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PROGRAM OUTLINE

Welder Endorsement: Multi-Process Alloy Welding (MPAW)

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WELDER ENDORSEMENT:
MULTI-PROCESS ALLOY WELDING (MPAW)
PROGRAM OUTLINE

APPROVED BY INDUSTRY

AUGUST 2016

BASED ON

WELDER NOA 2013

AND

CCDA HARMONIZATION

RECOMMENDATIONS 2015

Developed by
Industry Training Authority
Province of British Columbia

TABLE OF CONTENTS

Section 1

INTRODUCTION

Welder

Pre-requisites

To register for this program you must hold a:

- Welder Certificate of Qualification with Interprovincial Red Seal Endorsement

OR

- Welder B Certificate of Qualification with Interprovincial Red Seal Endorsement

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 Endorsement: Multi-Process Alloy Welding (MPAW) 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 Endorsement: Multi-Process Alloy Welding (MPAW) program has one level 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, this 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

The Industry Training Authority 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

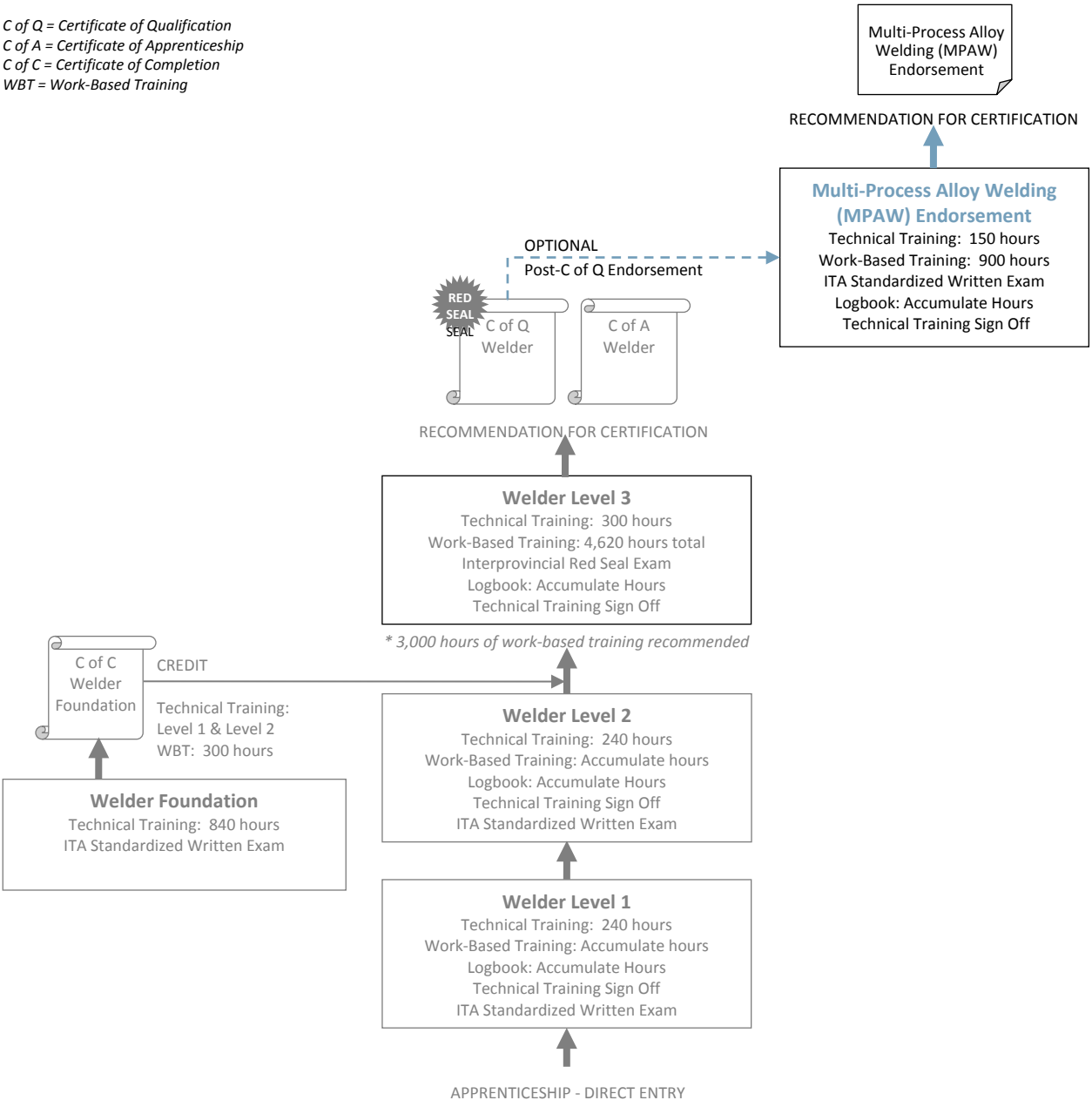
Welder Endorsement:

