Skilled Trades Ontario | Métiers spécialisés Ontario

Apprenticeship Curriculum Standard

Welder and Metal Fabricator

Level 1 Common Core

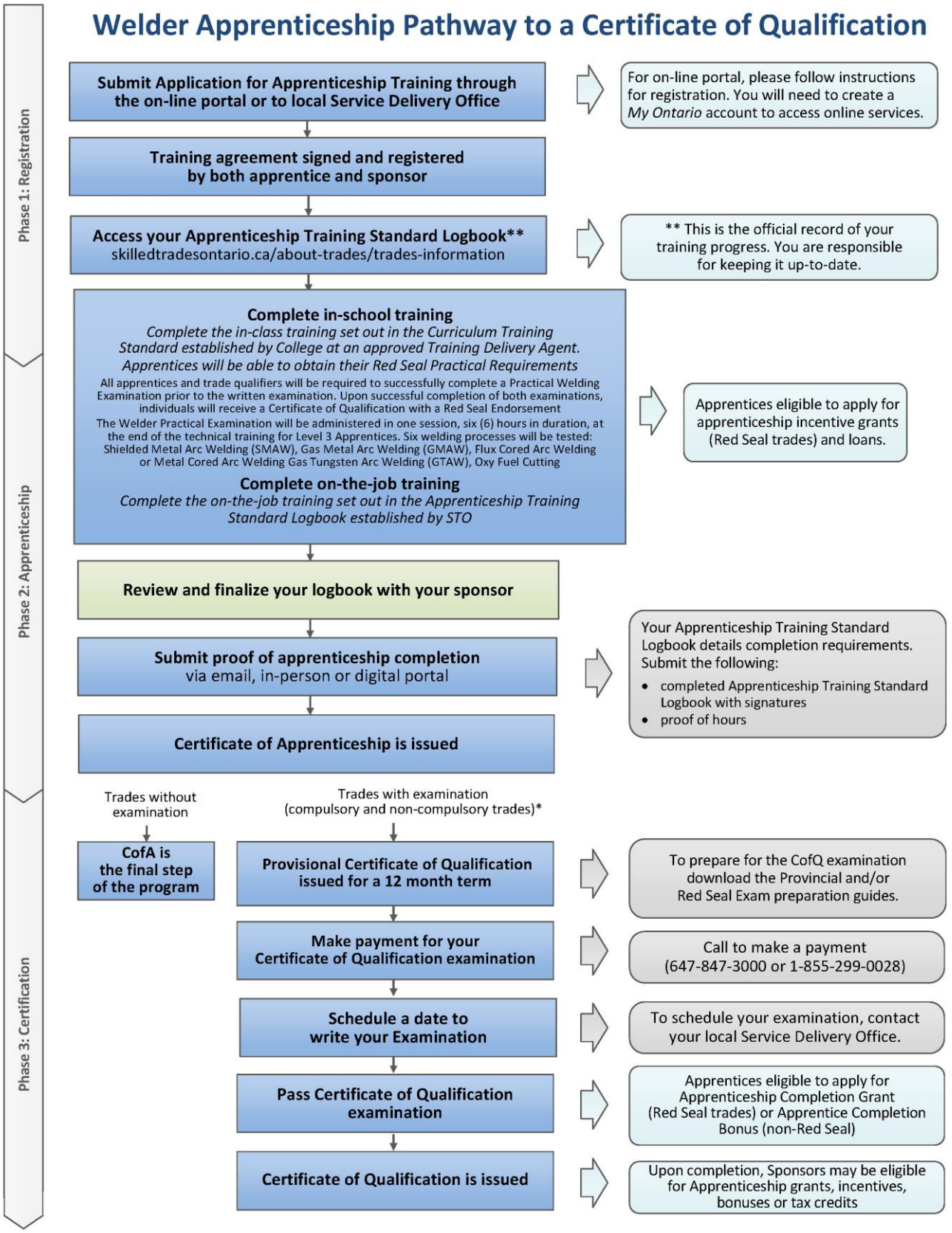
Metal Fabricator

Levels 2 and 3

456A & 437A

2017

Welder Apprenticeship Pathway to a Certificate of Qualification



* 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.

Maintained with transfer to Skilled Trades Ontario 2017 (V100)

Preface

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

The curriculum is organized into 3 levels of training. The Reportable Subjects Summary charts (located on pages 3, 57 and 82) 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)

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. Similarly, in order to advance to Level 3 of the program, an individual must have completed all of the units outlined in Level 1 and 2.

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 pages 101–102 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.

