



**Skilled
Trades**
Ontario

**Métiers
spécialisés**
Ontario

Apprenticeship
Curriculum Standard

Pressure Systems Welder

Levels 1 and 2

456P

2010

Apprenticeship Pathway to a Certificate of Qualification

Phase 1: Registration

Submit Application for Apprenticeship Training through the on-line portal or to local Service Delivery Office

For on-line portal, please follow instructions for registration. You will need to create a *My Ontario* account to access online services.

Training agreement signed and registered by both apprentice and sponsor

Access your Apprenticeship Training Standard Logbook**
skilledtradesontario.ca/about-trades/trades-information

** This is the official record of your training progress. You are responsible for keeping it up-to-date.

Complete on-the-job training

Demonstrate and receive sign-off on the competencies/skills in your Apprenticeship Training Standard Logbook

Complete in-school training

Attend and complete the in-class training set out in the Curriculum Training Standard

Apprentices eligible to apply for apprenticeship incentive grants (Red Seal trades) and loans.

Review and finalize your logbook with your sponsor

Submit proof of apprenticeship completion
via email, in-person or digital portal

Your Apprenticeship Training Standard Logbook details completion requirements. Submit the following:

- completed Apprenticeship Training Standard Logbook with signatures
- proof of hours

Certificate of Apprenticeship is issued

Trades without examination

CofA is the final step of the program

Trades with examination (compulsory and non-compulsory trades)*

Provisional Certificate of Qualification issued for a 12 month term

To prepare for the CofQ examination download the Provincial and/or Red Seal Exam preparation guides.

Make payment for your Certificate of Qualification examination

Call to make a payment (647-847-3000 or 1-855-299-0028)

Schedule a date to write your Examination

To schedule your examination, contact your local Service Delivery Office.

Pass Certificate of Qualification examination

Apprentices eligible to apply for Apprenticeship Completion Grant (Red Seal trades) or Apprentice Completion Bonus (non-Red Seal)

Certificate of Qualification is issued

Upon completion, Sponsors may be eligible for Apprenticeship grants, incentives, bonuses or tax credits

Phase 2: Apprenticeship

Phase 3: Certification

* For a list of trades subject to a certification examination, visit: skilledtradesontario.ca

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Please Note: This Standard has been revised to reflect the visual identity of Skilled Trades Ontario (STO) which replaced the Ontario College of Trades on January 1, 2022. The content of this Standard may refer to the former organization; however, all trade specific information or content remains relevant and accurate based on the original date of publishing.

Please refer to STO's website: skilledtradesontario.ca for the most accurate and up to date information. For information about BOSTA and its regulations, please visit [**Building Opportunities in the Skilled Trades Act, 2021 \(BOSTA\)**](#).

Any updates to this publication are available on-line; to download this document in PDF format, please follow the link: [Skilled Trades Ontario.ca](https://skilledtradesontario.ca).

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Maintained with transfer to Skilled Trades Ontario 2010 (V100)

Preface

This curriculum standard for the Pressure Systems Welder trade program is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into 2 levels of training. The Reportable Subjects Summary chart (located on page 3) summarizes the training hours for each reportable subject.

The curriculum identifies the learning that takes place in-school. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standards.

Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on a work site. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to verify that all apprentices have achieved the learning outcomes identified in the curriculum standard.

It is not the intent of the in-school curriculum to perfect on-the-job skills. The practical portion of the in-school program is used to reinforce theoretical knowledge. Skill training is provided on the job.

Please refer to Skilled Trades Ontario website (www.skilledtradesontario.ca) for the most accurate and up-to-date information about Skilled Trades Ontario. For information on *Building Opportunities in the Skilled Trades Act, 2021 (BOSTA)* and its regulations, please visit [Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 \(ontario.ca\)](http://www.skilledtradesontario.ca/building-opportunities-in-the-skilled-trades-act-2021-s.o.-2021-c.-28-bill)

Pre-requisites

In order to advance to Level 2 of the apprenticeship program, an individual must have completed all of the units outlined in Level 1.

Hours Disclaimer (if applicable)

It is agreed that Training Delivery Agents (TDAs) may need to make slight adjustments (with cause) according to particular apprentice needs and may deviate from the unit sequencing and the prescribed practical and theoretical hours shown within the standard. However, all TDAs will comply with the hours at the reportable subject level.

Suggested Equipment for Training Delivery Agencies

The listing of tools on page 84 and page 85 does not list minimum quantities based on the understanding that the delivering TDA is in the best position to determine the need based on its delivery methodology.

Personal and Safety Equipment: Personal protective equipment is at the discretion of the TDA who must conform to Ontario Provincial Health and Safety Regulations.

Introduction

The curriculum standard has been designed to give the instructor opportunity for flexibility and innovation without significant departures from content. Since the scope of the prescribed curriculum standard is quite extensive, the apprentice will be expected to reinforce the acquired knowledge through regular independent out-of-classroom assignments.

Level 1 of this curriculum is intended for those apprentices who do not have a Certificate of Apprenticeship in the 456A Welder trade and all-position certification in the SMAW, GTAW and GMAW or FCAW welding processes.

456P Apprentices who do not have those qualifications must complete Level 1 or successfully complete the Exemption Test and submit the same welding qualification certification.

Reportable Subject Summary

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
Level 1				
S0771	Welding Theory	33	33	0
S0772	Shielded Metal Arc Welding	66	2	64
S0773	Gas Tungsten Arc Welding	45	2	43
S0774	Gas Shielded Semi-Automatic Arc Welding	96	5	91
	Total	240	46	194
Level 2				
S0775	Codes for Pressure Welding	30	30	0
S0776	Manual Pressure Welding	96	5	91
S0777	Semi – Automatic Pressure Welding	51	3	48
S0778	Pressure Welding Procedures and Qualifications	24	24	0
S0779	Specialized Pressure Welding Techniques	39	11	28
	Total	240	73	167

Level 1

Reportable Subject Summary – Level 1

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
S0771	Welding Theory	33	33	0
S0772	Shielded Metal Arc Welding	66	2	64
S0773	Gas Tungsten Arc Welding	45	2	43
S0774	Gas Shielded Semi-Automatic Arc Welding	96	5	91
	Total	240	46	194

Number:	S0771		
Title:	Welding Theory		
Duration:	Total Hours: 33	Theory: 33	Practical: 0
Prerequisites:	None		
Content:	S0771.1 Welding Safety [3/0]		
	S0771.2 Shielded Metal Arc Welding [7/0]		
	S0771.3 Gas Tungsten Arc Welding [7/0]		
	S0771.4 Gas Shielded Semi-Automatic Welding [7/0]		
	S0771.5 Weld Quality, Inspection and Testing [9/0]		

Evaluation & Testing

- Assignments related to theory and appropriate application skills
- Minimum of one mid-term test during the term
- Final exam at end of term
- Periodic quizzes

Instructional and Delivery Strategies

Lecture and assignment work.