Multi-Process Alloy Welding (MPAW)

Program Credentialing Model

Apprenticeship Pathway

This graphic provides an overview of the Welder apprenticeship pathway.



** 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: "Red Seal Welder with Multi-Process Alloy Welding Endorsement" means a person who has advanced training, skills and abilities to weld all materials, including specialized alloys, by any manual welding process, in any position, and other such work as is usually done by a Red Seal Welder with Multi-Process Alloy Welding Endorsement.

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					

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
	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			
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
	Use the SAW process E7	Use combined GMAW, MCAW and FCAW processes E8				
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
Specialized Processes G	Describe specialized welding processes G1					

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
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: 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 Endorsement:

Multi-Process Alloy Welding (MPAW)

Multi-Process Alloy Welding (MPAW) Endorsement

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 o Carbon-molybdenum o Chromium-molybdenum o Nickel o Manganese-molybdenum o 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 o Horizontal (2G) position o Vertical (3G) position – uphill o 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 o 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 o Vertical (3F) position – uphill with E309 stainless steel filler metal electrodes – Tee joint o Overhead (4F) position – Tee joint
2. Weld multi-pass groove welds using (GTAW root) and SMAW fill and cap	• On low carbon steel pipe o Vertical fixed (2G) position with E309 stainless steel filler metal electrodes o 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)* o Vertical fixed (2G) position o Horizontal fixed (5G) position – uphill o 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 o Vertical fixed (2G) position o 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
	  o Monel
	  o Inconel
	  o Nichrome
	  o Nimonic alloys
	  o 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
	  o Brass
	  o Bronze
	  o Copper-silicon alloys (silicon bronze)
	  o Copper-aluminum (aluminum bronze)
	  o Copper-beryllium
	  o Copper-nickel alloys
	• Welding copper and copper alloys
	  o Preheating
	  o Shielding
	  o Joint geometry
	  o Deoxidization
	  o Filler metals
	  o Post-weld heat treatment
	  o Vaporization
	  o Hot cracking

3.	Describe magnesium and magnesium alloys and their weldability	• Pure magnesium • Magnesium alloys • Welding magnesium and its alloys: o Joint preparation o Cleaning o Shielding o Cracking o 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 o Grain structure – Alpha alloys – Beta alloys – Alpha-beta alloys • Welding titanium o Shielding o Porosity o Heat affected zone (HAZ) o Filler metals
6.	Describe zirconium and zirconium alloys and their weldability	• Zirconium alloys o Alpha alloys o Beta alloys o Commercial zirconium alloys • Weldability o 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 o Piping offset o Travel o Advance o 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:
		  o Table of trigonometric functions
		  o 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
	  o Use of fitting equipment
	  o Tack techniques
	  o 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:
	  o Use of fitting equipment
	  o Tack techniques
	  o 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
		  o Wedges
		  o Clamps
		  o Hand tools
		  o Pipe stands
		• Welding process and consumables
		• Organize work in sequential order
		• Fitting techniques
		  o Use of fitting equipment
		  o Tack techniques
		  o 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: Assessment Guidelines

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

PROGRAM:	**WELDER**
IN-SCHOOL TRAINING:	**OPTIONAL LEVEL: MULTI-PROCESS ALLOY WELDING (MPAW) ENDORSEMENT**
ITA DIRECT ACCESS 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 ITA 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 ITA examination as their final assessment.

ITA will enter the apprentices' Welder Specialty Metals Endorsement examination percentage score in ITA Direct Access.

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

Appendix B: 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, Industry Training Authority
- 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, Industry Training Authority
- 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, ITA
- 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