Welder and Metal Fabricator
Level 1
Common Core

Reportable Subject Summary Level 1 Common Core

#	Hours Unit	Theory	Practical	Total
	S3190: Trade Practices			
S3190.1	General Safety	12	0	12
S3190.2	Hand and Power Tools	4	5	9
S3190.3	Trade Calculations	24	0	24
Sub Totals		**40**	**5**	**45**
	S3191: Applied Blueprint Reading			
S3191.1	Applied Blueprint Reading	27	12	39
S3191.2	Joint Design and Welding Symbols	9	0	9
Sub Totals		**36**	**12**	**48**
	S3192: Welding Theory			
S3192.1	Power Sources and Equipment	9	0	9
S3192.2	Shielded Metal Arc Welding (SMAW)	9	0	9
S3192.3	Gas Metal Arc Welding (GMAW)	9	0	9
S3192.4	Flux Cored (FCAW) and Metal Cored (MCAW) Arc Welding	3	0	3
S3192.5	Thermal Cutting	9	0	9
Sub Totals		**39**	**0**	**39**
	S3193: Material and Process Quality I			
S3193.1	Distortion	12	0	12
S3193.2	Weld Quality	15	0	15
Sub Totals		**27**	**0**	**27**
	S3194: Shielded Metal Arc Welding (SMAW) Practical I			
S3194.1	Fillet Welds with Shielded Metal Arc Welding (SMAW) on Mild Steel	0	36	36
S3194.2	Groove Welds with Shielded Metal Arc Welding (SMAW) on Mild Steel	0	33	33
Sub Totals		**0**	**69**	**69**
	S3195: Gas Shielded Semi-Automatic Welding Practical I			
S3195.1	Fillet Welds with Gas Metal Arc Welding (GMAW)	0	21	21
S3195.2	Groove Welds with Gas Metal Arc Welding (GMAW)	0	15	15
S3195.3	Fillet Welds with Flux Cored Arc Welding (FCAW)	0	9	9
S3195.4	Groove Welds with Flux Cored Arc Welding (FCAW)	0	9	9
Sub Totals		**0**	**54**	**54**
	S3196: Thermal Cutting			
S3196.1	Oxy-Fuel-Gas Cutting	0	6	6
S3196.2	Plasma Arc Cutting	0	6	6
S3196.3	Air Carbon Arc Gouging	0	6	6
Sub Totals		**0**	**18**	**18**
Level 1 Totals		**142**	**158**	**300**

This level is common core between the following trades/occupations:
Welder and Metal Fabricator.

Number:	S3190		
Title:	**Trade Practices**		
Duration:	Total Hours: 45	Theory: 40	Practical: 5
Prerequisites:	None		
Content:	S3190.1	General Safety	
	S3190.2	Hand and Power Tools	
	S3190.3	Trade Calculations	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

General Safety - earplugs and muffs, leather gloves, face shields, leather jackets, fire blankets, masks, fire extinguishers, respirators, goggles, safety glasses, leather aprons.

Tools & Equipment:

Hand Tools / Power Tools - adjustable wrenches, Allen wrenches, bench vice, “C” clamps, chalk-line, cold chisels, electric extension cords, files, friction lighter, grinding and sanding disks, hacksaw, hammers, hand shears, layout table, magnets, metal markers, pipe clamps, pipe cutter, pipe wrenches, pliers, positioners, pry bars, punches, screwdrivers, scribers, snips, soapstone markers, socket sets, temperature indicating crayons, tip cleaners, toolboxes, tungsten sharpening grinders, vice grips, wire brushes, wire cutters, wrench sets, sanders, electric drills, angle grinders, grinders.

Trade Calculations - calculators

Instructional Strategies: demonstrations and practice, continuing appropriate use, periodic quizzes, math applications.

Number:	S3190.1		
Title:	**General Safety**		
Duration:	Total Hours: 12	Theory: 12	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the safe material handling operations, Industrial Safety Acts and potential workplace hazards in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

1.1 Explain material handling components and techniques and inspection methods.

- rigging/hoisting/material handling
  - equipment selection
  - tuggers
  - cable clamps
  - chain block hoists
  - chokers
  - connectors
  - ropes
  - chains
  - slings
  - clevices
  - hooks and plate clamps
  - spreaders
  - turning weldments
  - cranes
  - hand signals
  - mobile
  - jib
- overhead
- forklifts
- jacks
- come-along
- turn buckles

1.2 Describe the necessary PPE against common shop and construction hazards.

- electrical shock
  - water and electricity
  - good ground connection
  - cable connection
- fumes and gases
  - appropriate helmet and filter plates
  - respirators
  - flow meters
  - spatter
  - ozone
- fire
  - heat and burns
  - sparks
  - appropriate clothing
- radiation
  - Ultra-Violet
  - Infra-Red
  - white light
- noise
- fall protection
- falling objects
- scheduling
- sequence
- material selection and handling

