



ONTARIO COLLEGE OF TRADES

ORDRE DES MÉTIERS DE L'ONTARIO

Apprenticeship
Curriculum Standard

Pressure Systems Welder

Level 1 and 2

Trade Code: 456P

Date: 2010

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

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

Meanwhile, please refer to the College's website (<http://www.collegeoftrades.ca>) for the most accurate and up-to-date information about the College. For information on OCTAA and its regulations, please visit: <http://www.collegeoftrades.ca/about/legislation-and-regulations>

Pressure Systems Welder

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Pressure Systems Welder

RECOMMENDED MINIMUM EQUIPMENT:

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

Band saw	(1 each per shop)
Nibbler	
Ironworker	
Pedestal grinders	
Cut-off abrasive wheel saw	
Weld-bevel preparation equipment for plate and pipe	
Weld-coupon bending apparatus	
Approved smoke extraction/air make-up unit	
Welding and fabricating shops must be well lit, appropriately heated and ventilated	

Basic Hand Tools and Equipment

Adjustable wrenches (various sizes)
Allen wrenches (metric and imperial)
Bench and pipe vice
"C" clamps (various sizes)
Chalk-line
Cold chisels (various sizes)
Electric extension cords
Files (flat, half-round, rat-tail, bastard)
Friction lighter
Grinders, grinding and sanding disks
(for carbon steel, aluminum and
stainless steel)
Hacksaw
Hammers (chipping, ball peen)
Hand shears
Layout table
Magnets
Metal markers
Pipe clamps
Pipe cutter
Pipe wrenches
Root opening spacing tools

(1 per apprentice)

Pliers (needle nose, slip joint)
Positioners
Pry bars
Punches
Screwdrivers (slot, Phillips, Robertson,
various sizes)
Scribers
Snips (heavy duty sheet metal cutting)
Soapstone markers
Socket sets (metric and imperial)
Temperature indicating crayons
Tip cleaners
Toolboxes
Tungsten sharpening grinders
Vice grips (various sizes and types)
Wire brushes (for carbon steel,
aluminum and stainless steel)
Wire cutters
Work bench
Wrench sets (open and closed ends,
both metric and imperial)

Measuring Tools

Drafting equip
Combination square
Fillet gauges
Spirit level
Vernier caliper

(1 per apprentice)

Square
Straight edge
Scriber
Micrometer
Tape measure

Safety Equipment

Earplugs and muffs
Face shields
Fire blankets
Fire extinguishers
Goggles
Leather aprons

(1 per apprentice)

Leather gloves
Leather jackets
Masks (particle, vapour)
Respirators
Safety glasses

Pressure Systems Welder

INTRODUCTION

This new curriculum standard for the Pressure Systems Welder (456P) trade program is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into two levels of reportable subjects. The Program Summary of Reportable Subjects chart summarizes the training hours for each reportable subject.

The curriculum identifies only the learning that takes place off-the-job. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standard. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to ensure that all apprentices have achieved the learning outcomes identified in the curriculum standard. Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on the work site.

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. The practical welding skill training specified in this curriculum should be complemented with on-the-job skills practice.

For easy reference, a time allocation has been included for each reportable subject, unit and topics, along with a breakdown of theory and application in the delivery of the performance objectives.

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.

Pressure Systems Welder Level 1

PROGRAM SUMMARY OF REPORTABLE SUBJECTS

Subject Number	Reportable Subject	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

Subject Number: S0771

Reportable Title: WELDING THEORY

Duration in Hours: 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

Mark Distribution:

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

Instructional and Delivery Strategies:

Lecture and assignment work.

Reference Materials

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

S0771.1 WELDING SAFETY

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

S0771.2 SHIELDED METAL ARC WELDING

Duration:

Total Hours: 7

Theory: 7 hours

Practical: 0 hours

Cross-Reference to Training Standard Performance Objectives:

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

S0771.3 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

S0771.4 GAS SHIELDED SEMI-AUTOMATIC WELDING PROCESSES

Duration:

Total Hours: 7

Theory: 7

Practical: 0

Cross-Reference to Training Standard Performance Objectives:

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

S0771.5 – 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

Subject Number: S0772

Reportable Subject: SHIELDED METAL ARC WELDING (SMAW)

Duration:

Total Hours: 66

Theory: 2

Practical: 64

Prerequisites:

None

Contents:

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.

Mark Distribution:

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

Instructional and Delivery Strategies:

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

Reference Materials:

Alberta ILM Welder Apprenticeship Modules

S0772.1 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

S0772.2 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

S0772.3 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

Subject Number: **S0773**

Reportable Subject: **GAS TUNGSTEN ARC WELDING (GTAW)**

Duration:

Total Hours: 45

Theory: 2

Practical: 43

Prerequisites:

None

Contents:

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.

Mark Distribution:

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

Instructional and Delivery Strategies:

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

Reference Materials:

Alberta ILM Welder Apprenticeship Modules

S0773.1 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

S0773.2 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

S0773.3 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

Subject Number: **S0774**

Reportable Subject: **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.

Mark Distribution:

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

Instructional and Delivery Strategies:

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

Reference Materials:

Alberta ILM Welder Apprenticeship Modules

S0774.1 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

S0774.2 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

S0774.3 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)

S0774.4 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

S0774.5 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

Pressure Systems Welder Level 2

PROGRAM SUMMARY OF REPORTABLE SUBJECTS

Subject Number	Reportable Subject	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

Subject Number: **S0775**

Reportable Subject: **CODES FOR PRESSURE WELDING**

Duration in Hours:

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

Mark Distribution:

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

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

S0775.1 ASME BOILER AND PRESSURE VESSEL CODE

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

S0775.2 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

S0775.3 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

S0775.4 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

Subject Number: **S0776**

Reportable Subject: **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.

Mark Distribution:

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

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.

S0776.1 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

S0776.2 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

S0776.3 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

S0776.4 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)

Subject Number **S0777**

Reportable Subject: **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.

Mark Distribution:

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

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.

S0777.1 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

S0777.2 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

Subject Number: **S0778**

Reportable Subject: **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.

Mark Distribution:

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

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

S0778.1 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

S0778.2 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)

S0778.3 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

Subject Number: S0779

Reportable Subject: 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.

Mark Distribution:

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

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.

S0779.1 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

S0779.2 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

S0779.3 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

S0779.4 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

S0779.5 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