maintenance and repair
- Smelt and refining
- Motor vehicle, truck/trailer manufacture
- Mining
- Construction
- Iron and steel mills
- Special trades
- Mining services
- Coal mines
- Gas distribution and transmission
- Public administration and defence
- Machinery wholesalers
- Forestry and forest services
- Electric utilities
- Motor vehicle dealers and repairs
- Communications equipment and manufacture
- Pipeline
- Food and beverage industry

6. Communicate effectively

- Resumes
- Cover letter
- Internet information sourcing
- Listening skills
- Effective verbal communication
- Non effective verbal communication
- Workplace culture

Appendix B: Assessment Guidelines

Foundation Grading Sheet: Subject Competency and Weightings

PROGRAM:	**WELDER**
IN-SCHOOL TRAINING:	**FOUNDATION**
SKILLEDTRADESBC CODE:	**0123RWFNSE**

LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
A	Occupational Skills	17%	8%
B	Cutting and Gouging Processes	10%	5%
C	Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process	5%	3%
D	Shielded Metal Arc Welding (SMAW)	25%	37%
E	Semi-Automatic and Automatic Welding	25%	35%
F	Gas Tungsten Arc Welding (GTAW)	3%	4%
H	Basic Metallurgy	5%	2%
I	Welding Drawings, Layout and Fabrication	10%	6%
	Total	**100%**	**100%**
In-school theory / practical subject competency weighting		20%	80%
Final in-school percentage score		**IN-SCHOOL %**	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standard Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	**FINAL%**

Level 1 Grading Sheets: Subject Competency and Weightings

PROGRAM:	WELDER
IN-SCHOOL TRAINING:	LEVEL 1
SKILLEDTRADESBC CODE:	0123RWWSE01

LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
A	Occupational Skills	20%	10%
B	Cutting and Gouging Processes	18%	10%
C	Fusion and Braze Welding (TB) Using the Oxy-Fuel (OFW) Process	5%	5%
D	Shielded Metal Arc Welding (SMAW)	22%	35%
E	Semi-Automatic and Automatic Welding	25%	30%
I	Welding Drawings, Layout and Fabrication	10%	10%
	Total	**100%**	**100%**
In-school theory / practical subject competency weighting		20%	80%
Final in-school percentage score		**IN-SCHOOL %**	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standard Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	**FINAL%**

Level 2 Grading Sheets: Subject Competency and Weightings

PROGRAM:	WELDER
IN-SCHOOL TRAINING:	LEVEL 2
SKILLEDTRADESBC CODE:	0123RWWSE02

LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
A	Occupational Skills	10%	10%
D	Shielded Metal Arc Welding (SMAW)	25%	35%
E	Semi-Automatic Welding and Automatic Welding	25%	37%
F	Gas Tungsten Arc Welding (GTAW)	15%	12%
H	Basic Metallurgy	10%	1%
I	Welding Drawings, Layout and Fabrication	15%	5%
	Total	**100%**	**100%**
In-school theory / practical subject competency weighting		20%	80%
Final in-school percentage score		**IN-SCHOOL %**	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standard Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	**FINAL%**

Level 3 Grading Sheets: Subject Competency and Weightings

PROGRAM:	WELDER
IN-SCHOOL TRAINING:	LEVEL 3
SKILLEDTRADESBC CODE:	0123RWW03

LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
D	Shielded Metal Arc Welding (SMAW)	15%	45%
E	Semi-Automatic and Automatic Welding	10%	20%
F	Gas Tungsten Arc Welding (GTAW)	15%	30%
H	Basic Metallurgy	15%	0%
I	Welding Drawings, Layout and Fabrication	15%	5%
J	Quality Control and Inspection	15%	0%
K	Standards, Codes, Specifications and Welder Qualifications	15%	0%
	Total	**100%**	**100%**
In-school theory / practical subject competency weighting		20%	80%
Final in-school percentage score		**IN-SCHOOL %**	

Final in-school percentage score Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Interprovincial Red Seal or SkilledTradesBC CofQ exam.	IN-SCHOOL %

All apprentices who complete Level 3 of the Welder program with a FINAL level percentage score of 70% or greater will write the Interprovincial Red Seal examination as their final assessment.

SkilledTradesBC will enter the apprentices' Welder Red Seal Interprovincial examination percentage score in SkilledTradesBC Portal.

A minimum percentage score of 70% on the examination is required for a pass.