1.3 Explain the safe use and operation of equipment.

- storage and handling of compressed gas cylinders
- power tools
- hand tools
- fabricating equipment
- automated equipment
- lockout
- scaffolding
- safety harness
- permits

1.4 Describe the *Workplace Hazardous Materials Information System (WHMIS).*

- right to know
- legislation including but not limited to *Canadian Center Occupational Health and Safety (CCOHS)*
- safe handling of products
- hazardous materials
- Threshold Limit Values (TLVs)
- Material Safety Data Sheets (MSDS)
- knowledge of company policies, workplace practices, government legislation and regulations

1.5 Describe the *Occupational Health and Safety Act (OHSA)*.

- legislation
- responsibility of employer and employee

1.6 Identify potential Workplace Hazards.

- confined spaces
- oxygen depletion
- moving equipment
- tripping hazards
- near misses
- emergency responses
- incident reports
  - safety/hazard assessment forms
- fires
- hot work

1.7 Describe effective verbal and non-verbal communication.

- use of common trade or non-technical terminology depending on the audience
  - supervisor
  - related professionals
  - suppliers
  - clients
- explain processes and ideas in a clear, concise and precise manner

Number:	S3190.2		
Title:	**Hand and Power Tools**		
Duration:	Total Hours: 9	Theory: 4	Practical: 5

General Learning Outcomes

Upon successful completion the apprentice is able to use measuring, small hand and power tools including but not limited to and in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

2.1 Describe the application and use of small hand and power tools.

- small hand tools
  - chipping hammer
  - wire brush
  - side cutters
  - hammer
  - cold chisel
  - pliers
  - vise grips
  - hack saw
  - scalers
  - hole saw
- pneumatic powered hand tools
- electric powered hand tools
  - wheel grinders
  - pedestal grinders
  - disc grinders
  - portable drills
- bench grinders
- abrasive cut-off saws
- die grinders
- drill press
- nibblers

2.2 Use welding measuring tools.

- fillet gauge
- contour gauge
- throat gauges

2.3 Use fit-up measurement tools.

- measuring tape
- ruler
- Vernier
- micrometer
- level
- centre head
- combination square
- protractor
- bevel angle
- calibration

Number:	S3190.3		
Title:	**Trade Calculations**		
Duration:	Total Hours: 24	Theory: 24	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to explain basic arithmetic, applied calculations, systems of measurements and basic geometry in accordance with the requirements for the welding and fabricating trades.

Learning Outcomes and Content

3.1 Define the fundamentals of basic arithmetic and perform the applied calculations.

- adding, subtracting, multiplying and dividing
- exponents and square root
- mathematical calculations
  - work orders
  - estimates
  - invoices
  - use of calculators

3.2 Explain the procedures and perform calculations.

- fractions and decimals
- converting fractions to decimals and decimals to fractions
- percentages

3.3 Explain fundamental formulas and perform calculations.

- perimeter
- circumference
- area
- volume
- mass
  - pressure

3.4 Explain the fundamentals of systems of measurement and perform calculations.

- difference between metric and imperial systems of measurement
- use of conversion tables and charts

3.5 Explain the fundamentals of basic geometry and perform basic “geometric shapes” calculations.

- angular measurements and calculations
- right angle triangle
- Pythagorean theorem
- 3-4-5 triangle

Number:	S3191		
Title:	**Applied Blueprint Reading**		
Duration:	Total Hours: 48	Theory: 36	Practical: 12
Prerequisites:	None		
Content:	S3191.1	Applied Blueprint Reading	
	S3191.2	Joint Design and Welding Symbols	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3191.1		
Title:	**Applied Blueprint Reading**		
Duration:	Total Hours: 39	Theory: 27	Practical: 12

General Learning Outcomes

Upon successful completion the apprentice is able to perform and interpret drawings, common views and basic drafting and sketching operations as applied to the welder/fabricator programs.

Learning Outcomes and Content

1.1 Define the content and organization of drawings.

- purpose of a drawing
- components of the drawing
  - lines
  - views
  - symbols
  - title block
  - bill of materials
  - notes and specifications
- types of work drawings
  - engineering drawings
  - erection drawings
  - erection diagrams
  - architectural drawings
  - assembly prints
  - sub-assembly prints
  - overview of CAD drawings
  - blueprints
  - shop details or working drawings
  - sketches
  - common scales
  - imperial and metric measurements
  - third angle projection
  - first angle projection
- customer specifications
- work orders
- requisitions/purchase orders
- procedure sheets

1.2 Define the purpose and function of the common types of lines found on drawings.

- object lines
- hidden lines
- centre lines
- dimension and extension lines
- leader lines
- break lines
- cutting plane lines
- hatch lines
- phantom lines