Reference Materials

- Ontario Occupational Health and Safety Act
- Alberta ILM Welder Apprenticeship Modules

Number:	S0771.1		
Title:	Welding Safety		
Duration:	Total Hours: 3	Theory: 3	Practical: 0
Cross-Reference to Training Standard: 0816.01 - 0816.03, 0817.02, 0818.01 - 0818.09, 0819.01 - 0819.04, 0820.02, 0820.03, 0821.01, 0821.02			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe the safe work practices considering, Industrial Safety Acts and potential workplace hazards in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes

1.1 Describe the necessary personal protection against common shop and construction hazards.

[1/0]

- electrical shock
 - water and electricity
 - good ground connection
 - cable connection
- fumes and gases
 - ozone and nitrogen dioxide
- heat and burns
 - spatter
 - fire
 - sparks
- appropriate clothing
- radiation
 - ultraviolet, infrared and visible light
 - appropriate helmet and filter plates
- noise
- fall protection
- falling objects

- 1.2 Explain the safe use and operation of equipment.
[1/0]
- storage and handling of compressed gas cylinders
 - power tools
 - hand tools
 - fabricating equipment
 - lockout
 - scaffolding
 - safety harness
 - elevated platforms
- 1.3 Identify potential workplace hazards.
[1/0]
- confined spaces
 - oxygen depletion
 - moving equipment
 - tripping hazards
 - emergency responses
 - incident reports – near misses
 - fires

Number:	S0771.2		
Title:	Shielded Metal Arc Welding		
Duration:	Total Hours: 7	Theory: 7	Practical: 0
Cross-Reference to Training Standard: 0817.02, 0818.01, 0818.04, 0818.05, 0818.09, 0820.03, 0821.01, 0821.02			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe the fundamentals of the SMAW process in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

- 2.1 Define the fundamentals of the SMAW process.
[2/0]
- method of melting, freezing and fusion
 - arc characteristics
 - arc length and effect on voltage
 - penetration
 - travel speed and effects of too fast or too slow travel speed
 - weld contamination protection
 - electrode angle
- 2.2 Describe the equipment requirements for the SMAW process.
[2/0]
- power sources
 - transformers
 - rectifiers
 - inverters
 - generators
 - power source controls
 - amperage
 - duty cycle
 - voltage
 - current type and polarity
 - arc force
 - electrode holders

- welding cables
 - cable size and condition
 - connectors
 - relationship to required amperage
 - work lead
 - completion of welding circuit
 - clamps in good repair

2.3 Describe the construction and characteristics of SMAW electrodes.
[1.5/0]

- basic construction features
 - core wire
 - flux covering
- shielding
- manufacturing methods of welding electrodes
 - electrode concentricity
- functions of the flux coating
- flux coating base material
 - low hydrogen (basic)
 - cellulose
 - iron powder
- chemical properties and alloying elements
- classification of SMAW electrodes, CSA and AWS
 - mild steel
 - low alloy
 - stainless steel
 - meaning of each letter and numerical group
 - imperial and metric versions
- storage and handling
 - re-baking and electrode conditioning
 - storage temperatures

2.4 Describe the SMAW procedure variables and their effect on quality and productivity.

[1.5/0]

- primary variables (conducted prior to welding)
 - joint design and fit-up
 - consumables
 - current type and polarity
 - amperage
 - electrode size
- secondary variables (conducted during welding)
 - travel speed
 - arc length
 - electrode and work angles
 - weaving or stringer
- multiple passes

Number:	S0771.3		
Title:	Gas Tungsten Arc Welding (GTAW)		
Duration:	Total Hours: 7	Theory: 7	Practical: 0
Cross-Reference to Training Standard: 0817.02, 0818.01, 0818.02, 0818.04, 0818.06, 0818.09, 0820.02, 0820.03, 0821.01, 0821.02			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Explain the of set-up and operation of the GTAW process and selection of GTAW consumables in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

3.1 Define the fundamentals of the GTAW process.
[2/0]

- non-consumable tungsten electrode
- gas shielding of weld
- advantages of the GTAW process
 - no spatter
 - all position capable
 - high quality welds
 - concentrated high-temperature arc
 - wide variety of applications and alloys
- limitations of the GTAW process
 - deposition rates
 - pre-cleaning required

3.2 Explain the safety concerns applicable to the GTAW process.
[1/0]

- arc radiation
- air quality
- fumes and gases
 - oxygen depletion
- high frequency current
- thorium
- high pressure cylinders

3.3 Describe the required equipment and components for the GTAW process.
[1/0]

- fundamentals and characteristics of the constant current power source
 - welding current type and polarity
 - high frequency (HF) circuit
 - contactor and current control methods
 - manual and remote controls
 - torch thumbwheel
- shielding gas supply system
 - cylinders or bulk systems
 - regulator and flow meter
- torches
 - air and water cooled
 - amperage rating
 - collet and body
 - nozzle
 - gas lens
- coolant circulators

3.4 Explain the set-up and control of the process variables for the GTAW process.
[3/0]

- shielding gas type
 - flow rate (imperial and metric)
 - backing gas and purging
- filler material
 - type (alloy) and classification
 - size
- tungsten electrode
 - type and grade
 - size
 - conditioning and contamination control
- nozzle configurations and sizes
- current type and polarity
- amperage adjustment
- arc initiation methods
 - scratch start
 - lift start
 - high frequency start

- torch and filler rod angles
- arc length
- travel speed
- filler rod addition method

Number:	S0771.4		
Title:	Gas Shielded Semi-Automatic Welding Processes		
Duration:	Total Hours: 7	Theory: 7	Practical: 0
Cross-Reference to Training Standard: 0817.02, 0818.01, 0818.03, 0818.04, 0818.07 - 0818.09, 0820.02, 0820.03			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe the fundamentals, construction features and consumables of the Gas Metal Arc Welding (GMAW) and Flux Cored Arc Welding (FCAW) processes in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

4.1 Define the fundamentals of the GMAW process.
[1/0]

- modes of metal transfer
 - short-circuiting transfer
 - spray arc transfer
 - pulsed
- gas shielding
 - purpose
 - argon
 - CO₂
 - mixed gases

4.2 Define the fundamentals of the FCAW process.
[1/0]

- process applications, benefits and limitations
- weld puddle shielding
 - self shielded FCAW wires
 - gas shielded FCAW wires

- 4.3 Explain the function of the components of the GMAW and FCAW process.
[1/0]
- fundamentals and characteristics of the Constant Voltage power source
 - self- correcting arc gap
 - wire feeders
 - spool guns
 - push type
 - push-pull type
 - drive rolls
 - liners
 - gas diffusers
 - contact tips / tubes
 - nozzles
 - water cooled guns
- 4.4 Explain the selection and characteristics of consumables necessary for GMAW short-circuit transfer and spray-arc transfer.
[1/0]
- optimal wire type and diameter
 - filler metal classification system
 - low alloy
 - steels
 - stainless steels
 - types and sizes
 - purpose of copper plating vs copper free
 - shielding gas
 - types
 - flow rate
- 4.5 Describe the procedure variables for GMAW and their affect on quality and productivity.
[1.5/0]
- primary variables (conducted prior to welding)
 - joint design and fit-up
 - wire type and diameter
 - shielding gas
 - current type and polarity
 - wire feed speed and amperage
 - voltage

- secondary variables (conducted during welding)
 - travel speed
 - contact tip to work distance
 - work and gun angles
 - multi-passes
 - weaving

4.6 Describe the fundamentals of the pulsed-arc metal transfer mode of the Gas Metal Arc Welding – Pulsed (GMAW-P) process.
[1.5/0]

- advantages and limitations
- applications
- power sources requirements
- wire feeder requirements
- additional GMAW-P variables
 - peak current
 - peak time
 - background current
 - background time
- control of variables
 - synergic controls
 - trim controls

Number: S0771.5

Title: Weld Quality, Inspection and Testing

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

Cross-Reference to Training Standard: 0810.01, 0811.01, 0812.01-0812.03, 0813.01, 0813.02, 0814.01, 0814.02, 0815.01-0815.03, 0816.01-0816.03, 0817.01-0817.03, 0818.01-0818.09, 0819.01 - 0819.03, 0820.01-0820.03, 0821.01, 0821.02

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe the features of weld quality, welding discontinuity and welding procedures in accordance with government safety regulations, manufacturer's recommendations and approved industry standards. Explain the function and application of destructive and non-destructive testing methods for welds in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

5.1 Define welding discontinuities and their effect on weld quality.
[1/0]

- types of welding discontinuities
- weld quality
- intended function of a weld
- applicable specification
- acceptance criteria of a weld
- acceptable discontinuities
- unacceptable discontinuities

5.2 Explain the types and causes of dimensional and / or geometric discontinuities.
[2/0]

- fillet weld leg
- throat dimension measurement
- causes of and significance of insufficient leg length or throat dimension
- incorrect weld shape
 - convexity
 - concavity
- excess reinforcement