Multi-Process Alloy Welding (MPAW) Grading Sheets: Subject Competency and Weightings

PROGRAM:	WELDER
IN-SCHOOL TRAINING:	OPTIONAL LEVEL: MULTI-PROCESS ALLOY WELDING (MPAW) ENDORSEMENT
SKILLEDTRADESBC CODE:	0123RWW04

LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
D	Shielded Metal Arc Welding (SMAW)	15%	45%
F	Gas Tungsten Arc Welding (GTAW)	15%	50%
G	Specialized Processes	15%	0%
H	Basic Metallurgy	30%	0%
I	Welding Drawings, Layout and Fabrication	25%	5%
	Total	**100%**	**100%**
In-school theory / practical subject competency weighting		20%	80%
Final in-school percentage score		**IN-SCHOOL %**	

Final in-school percentage score Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Interprovincial Red Seal or SkilledTradesBC CofQ exam.	IN-SCHOOL %

All apprentices who complete the Optional Level: Specialty Metals Endorsement of the Welder program with a FINAL level percentage score of 70% or greater will write the SkilledTradesBC examination as their final assessment.

SkilledTradesBC will enter the apprentices' Welder Specialty Metals Endorsement examination percentage score in SkilledTradesBC Portal.

A minimum percentage score of 70% on the examination is required for a pass.

Appendix C: Previous Contributors

Welder Program Review and Revision 2009 – 2010:

In 2009 – 2010, a Program Review Committee was established to oversee and advise on the review of the Welding Training Program. The PRC was made up of the following members:

- Dennis Brode, The Gisborne Group
- Tim Cross, Fleet Maintenance Facility Cape Breton
- Jerry Dardengo, WMG Victoria Shipyards
- Kerry Jothen, Human Capital Strategies, Chair
- Bernie Kragt, Arc Right Fabrication Ltd.
- Jeff Lekstrom, Northern Lights College
- Al Philips, Piping Industry Apprenticeship Board (PIAB) Trade School
- Jim McCarthy, United Steel Workers
- Ken Pearce, Canadian Welding Bureau
- Mike Parson, EnCana Corporation
- Rob Scales, SkilledTradesBC
- Brian Shale, Tolko Industries Ltd.
- Gene von Matt, Teck Coal Limited, Elkview Operations

In addition, consultations were held with bodies representing the training providers:

- Trades Training Consortium
- Welding Articulation Committee (WAC)
- Presidents' Council

A complete list of the regional consultation session participants appears in Appendix 2 of the B.C. Welding Review Final Report (July 2010).

Initial Welder Program Outline Development:

Representatives from industry, labour and training providers were included in the makeup of the project committees. Members of the primary committees were selected with consideration to capturing representation from across the province, as well as representation of large and small companies.

Project Steering Committee (2008) members included:

- Sheldon Frank, Chair, Welding Articulation Committee; Instructor, University College of the Fraser Valley
- Jim Carson, Instructor, University College of the Fraser Valley
- Ralph Finch, Dean of Trades, Thompson Rivers University
- Les Wiebe, Instructor, Thompson Rivers University
- Lindsay Langill, Director, SkilledTradesBC
- Jeff Lekstrom, Dean of Trades and Apprenticeship Training, Northern Lights College; System Liaison Person for the Welding Articulation Committee
- Peter Haigh, Instructor, Northwest Community College
- Curt Cain, Director, Resource Training Organization ex officio
- Raili Sharron McIvor, Articulation Coordinator, B.C. Council on Admissions and Transfer

- Sherry Brown, Director, Queen's Printer Publication Services
- Graham Duncan, Director, Open School BC, Queen's Printer
- Eleanor Liddy, Manager of Content, Open School BC, Queen's Printer
- Solvig Norman, Senior Project Manager, Open School BC, Queen's Printer
- Adrian Hill, Project Manager, Open School BC, Queen's Printer
- Kai Robinson, Business Project Coordinator, Open School BC, Queen's Printer

Standards Review Committee (2008) members included:

- Ian MacDonald, Highland Valley Copper
- Stan Boehm, SS Stainless Steel Inc.
- Stan McArthur, Catalyst Paper (Campbell River)
- Tim Cross, FMF Cape Breton
- Greg Burkett, Okanagan College
- Al Wood, BCIT
- Mervyn Kube, PIAB/UA Trade School
- Dan Burroughs, Sheet Metal Workers' Local 280
- Ron McKeown, Kwantlen College Faculty Association
- Al Constable, ILWU Local 50

Project Review Committee members included:

- Lindsay Langill, SkilledTradesBC
- Brad Smith, Catalyst Paper (Campbell River)
- Judy Kujundzic, Victoria Shipyards
- Sheldon Frank, University College of the Fraser Valley
- Al Phillips, PIAB/UA Trade School
- Ed Ferrero, Technical Safety BC
- Ken Bauder, ILWU Canada