- 5.3 Identify the types and causes of structural soundness discontinuities.
[2/0]
- cracks
 - inclusions
 - porosity
 - lack of fusion
 - incomplete penetration
 - undercut
 - overlap
- 5.4 Define procedures for correction of defective weld quality.
[1/0]
- defect excavation procedures
 - inspection of cavity prior to weld repair
 - weld repair procedures
- 5.5 Explain the function and application of mechanical test methods.
[1/0]
- bend testing
 - face and root
 - side
- 5.6 Explain the function and application of non-destructive examination methods.
[2/0]
- visual inspection method per applicable specifications
 - gauges
 - pre-weld preparation
 - penetrant testing
 - magnetic particle testing
 - radiography
 - ultrasonic testing

Evaluation Structure				
Theory Testing	Practical Testing	Projects	Notebook & Organizational Skills	Final Assessment
60%	0%	15%	10%	15%

Number:	S0772		
Title:	Shielded Metal Arc Welding (SMAW)		
Duration:	Total Hours: 66	Theory: 2	Practical: 64
Prerequisites:	None		
Content:	S0772.1 Fillet Weld with SMAW on Mild Steel [2/18] S0772.2 Groove Weld in all Positions with SMAW [0/33] S0772.3 Perform SMAW Welds for Destructive Testing [0/13]		

Evaluation & Testing

- Practical projects related to the welding process procedure and position.
- Unit practical tests evaluated in accordance with applicable industrial weld quality acceptance criteria.

Instructional and Delivery Strategies

Teacher-led practical skills training with demonstration and observation in welding shop.

Reference Materials

- Alberta ILM Welder Apprenticeship Modules

Number:	S0772.1		
Title:	Fillet Weld with SMAW On Mild Steel		
Duration:	Total Hours: 20	Theory: 2	Practical: 18
Cross-Reference to Training Standard: 0811.01, 0811.02, 0812.01 - 0812.03, 0814.01, 0814.02, 0818.01, 0818.04, 0818.05, 0818.09			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform fillet welding with the SMAW process in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 1.1 Describe the equipment set-up of the SMAW process.
[2/0]
 - power source
 - equipment
 - consumables
 - material
 - technique
 - type of welds
- 1.2 Set-up and maintain equipment for SMAW applications.
[0/2]
 - electrode selection
 - type and size
 - power source controls
 - amperage
 - voltage
 - current type and polarity
 - electrode holders
 - various types

- welding cables
 - cable size and condition
 - relationship to required amperage
 - work lead and clamp
 - completion of welding circuit
- clamps in good repair
- work lead locations

1.3 Fillet weld mild steel using the SMAW process.
[0/15]

- stops and restarts
- filling crater
- fillet welds
 - tee joint
 - lap joint
- plate
- structural shapes
- structural shapes to plate
- positions
 - flat (1F)
 - horizontal (2F)
 - vertical (3F)
 - overhead (4F)
- electrodes
 - cellulose
 - basic

1.4 Perform post-weld operations.
[0/1]

- removing all slag
- removing all spatter
- methods of cleaning and finishing of completed weld to specifications
 - wire brushing
 - filing
 - grinding
 - hand tools
 - power tools
- measuring weld size to meet specifications
- visual examination of weld for discontinuities

Number:	S0772.2		
Title:	Groove Weld In All Positions With SMAW		
Duration:	Total Hours: 33	Theory: 0	Practical: 33
Cross-Reference to Training Standard: 0811.01, 0811.02, 0812.01 - 0812.03, 0814.01, 0814.02, 0818.01, 0818.04, 0818.05, 0818.09			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform groove welding procedures with the SMAW process in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the CSA or ASME Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 2.1 Prepare base metal for groove welding as required by weld symbol and welding procedure.
[0/2]
- type of groove joint
 - welding symbol
 - type of metal
 - backing requirement
 - method of joint preparation
 - joint opening
 - placement of tacks
- 2.2 Perform groove welding of mild steel using the SMAW process.
[0/30]
- single vee-groove
 - groove test plates with backing using E4918
 - flat (1G)
 - horizontal (2G)
 - vertical (3G)
 - overhead (4G)

- 2.3 Perform post-weld operations.
 [0/1]
- inspection of welds
 - non-destructive test methods
 - destructive test methods

Number:	S0772.3		
Title:	Perform SMAW Welds for Destructive Testing		
Duration:	Total Hours: 13	Theory: 0	Practical: 13
Cross-Reference to Training Standard: 0811.01, 0811.02, 0812.01 - 0812.03, 0814.01, 0814.02, 0818.01, 0818.04, 0818.05, 0818.09			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Demonstrate a working knowledge of preparing and performing destructive testing in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 3.1 Perform welds for destructive testing.
[0/8]
- groove weld tests in position to identified procedures
 - vee-groove with backing
 - consumables E4918
 - positions required
 - flat (1G)
 - horizontal (2G)
 - vertical (3G)
 - overhead (4G)
- 3.2 Perform preparatory operations for destructive testing.
[0/4]
- remove backing
 - grind surface
 - layout coupons
 - cut coupons
 - grind coupons

3.3 Perform destructive testing.
[0/1]

- bend coupons
 - face and root bend
 - side bend

Evaluation Structure				
Theory Testing	Practical Testing	Projects	Notebook & Organizational Skills	Final Assessment
0%	30%	70%	0%	0%

Number:	S0773		
Title:	Gas Tungsten Arc Welding (GTAW)		
Duration:	Total Hours: 45	Theory: 2	Practical: 43
Prerequisites:	None		
Content:	S0773.1 Set-Up Equipment For GTAW on Mild and Stainless Steels [2/3] S0773.2 Perform Mild Steel Welds Using the GTAW Process [0/27] S0773.3 Perform Stainless Steel Welds Using the GTAW Process [0/13]		

Evaluation & Testing

- Practical projects related to the welding process procedure and position.
- Unit practical tests evaluated in accordance with applicable industrial weld quality acceptance criteria.

Instructional and Delivery Strategies

Teacher-led practical skills training with demonstration and observation in welding shop.

Reference Materials

- Alberta ILM Welder Apprenticeship Modules

Number: S0773.1

Title: Set-Up Equipment for GTAW on Mild and Stainless Steels

Duration: Total Hours: 5 Theory: 2 Practical: 3

Cross-Reference to Training Standard: 0811.01, 0811.02, 0812.01 - 0812.03, 0814.01, 0814.02, 0818.01, 0818.02, 0818.06, 0818.09

General Learning Outcome

Upon successful completion, the apprentice is able to:

Demonstrate a working knowledge of welding with the GTAW process.

Learning Outcomes and Content

1.1 Describe equipment set-up and the process of GTAW.
[2/0]

- power source
- equipment
- shielding gas
- material
- type of welds and joints

1.2 Set-up equipment for a variety of GTAW applications.
[0/3]

- material preparation and fit-up
- pre-weld cleaning methods
- position of welding
- equipment setup
 - current type and polarity
 - amperage
 - arc initiation method
- torch setup
 - collet and body
 - nozzle type and size
 - tungsten electrode type, size and preparation
- shielding gas
 - flow rate (imperial and metric)
- filler wire type, specification and diameter

Number:	S0773.2		
Title:	Perform Mild Steel Welds Using the GTAW Process		
Duration:	Total Hours: 27	Theory: 0	Practical: 27
Cross-Reference to Training Standard: 0811.01, 0811.02, 0812.01 - 0812.03, 0814.01, 0814.02, 0818.01, 0818.02, 0818.06, 0818.09			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform groove and fillet welding on mild steel with the GTAW process in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the CSA or ASME Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 2.1 Perform welds using the GTAW process.
[0/26]
- fillet weld tee joints
 - flat (1F)
 - horizontal (2F)
 - fillet weld lap joints
 - horizontal (2F)
 - fillet weld corner joints
 - flat (1F)
 - horizontal (2F)
 - square butt groove welds
 - flat (1G)
 - horizontal (2G)
 - vertical (3G)
- 2.2 Perform post weld operations.
[0/1]
- prepare completed welds for inspection
 - visually inspect completed welds

Number:	S0773.3		
Title:	Perform Stainless Steel Welds Using the GTAW Process		
Duration:	Total Hours: 13	Theory: 0	Practical: 13
Cross-Reference to Training Standard: 0811.01, 0811.02, 0812.01 - 0812.03, 0814.01, 0814.02, 0818.01, 0818.02, 0818.06, 0818.09			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform groove and fillet welding on stainless steel in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 3.1 Perform fillet and square groove welds on stainless steel with the GTAW process.
[0/12]
- welding parameters
 - shielding gas specification
 - equipment set-up
 - filler wire type and specification
 - material preparation
 - fillet welds - technique cup walking and freehand
 - horizontal (2F)
 - vertical (3F)
 - Square groove welds (plate)
 - flat (1G)
 - horizontal (2G)
- 3.2 Perform post weld operations.
[0/1]
- prepare completed welds for inspection
 - visually inspect completed welds

Evaluation Structure				
Theory Testing	Practical Testing	Projects	Notebook & Organizational Skills	Final Assessment
0%	30%	70%	0%	0%

Number:	S0774		
Title:	Gas Shielded Semi-Automatic Welding		
Duration:	Total Hours: 96	Theory: 5	Practical: 91
Prerequisites:	None		
Content:	S0774.1 Fillet Welds with Gas Metal Arc Welding (GMAW) [2/21] S0774.2 Groove Welds with Gas Metal Arc Welding (GMAW) [0/33] S0774.3 Pulsed Arc Gas Metal Arc Welding (GMAW-P) [1/11] S0774.4 Fillet Welds with Flux Cored Arc Welding (FCAW) [1/12] S0774.5 Groove Welds with Flux Cored Arc Welding (FCAW) [1/14]		

Evaluation & Testing

- Practical projects related to the welding process procedure and position.
- Unit practical tests evaluated in accordance with applicable industrial weld quality acceptance criteria.

Instructional and Delivery Strategies

Teacher-led practical skills training with demonstration and observation in welding shop.

Reference Materials

Alberta ILM Welder Apprenticeship Modules

Number:	S0774.1		
Title:	Fillet Weld with Gas Metal Arc Welding (GMAW)		
Duration:	Total Hours: 23	Theory: 2	Practical: 21
Cross-Reference to Training Standard: 0812.01 - 0812.03, 0818.01, 0818.03, 0818.04			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform fillet welding with the GMAW process in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 1.1 Describe equipment set-up and the process of the GMAW.
[1/0]
 - power source
 - wire feeder
 - shielding gas and consumables
 - technique
 - type of welds & joints
- 1.2 Set-up and maintain equipment for a variety of GMAW applications.
[0/2]
 - consumables for the application
 - wire type & specification
 - diameter
 - shielding gas
 - changing shielding gas cylinders
 - adjusting gas flow rate
 - gas leak detection
 - welding parameters
 - voltage
 - wire feed speed

- work lead connection
- wire feeders
 - drive roll tension
 - spool axle tension
- contact tip
- nozzle configuration and sizes
- liner wear and restrictions

1.3. Perform fillet welding using the GMAW process on mild steel.
[0/17]

- pre-cleaning and preparation
- modes of metal transfer
 - short circuit
 - spray
- joint types
 - lap joint
 - tee joint
 - corner joint
- positions
 - flat (1F)
 - horizontal (2F)
 - vertical (3F)
 - overhead (4F)
- applications
 - plate and sheet
 - structural shapes
 - structural shapes to plate

1.4 Perform post weld operations.
[1/2]

- clean and finish welds to specifications
- visually inspect and evaluate finished welds

Number:	S0774.2		
Title:	Groove Weld with Gas Metal Arc Welding (GMAW)		
Duration:	Total Hours: 33	Theory: 0	Practical: 33
Cross-Reference to Training Standard: 0812.01 - 0812.03, 0818.01, 0818.03, 0818.04			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform groove welding with the GMAW process in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 2.1 Prepare base metal for groove welding.
[0/2]
- type of groove joint
 - welding symbol
 - type of metal
 - backing requirements
 - method of joint preparation
 - surface finish
 - joint opening
 - placement of tacks
 - preheat requirement
- 2.2 Perform groove welding on mild steel using the GMAW process.
[0/12]
- pre-cleaning and preparation
 - modes of metal transfer
 - short circuit
 - spray
 - joints
 - single bevel groove with backing
 - single vee-groove

- positions
 - flat (1G)
 - horizontal (2G)
 - vertical (3G)
 - overhead (4G)
- material
 - plate

2.3 Perform post weld operations.
[0/1]

- clean and finish welds to specifications
- visually inspect and evaluate finished welds

2.4 Perform welds for destructive testing.
[0/14]

- positions
 - flat (1G)
 - horizontal (2G)
 - vertical (3G)
 - overhead (4G)

2.5 Perform operations for destructive testing.
[0/4]

- remove backing
- grind surfaces
- layout coupons
- cut coupons
- grind coupons
- bend tests
 - face and root bends
 - side bends

Number:	S0774.3		
Title:	Pulsed Arc Gas Metal Arc Welding (GMAW-P)		
Duration:	Total Hours: 12	Theory: 1	Practical: 11
Cross-Reference to Training Standard: 0812.01 - 0812.03, 0818.01, 0818.03, 0818.04			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Demonstrate a working knowledge of fillets and groove welds with the GMAW-P process.

Learning Outcomes and Content

- 3.1 Describe equipment set-up and the process of GMAW-P.
[1/0]
- equipment
 - power source
 - wire feeder
 - pulsing variables
 - shielding gas
 - technique
 - material
 - type of welds
- 3.2 Perform fillet and groove welds with the GMAW-P process on mild steel.
[0/11]
- material
 - thin gauge
 - fillet welds
 - flat (1F)
 - horizontal (2F)
 - vertical –up (3F)
 - overhead (4F)
 - groove welds
 - vertical (3G)

Number:	S0774.4		
Title:	Fillet Weld with Flux Cored Arc Welding (FCAW)		
Duration:	Total Hours: 13	Theory: 1	Practical: 12
Cross-Reference to Training Standard: 0812.01 - 0812.03, 0818.01, 0818.03, 0818.04			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform fillet welding with the FCAW process in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 4.1 Set up equipment for a variety of FCAW applications.
[1/2]
- consumables for the application
 - wire type and size
 - gas shielded
 - self-shielded
 - shielding gas
 - changing shielding gas cylinders
 - adjusting gas flow rate
 - gas leak detection
 - welding parameters
 - voltage
 - wire feed speed
 - maintenance of equipment
 - wire feeders
 - drive rolls
 - spool axle tension
 - contact tip
 - gun nozzle
 - gun liner

4.2 Perform welding of mild steel using the FCAW process.
[0/8]

- fillet welds
- lap joint
- tee joint
- corner joint
- positions
 - flat (1F)
 - horizontal (2F)
 - vertical (3F)
 - overhead (4F)
- applications
 - plate
 - structural shapes
 - structural shapes to plate

4.3 Perform post weld operations.
[0/2]

- clean and finish welds to specifications
- visually inspect and evaluate finished welds

Number:	S0774.5		
Title:	Groove Weld with Flux Cored Arc Welding (FCAW)		
Duration:	Total Hours: 15	Theory: 1	Practical: 14
Cross-Reference to Training Standard: 0812.01 - 0812.03, 0818.01, 0818.03, 0818.04			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform groove welding with the FCAW process in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 5.1 Prepare base metal for groove welding.
[1/2]
- type of groove joint
 - welding symbol
 - backing requirements
 - method of joint preparation
 - joint opening
 - placement of tacks
- 5.2 Perform groove welding on mild steel using the (FCAW) process.
[0/7]
- single bevel with backing bar
 - positions
 - flat (1G)
 - horizontal (2G)
 - vertical (3G)
 - overhead (4G)
- 5.3 Perform post weld operations.
[0/1]
- clean and finish welds to specifications
 - visually inspect and evaluate finished welds

5.4 Prepare welds for destructive testing.
[0/2]

- positions
 - flat (1G)
 - horizontal (2G)
 - vertical (3G)
 - overhead (4G)

5.5 Perform operations for destructive testing.
[0/2]

- remove backing
- grind surfaces
- layout coupons
- cut and grind coupons
- side bend test

Evaluation Structure				
Theory Testing	Practical Testing	Projects	Notebook & Organizational Skills	Final Assessment
0%	30%	70%	0%	0%

Level 2

Reportable Subject Summary – Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
S0775	Codes for Pressure Welding	30	30	0
S0776	Manual Pressure Welding	96	5	91
S0777	Semi-Automatic Pressure Welding	51	3	48
S0778	Pressure Welding Procedures and Qualifications	24	24	0
S0779	Specialized Pressure Welding Techniques	39	11	28
	Total	240	73	167

Number:	S0775		
Title:	Codes for Pressure Welding		
Duration:	Total Hours: 30	Theory: 30	Practical: 0
Prerequisites:	None		
Content:	S0775.1 ASME Boiler and Pressure Vessel Code [6/0]		
	S0775.2 Material Specifications [12/0]		
	S0775.3 Product Specifications [6/0]		
	S0775.4 Inspection Specifications [6/0]		

Evaluation & Testing

- Assignments related to theory and appropriate application skills
- Final exam at end of term
- Periodic quizzes

Instructional and Delivery Strategies

Lecture and assignment work with welding procedures and codes.

Reference Materials

- *ASME* Boiler and Pressure Vessel Code, Section II – Part A, B and C, Section V, Section VIII and Section IX
- CSA Standard B51 - Boiler, Pressure Vessel and Pressure Piping Code
- Alberta ILM Welder Apprenticeship Module 120304e – Codes and Standards

Number:	S0775.1		
Title:	ASME Boiler and Pressure Vessel Code		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross-Reference to Training Standard: 0811.01, 0811.02, 0814.01, 0814.02			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe the outline of the American Society of Mechanical Engineers (*ASME*) Boiler and Pressure Vessel Code (BPVC) as it relates to the welding of pressure system components.

Learning Outcomes and Content

- 1.1 Define the scope of the *ASME* BPVC.
[2/0]
 - Regulatory requirement for compliance to the *ASME* BPVC
 - Sections of *ASME* BPVC relating to materials, design, fabrication, welding and inspection
- 1.2 Explain the application of the *ASME* BPVC in pressure systems.
[2/0]
 - Requirements for boilers, pressure vessels and nuclear components
 - Requirements of the Canadian Standards Association (CSA) B51 – Boiler, Pressure Vessel and Pressure Piping Code
- 1.3 Identify the function and role of various jurisdictions and inspectors for pressure welding.
[2/0]
 - Technical Standards and Safety Authority (TSSA)
 - Customer inspectors
 - In-plant inspection and monitoring

Number:	S0775.2		
Title:	Material Specifications		
Duration:	Total Hours: 12	Theory: 12	Practical: 0
Cross-Reference to Training Standard: 0811.01, 0811.02, 0814.01, 0814.02			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Select base and filler metals as specified on welding procedure documents and explain the numbering system and characteristics of the selected materials.

Learning Outcomes and Content

- 2.1 Select base metals as specified on the Welding Procedure Specification.
[4/0]
- Ferrous metals in accordance with *ASME* BPVC Sect. II – Part A
 - Non-ferrous metals in accordance with *ASME* BPVC Sect. II – Part B
 - SA and SB material specifications and corresponding “P” numbers
- 2.2 Select welding filler metals as specified on the Welding Procedure Specification.
[2/0]
- Correct size and with required approvals
 - Designations in accordance with *ASME* BPVC Sect. II – Part C
 - Filler metal form
 - Electrode rod
 - Electrode wire
 - Filler rod
- 2.3 Describe the basis for various filler metal designations including “F” numbers.
[6/0]
- SFA number
 - Classification number
 - F number
 - A number

Number:	S0775.3		
Title:	Product Specifications		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross-Reference to Training Standard: 0818.02			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe welding requirements based on the type of pressure component and applicable code section.

Learning Outcomes and Content

- 3.1 Identify the applicable code section based on the type of pressure component.
[3/0]
- Power boilers – Sect. I
 - Nuclear components – Sect. III
 - Pressure Vessels – Sect. VIII
 - Power and Process Piping
 - ASME B31
 - CSA B51
- 3.2 Identify requirements specified in applicable construction code.
[3/0]
- Material preparation
 - Identifying welds with welder stamping
 - Tapered transitions
 - Specified sign-offs after various stages of construction
 - Testing
 - Non-destructive testing
 - Hydrostatic testing

Number:	S0775.4		
Title:	Inspection Specifications		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross-Reference to Training Standard: 0818.04			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe inspection requirements based on applicable code sections.

Learning Outcomes and Content

- 4.1 Identify source of weld quality acceptance criteria.
[2/0]
- Sect. I
 - Sect. III
 - Sect. VIII
- 4.2 Describe requirements for non-destructive testing as specified in *ASME* BPVC – Sect. V.
[2/0]
- visual inspection
 - penetrant inspection
 - magnetic particle inspection
 - radiographic inspection
 - ultrasonic inspection
- 4.3 Describe the different weld quality characteristics that are the basis for acceptance criteria.
[2/0]
- Size, shape and reinforcement
 - Properties
 - mechanical
 - chemical
 - maintaining essential variables
 - Soundness
 - porosity
 - cracks
 - fusion defects
 - inclusions

Evaluation Structure				
Theory Testing	Practical Testing	Projects	Notebook & Organizational Skills	Final Assessment
70%	0%	0%	0%	30%

Number:	S0776		
Title:	Manual Pressure Welding		
Duration:	Total Hours: 96	Theory: 5	Practical: 91
Prerequisites:	S0772, S0773		
Content:	S0776.1 Cutting and Preparation [0/11]		
	S0776.2 Fit-Up and Assembly [2/9]		
	S0776.3 Shielded Metal Arc Welding (SMAW) [0/36]		
	S0776.4 Gas Tungsten Arc Welding (GMAW) [3/35]		

Evaluation & Testing

- Practical projects related to the welding process procedure and position.
- Unit practical tests evaluated in accordance with applicable industrial weld quality acceptance criteria.

Instructional and Delivery Strategies

Teacher-led practical skills training with demonstration and observation in welding shop.

Reference Materials

- Equipment manuals and practical welding exercises based on Welding Procedure Specifications.

Number:	S0776.1		
Title:	Cutting and Preparation		
Duration:	Total Hours: 11	Theory: 0	Practical: 11
Cross-Reference to Training Standard: 0816.01 - 0816.03, 0819.04			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform cutting and preparation of pressure vessel and pipe components to specifications.

Learning Outcomes and Content

- 1.1 Perform manual oxy-fuel cutting and bevelling on pipe.
[0/3]
 - Tip selection
 - Oxyfuel pressures
 - Straight cuts
 - Bevels
 - Finished bevel cuts
- 1.2 Perform mechanized oxy-fuel torch cutting and bevelling processes (pipe bevellers).
[0/2]
 - Pipe beveller set-up
 - Oxyfuel pressures
 - Cutting machine set-up
 - Straight cuts
 - Finished bevel cuts
- 1.3 Perform mechanized air powered bevelling on pipe.
[0/2]
 - Die selection
 - Bevelling machine set-up
 - finished bevel cuts

- 1.4 Perform finished bevelling by grinding.
[0/2]
- Grinder size and type
 - Grinding consumable
 - Straight cuts
 - Bevels
 - Bevel finishes
- 1.5 Perform plasma arc cutting and bevelling on pressure pipe.
[0/2]
- Air pressure
 - Amperage
 - Straight cut
 - free hand method
 - drag cup method
 - Bevels
 - free hand method

Number:	S0776.2		
Title:	Fit-Up and Assembly		
Duration:	Total Hours: 11	Theory: 2	Practical: 9
Cross-Reference to Training Standard: 0817.01 - 0817.03			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform fit-up and assembly of pressure vessel and pipe components to specifications.

Learning Outcomes and Content

- 2.1 Identify material.
[1/0]
 - Component stamping
 - Colour coding
 - Heat numbers
 - Mill test reports

- 2.2 Select pressure boundary components.
[1/1]
 - Pressure pipe schedules and sizes
 - Pressure tube sizes and uses
 - Pressure fittings
 - reducers
 - flanges
 - tee connections
 - “Y” connections
 - 45° elbows
 - 90° elbows
 - sock-o-lets
 - weld-o-lets
 - thread-o-lets

- 2.3 Assemble and tack weld SMAW pipe project.
[0/5]
- Use wrap to lay out pipe
 - Tee and butt connection
 - cut pipe with oxy-fuel or plasma arc process
 - root face prep
 - ensure acceptable mismatch
 - fit components with correct gap
 - feather tack welds
 - See Appendix A for SMAW pipe project drawing
- 2.4 Assemble and tack weld GTAW pipe project.
[0/3]
- Use wrap to lay out pipe
 - Socket and butt connection
 - Cut pipe
 - chop saw
 - horizontal band saw
 - grinder (zip cut)
 - Feather edge prep
 - Ensure acceptable mismatch
 - Pre-cleaned socket prep
 - See Appendix B for GTAW pipe project drawing

Number:	S0776.3		
Title:	Shielded Metal Arc Welding (SMAW)		
Duration:	Total Hours: 36	Theory: 0	Practical: 36
Cross-Reference to Training Standard: 0812.01 - 0812.03, 0818.01, 0818.04, 0818.05			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform SMAW welding on pressure vessel and pipe components in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 3.1 Perform welds on pipe using SMAW.
[0/33]
- Use SMAW fitting project (from 2.3)
 - Tee connection
 - weld root 5G position
 - prep for visual inspection
 - weld hot pass(es) (fill)
 - prep for visual inspection
 - weld cap pass to code specifications
 - Butt weld
 - weld root 6G position
 - prep for visual inspection
 - weld hot pass(es) (fill)
 - prep for visual inspection
 - weld cap pass(es) to code specifications
- 3.2 Perform preparations for destructive bend testing.
[0/2]
- Lay out and cut coupons
 - Grind surfaces

3.3 Perform destructive testing on welds.
 [0/1]

- Visual inspection of coupons
- Destructive test welds
 - Face bends
 - Root bends

Number:	S0776.4		
Title:	Gas Tungsten Arc Welding (GTAW)		
Duration:	Total Hours: 38	Theory: 3	Practical: 35
Cross-Reference to Training Standard: 0812.01 - 0812.03, 0818.01, 0818.02, 0818.06			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform GTAW welding on pressure vessel and pipe components in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the CSA or ASME Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 4.1 Perform welds on pipe using GTAW root with SMAW fill and cap.
[2/30]
- Use GTAW fitting project (from 2.2.4)
 - Socket connection
 - weld root 5G position
 - prep for visual inspection
 - complete weld to code specifications
 - prep for visual inspection
 - Butt weld
 - install purging caps
 - argon purge assembly
 - verify full purge
 - weld root 1/8 inch ER309L, 2G, 5G position
 - prep for visual inspection
 - weld hot pass(es) 3/32 inch E309L-16
 - prep for visual inspection
 - weld cap pass(es) to code specifications 1/8 inch E309L-16
- 4.2 Perform preparations for destructive bend testing.
[0/2]
- Lay out butt weld coupons
 - Cut coupons
 - Grind surfaces

- 4.3 Perform destructive testing.
[0/1]
- Visual inspection of coupons
 - Destructive test welds
 - root bends
 - face bends
- 4.4 Prepare socket weld for destructive testing.
[0/1]
- Lay out pipe for saw cutting (cold cut)
 - Saw cut socket assembly per drawing
- 4.5 Perform socket weld testing procedures.
[1/1]
- Polish weld specimens
 - Macro etch specimens
 - Inspect for minimum 10% weld penetration (no inclusions)

Evaluation Structure				
Theory Testing	Practical Testing	Projects	Notebook & Organizational Skills	Final Assessment
5%	65%	0%	0%	30%

Number:	S0777		
Title:	Semi-Automatic Pressure Welding		
Duration:	Total Hours: 51	Theory: 3	Practical: 48
Prerequisites:	S0774		
Content:	S0777.1 Gas Metal Arc Welding (GMAW) [1/29] S0777.2 Flux Cored Arc Welding (FCAW) [2/19]		

Evaluation & Testing

- Practical projects related to the welding process procedure and position.
- Unit practical tests evaluated in accordance with applicable industrial weld quality acceptance criteria.

Instructional and Delivery Strategies

Teacher-led practical skills training with demonstration and observation in welding shop.

Reference Materials

- Equipment manuals and practical welding exercises based on Welding Procedure Specifications.

Number:	S0777.1		
Title:	Gas Metal Arc Welding (GMAW)		
Duration:	Total Hours: 30	Theory: 1	Practical: 29
Cross-Reference to Training Standard: 0811.02, 0812.01 - 0812.03, 0813.02, 0814.02, 0818.01, 0818.03, 0818.04, 0818.07 - 0818.09			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform GMAW welding in short-circuiting, spray-arc, and pulsed-spray transfer modes on pressure vessel and pipe components in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 1.1 Describe equipment set-up and the process of GMAW utilizing short circuit, spray transfer and pulsed methods typically used in the pressure systems industry.
[1/0]
- Equipment
 - Power source
 - Parameter control devices
 - Wire feeder
 - Pulsing variables
 - Shielding gas
 - Consumables
 - Technique
 - Material
 - Type of welds

- 1.2 Perform groove welds on pipe with the GMAW process on carbon steel and low alloy steel as determined by the WPS.
[0/15]
- Groove welds
 - open root
 - Positions
 - horizontal / vertical, (2G) / (5G)
 - all (6G)
 - Progression
 - upward
 - downward
 - Material
 - mild steel pipe
 - Joints
 - single vee-groove, open root
 - Consumables
 - continuous
- 1.3 Perform preparations for destructive testing as required by the *ASME BPVC*.
[0/2]
- Lay out and cut coupons
 - Grind surfaces and coupons
- 1.4 Perform destructive testing.
[0/1]
- Destructive test welds
 - root bend
 - face bend

- 1.5 Perform groove welds on pipe using the GMAW process with stainless steel consumables.
[0/8]
- Groove welds
 - open root
 - Positions
 - horizontal / vertical, (2G) / (5G)
 - all (6G)
 - Material
 - mild steel pipe
 - Joints
 - single vee-groove, open root
 - Consumable – any one of
 - E308(L), E316(L), E309(L)
- 1.6 Perform preparations for destructive testing.
[0/2]
- Lay out coupons
 - Cut coupons
 - Grind surfaces and coupons
- 1.7 Perform destructive testing as required by the *ASME* BPVC.
[0/1]
- Destructive test welds
 - Face and root bend

Number: S0777.2
Title: **Flux Cored Arc Welding (FCAW)**
Duration: Total Hours: 21 Theory: 2 Practical: 19
Cross-Reference to Training Standard: 0811.01, 0811.02, 0812.01 - 0812.03, 0813.02, 0814.02, 0818.01, 0818.03, 0818.04, 0818.07 - 0818.09

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform FCAW welding on pressure vessel and pipe components in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 2.1 Describe equipment and set-up the process of FCAW methods typically used in the pressure systems industry and determined by WPS.
[2/0]
- Power source
 - Equipment
 - Parameter control devices
 - Wire feeder
 - Pulsing variables
 - Shielding gas
 - Consumables
 - Applied Set-Up Technique
 - Material
 - Type of welds

2.2 Perform groove welds on pipe with the FCAW process on carbon steel and low alloy steel as determined by the WPS.
[0/7]

- Groove welds
- open root
- Positions
 - horizontal / vertical, (2G) / (5G)
 - all (6G)
- Material
 - mild steel pipe
- Joints
 - single vee-groove, open root
- Consumables
 - continuous
 - as per described “F” number

2.3 Perform preparations for destructive testing.
[0/2]

- Lay out coupons
- Cut coupons
- Grind surfaces
- Grind coupons

2.4 Perform destructive testing.
[0/1]

- Destructive test welds
 - root bend
 - face bend

2.5 Perform groove welds on pipe using FCAW process with stainless steel consumables.
[0/6]

- Groove welds
 - open root
- Positions
 - horizontal / vertical, (2G) / (5G)
 - all (6G)
- Material
 - mild steel pipe
- Joints
 - single vee-groove, open root
- Consumable – any one of
 - E308(L), E316(L), E309(L)

2.6 Perform preparations for destructive testing.
[0/2]

- Lay out coupons
- Cut coupons
- Grind surfaces
- Grind coupons

2.7 Perform destructive testing.
[0/1]

- Destructive test welds
 - root bend
 - face bend

Evaluation Structure				
Theory Testing	Practical Testing	Projects	Notebook & Organizational Skills	Final Assessment
5%	65%	0%	0%	30%

Number:	S0778		
Title:	Pressure Welding Procedures and Qualification		
Duration:	Total Hours: 24	Theory: 24	Practical: 0
Prerequisites:	S0775		
Content:	S0778.1 Welding Procedure Specifications [9/0]		
	S0778.2 Procedure Qualification Records [5/0]		
	S0778.3 Welding Performance Qualification [10/0]		

Evaluation & Testing

- Assignments related to theory and appropriate application skills.
- Final exam at end of term.
- Periodic quizzes.

Instructional and Delivery Strategies

Lecture and assignment work with welding procedures and codes.

Reference Materials

- *ASME* Boiler and Pressure Vessel Code, Section II – Part A, B and C, Section V, Section VIII and Section IX
- CSA Standard B51 - Boiler, Pressure Vessel and Pressure Piping Code
- Alberta ILM Welder Apprenticeship Module 120304e – Codes and Standards

Number:	S0778.1		
Title:	Welding Procedure Specifications		
Duration:	Total Hours: 9	Theory: 9	Practical: 0
Cross-Reference to Training Standard: 0814.01, 0814.02, 0815.01 - 0815.03			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe and apply the information listed on a weld procedure specification as determined by the *ASME* BPVC requirements and in accordance with a Welding Procedure Specification (WPS).

Learning Outcomes and Content

- 1.1 Describe the information found on a WPS.
[6/0]
- Welding processes and modes
 - joint design
 - Pass sequence and symbols
 - Base metals (“P” numbers)
 - Filler metals (“F” numbers)
 - Positions
 - Heat treatment
 - Pre-heat
 - Post-Heat
 - Interpass maintenance
 - Gas selection
 - Technique
 - Electrodes
 - Electrical characteristics

- 1.2 Access additional information from *ASME* BPVC Section IX as needed to develop a WPS.
[1/0]
- Welding variables
 - essential
 - non-essential
 - Supplementary
 - Testing requirements
- 1.3 Develop a WPS for welding specified weld joint.
[2/0]
- Welding process
 - Base metal size and thickness
 - Position
 - *ASME* IX

Number:	S0778.2		
Title:	Procedure Qualification Records		
Duration:	Total Hours: 5	Theory: 5	Practical: 0
Cross-Reference to Training Standard: 0814.01, 0814.02, 0815.01 - 0815.03			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe the principles, format and content of a Procedure Qualification Record (PQR) as determined by the *ASME* BPVC requirements and in accordance with a WPS.

Learning Outcomes and Content

2.1 Describe the information required to perform a PQR.
[3/0]

- Joints (clause QW-402)
- Base Metals (clause QW-403)
- Filler Metals (clause QW-404)
- Position (clause QW-405)
- Preheat (clause QW-406)
- Post-weld Heat Treatment (clause QW-407)
- Gas (clause QW-408)
- Electrical Characteristics (clause QW-409)
- Technique (clause QW-410)

2.2 Describe the testing required to perform a PQR.
[2/0]

- Non-destructive and Metallographic Tests
- Tensile Test (clause QW-150)
- Guided Bend Tests (clause QW-160)
- Toughness Tests (clause QW-170)
- Chemical Analysis
- Fillet Weld Test (clause QW-180)

Number:	S0778.3		
Title:	Welding Performance Qualification		
Duration:	Total Hours: 10	Theory: 10	Practical: 0
Cross-Reference to Training Standard: 0814.01, 0814.02, 0815.01 - 0815.03			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Describe the information documented on a Welder Performance Qualification Record (WPQR) or a Technical Standards and Safety Authority (TSSA) Welder/Welding Operator Identification Card.

Learning Outcomes and Content

- 3.1 Describe the actual values shown on a WPQR.
[1/0]
- Welding process(es) used
 - Type(s)
 - Base materials
 - Thickness(es)
 - Variables for all processes (clause QW-350)
 - Backing material
 - ASME “P” or “S” numbers
 - Material configuration
 - SFA numbers (clause QW-404)
 - Consumable inserts (clause QW-404)
 - Welding position (clause QW-405)
 - Manual or semi-automatic variables (clause QW-350)
 - Filler metal “F” numbers (clause QW-404)
 - Filler metal product form (clause QW-404)
 - Weld deposit thickness (clause QW-404)
 - Progression (clause QW-405)
 - Backing gas (clause QW-408)
 - GMAW transfer mode (clause QW-409)
 - GTAW current and polarity (clause QW-409)

3.2 Describe the range qualified shown on a WPQR.
[2/0]

- Variables for all processes
 - Backing material
 - ASME “P” or “S” numbers
 - Material configuration
 - SFA numbers
 - Consumable inserts
 - Welding position
- Manual or semi-automatic variables
 - Filler metal “F” numbers
 - Filler metal product form
 - Weld deposit thickness
 - Progression
 - Backing gas
 - GMAW transfer mode
 - GTAW current and polarity

3.3 Describe the testing requirements located on a WPQR.
[4/0]

- Bend test
- Transverse root and face (clause QW-462.3a)
- Longitudinal root and face (clause QW-462.3b)
- Pipe bend specimen, corrosion-resistant overlay (clause QW462.5c)
- Plate bend specimen, corrosion-resistant overlay (clause QW462.5d)
- Macro test for fusion (clause QW-462.5b)
- Macro test for fusion (clause QW-462.5e)
- Radiographic (clause QW-191)
- Fillet weld – fracture test (clause QW-180)
- Macro examination (clause QW-184)
- Other tests e.g.: liquid penetrant inspection
- Qualification expiry date

3.4 Describe the actual values and qualification ranges shown on a Brazer Performance Qualification Record (BPQR).
[2/0]

- Material specifications (clause QB-402)
- Thickness
- Filler materials (clause QB-403)
- Specification number
- Classification number
- “F” number
- Brazing temperature range (clause QB-404)
- Brazing flux (clause QB-406)
- Flow position(s) (clause QB-407)
- Method of applying filler metal
- Joint types (clause QB-408)
- Joint clearance
- Length overlap
- Technique (clause QB-410)
- Torch brazing, manual or mechanical

3.5 Describe the testing requirements located on a BPQR.
[1/0]

- Peel or sectioning test results clause QB-170 or clause QB-180
- Qualification expiry date

Evaluation Structure				
Theory Testing	Practical Testing	Projects	Notebook & Organizational Skills	Final Assessment
70%	0%	0%	0%	30%

Number:	S0779		
Title:	Specialized Pressure Welding Techniques		
Duration:	Total Hours: 39	Theory: 11.5	Practical: 27.5
Prerequisites:	S0772, S0773		
Content:	S0779.1 Braze Pressure Systems [2/7] S0779.2 Locate Weld Defects [4.5/0.5] S0779.3 Remove Weld Defects and Prepare for Re-welding [1/4] S0779.4 Mirror Welding [2/8] S0779.5 Window Welding [2/8]		

Evaluation & Testing

- Practical projects related to the welding process procedure and position.
- Unit practical tests evaluated in accordance with applicable industrial weld quality acceptance criteria.
- Periodic quizzes.

Instructional and Delivery Strategies

Teacher-led practical skills training with demonstration and observation in welding shop.

Reference Materials

- Equipment manuals and practical welding exercises based on Welding Procedure Specifications.

Number:	S0779.1		
Title:	Braze Pressure Systems		
Duration:	Total Hours: 9	Theory: 2	Practical: 7
Cross-Reference to Training Standard: 0819.01 - 0819.04			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Perform brazing procedures on pressure system metals in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 1.1 Describe the setup and shutdown procedures of oxy-fuel brazing equipment.
[1/0]
- 1.2 Identify brazing joint defects.
[0/1]
 - Improper joint preparation
 - Penetration
 - Flow
 - Fill
 - Profile and size
 - Overheating of base metal
- 1.3 Select brazing filler alloys and flux types for brazing various metals.
[0/1]
 - Copper to copper
 - Copper to stainless steel
 - Stainless steel to stainless steel
 - Carbon steel to stainless steel

1.4 Perform brazed lap joints in accordance with applicable codes or standards.
[1/5]

- Material thickness
- Fluxing of joint and rod
- Cleaning and purging of joint
- Joint gap
- Torch and filler rod manipulation
- Material type
 - Copper to copper
 - Copper to stainless steel
 - Stainless steel to stainless steel
 - Carbon steel to stainless steel

Number:	S0779.2		
Title:	Locate Weld Defects		
Duration:	Total Hours: 5	Theory: 4.5	Practical: 0.5
Cross-Reference to Training Standard: 0820.01			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Identify and locate weld defects as defined by *CSA* and *ASME* codes and standards in pipe welds using visual inspection and non-destructive testing reports.

Learning Outcomes and Content

- 2.1 Identify the types and characteristics weld defects as defined by *CSA* and *ASME* codes and standards.
[1/0]
- Size, shape
 - Allowable limits
 - Fusion, penetration
 - Discontinuities:
 - Cracks
 - Slag
 - Porosity
 - Lack of fusion
- 2.2 Identify the allowable tolerances for weld defects as specified by *ASME* and *CSA* codes.
[0.5/0]
- 2.3 Identify methods of NDE and their use in identifying weld defects on pipe.
[1/0]
- Radiographic
 - Ultrasonic
 - Magnetic particle
 - Liquid penetrant

- 2.4 Visually inspect pipe welds and identify weld defects with and without aids.
[0/0.5]
- Gauges
 - Oblique light
 - Inspection mirror
- 2.5 Determine the location and extent of weld defects identified by visual and non-destructive inspection reports.
[2/0]
- Location:
 - Which joint
 - Where on joint
 - Where in joint
 - Extent of defect
 - Type of defect

Number:	S0779.3		
Title:	Remove Weld Defects and Prepare for Re-Welding		
Duration:	Total Hours: 5	Theory: 1	Practical: 4
Cross-Reference to Training Standard: 0820.02, 0820.03			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Remove weld defects according to required standards re-weld in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 3.1 Identify the extent of material to be removed to ensure proper repair.
[0.5/0]
- Excess material
 - *CSA* and *ASME* standards
- 3.2 Remove weld defects using air carbon arc gouging equipment.
[0.5/1]
- Advantages and limitations
 - Select electrodes
 - Setup equipment
 - Gouging techniques
 - Required preparation of gouged joints for re-welding
- 3.3 Remove weld defects using grinders.
[0/0.5]
- Select disk grinders
 - Select die grinders
 - Technique for grinding out weld flaws.

- 3.4 Prepare welds for re-welding.
[0/0.5]
- Cavity profile
 - Surface condition
 - Extent of excavation
 - Non-destructive testing procedures
- 3.5 Re-weld repair joints in accordance with specifications.
[0/2]
- Welding procedure
 - Preheating
 - Electrodes
 - Process

Number:	S0779.4		
Title:	Mirror Welding		
Duration:	Total Hours: 10	Theory: 2	Practical: 8
Cross-Reference to Training Standard: 0821.01			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Weld plates and pipe in all positions using mirror welding techniques in accordance with government safety regulations, manufacturer's recommendations and approved industry standards with a focus of meeting or exceeding the testing requirements of the *CSA* or *ASME* Codes/Standards regarding weld quality.

Learning Outcomes and Content

- 4.1 Perform SMAW welds in all positions using mirror welding techniques on joints with restricted vision on one plane.
[1/4]
- Open roots
 - Fill and cover passes
 - Electrode selection
 - Equipment setup
 - Up-hand progression welding
 - Mirror positioning and manipulation
 - Handheld
 - Base mount
 - Electrode manipulation and positioning

4.2 Perform GTAW welds in all positions using mirror welding techniques on joints with restricted vision on one plane.

[1/4]

- Open roots
- Fill and cover passes
- Mirror positioning and manipulation
- handheld
- Base mount
- Equipment selection
- Torch and cup
- Electrode selection
- Equipment setup
- Filler rod selection
- Torch and filler rod manipulation

Number:	S0779.5		
Title:	Window Welding		
Duration:	Total Hours: 10	Theory: 2	Practical: 8
Cross-Reference to Training Standard: 0821.02			

General Learning Outcome

Upon successful completion, the apprentice is able to:

Weld open root pipe joints using the SMAW or the GTAW process and the window welding technique for joints that have restricted accessibility in two planes.

Learning Outcomes and Content

- 5.1 Identify the advantages and limitations of welding pipe with a window welding technique.
[1/0]
- Standards
 - Pipe size
 - Type of material
 - Required window size for SMAW and GTAW processes
- 5.2 Cut and remove window blank.
[0/2]
- Oxy-acetylene torch
 - Window size and shape
 - Window blank size and shape
 - Affect of cutting on base material
- 5.3 Prepare joints for window welding.
[1/1]
- New pipe
 - Repair existing pipe
 - Torch manipulation
 - Prepare joint profile for SMAW/GTAW
 - Cleaning

5.4 Weld pipe joints using the window techniques and the SMAW process.
[0/4]

- Open root
- Electrode selection
- Weld pipe root
- Weld the window blank

5.5 Weld pipe joints using the window techniques and the GTAW process.
[0/1]

- Open root
- Back shielding (purging)
- Electrode selection
- Torch and filler rod manipulation
- Weld pipe root
- Weld the window blank

Evaluation Structure				
Theory Testing	Practical Testing	Projects	Notebook & Organizational Skills	Final Assessment
20%	50%	0%	0%	30%

APPENDIX A: Recommended Minimum Tools and Equipment List

Power Sources and Equipment	Quantity
SMAW (CC) (AC/DC) power source and equipment	1 per apprentice
GTAW (CC), AC/DC, high frequency, square wave, pulsed power source and equipment, water-cooled torch, foot controller	1 per 5 apprentices
Plasma arc cutting power source and equipment	1 per 5 apprentices
Air-Carbon-Arc-Gouging power source and equipment	1 per 5 apprentices
Oxy-fuel-gas manual cutting equipment	1 per apprentice
Oxy-fuel-gas semi-automatic cutting equipment	1 per 5 apprentices
Oxy-fuel-gas-heating torch and equipment	1 per 5 apprentices
Approved electrode storage oven	1 per shop
Compressed air supply (80-100 psi)	1 per shop

Fabrication Machines (1 each per shop)

Band saw
 Nibbler
 Ironworker
 Pedestal grinders
 Cut-off abrasive wheel saw
 Weld-bevel preparation equipment for plate and pipe
 Weld-coupon bending apparatus
 Approved smoke extraction/air make-up unit
 Welding and fabricating shops must be well lit, appropriately heated and ventilated

Measuring Tools (1 per apprentice)

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

Safety Equipment (1 per apprentice)

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

Basic Hand Tools and Equipment (1 per apprentice)

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



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