1.3 Define the purpose and function of the common views and presentations found on drawings.

- orthographic projection
- six principal views
- revolved views
- selecting the appropriate “front” or most descriptive view
- isometric drawing
  - three dimensional sketching
  - oblique and perspective views
- pictorial drawing
  - “true” perspective
  - vanishing point
  - not to be scaled
- section views
  - full and partial selections
  - revolved section
  - half section

1.4 Describe the commonly available structural shapes.

- shapes available by weight and measures
- sheet
  - common sizes and gauge measurement system
- plate
  - commonly available sizes
  - thickness, width and length
- pipe
  - schedules available
  - nominal size and common lengths
  - Hollow Structural Sections (HSS)
  - Round

- flat
  - bar
  - square
  - rectangular
  - round
  - square
  - hexagonal
- angle
  - common types and sizes
- channel
  - common types and sizes
  - dimensioning standards
- beams
  - common types and sizes

1.5 Perform assigned drafting and sketching operations.

- use appropriate drafting tools to complete drawing
  - compass
  - protractor
  - rule
  - divider
- complete orthographic drawing of a designated object showing various views
  - front
  - back
  - side (right or left)
  - top or bottom
  - types of lines
  - dimensioning
- complete three dimensional drawing or sketch of a designated object
- isometric
- oblique
- pictorial

Number:	S3191.2		
Title:	**Joint Design and Welding Symbols**		
Duration:	Total Hours: 9	Theory: 9	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to explain the features of joint types, positions and welding symbols as applied to the welder/fabricator programs.

Learning Outcomes and Content

2.1 Define the fundamental joint types and positions.

- five basic joints
  - butt
  - T
  - lap
  - corner
  - edge
  - geometry of joint preparation
  - terminology of joints
  - positions, plate and pipe
  - flat, (1F), (1G)
  - horizontal, (2F), (2G)
  - vertical, (3F), (3G)
  - progression up
  - progression down
  - overhead, (4F), (4G)
  - (5F), (5G), (6G)

2.2 Explain the purpose and use of different joints.

- application of each basic joint
- introduction to joint limitations
- thickness
- economy
- process
- position
- accessibility
- distortion
- complete and partial joint penetration
- bevelling/chamfering methods

2.3 Explain the components of welding symbols.

- reference line
- arrow side and other significance
- multiple reference lines
- arrows
- broken arrows
- tail
- specifications and notes
- process
- basic weld symbols
  - fillet
  - groove
  - plug/slot

2.4 Explain the design and application of welding symbols.

- groove welds
  - designation of complete and partial penetration groove welds
  - V-groove
  - bevel groove
  - J-groove
  - single and double – combination grooves
  - edge preparations
  - bevel angle
  - included angle
  - chamfer
  - dimensioning
  - root gap
  - root face
- back or backing welds
  - melt-thru
  - open grooves and use of backing
  - other/auxiliary
- surface contours and methods of finishing
- fillet welds
  - continuous
  - intermittent
  - opposite
  - staggered
  - dimensions
  - leg sizes
  - throat
  - face
  - length

- other welds
  - plug and slot
  - cladding
  - spot welds
  - auxiliary symbols
  - field weld symbols
  - weld all-around symbol
  - surface contours
  - methods of finishing

Number:	S3192		
Title:	**Welding Theory**		
Duration:	Total Hours: 39	Theory: 39	Practical: 0
Prerequisites:	None		
Content:	S3192.1	Power Sources and Equipment	
	S3192.2	Shielded Metal Arc Welding (SMAW)	
	S3192.3	Gas Metal Arc Welding (GMAW)	
	S3192.4	Flux Cored (FCAW) and Metal Cored (MCAW) Arc Welding	
	S3192.5	Thermal Cutting	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3192.1		
Title:	**Power Sources and Equipment**		
Duration:	Total Hours: 9	Theory: 9	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the functions and controls of welding power sources in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

1.1 Define the functions of welding power sources.

- constant current
- constant voltage
- inverters
- transformers
- transformer rectifiers
- generators
- engine drives
- amperage controls
- principle of inductance
- tapped control
- saturable reactor
- magnetic amplifier
- manuals/catalogues

1.2 Describe the effects of power source controls on welding processes.

- amperage (WFS)
- voltage
- voltage trim
- remote controls
- output characteristics
- current type
- polarity
- slope control
- inductance
- square wave
- high frequency
- AC balancer

- transformer rectifier
- inverter
- welding current output frequency
- inverter controls

Number:	S3192.2		
Title:	**Shielded Metal Arc Welding (SMAW)**		
Duration:	Total Hours: 9	Theory: 9	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the fundamentals of the Shielded Metal Arc Welding (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 Shielded Metal Arc Welding (SMAW) process.

- development of arc welding
- fusion
- arc characteristics
- arc length
- effects of amperage and voltage
- effects of polarity
- penetration
- travel speed
- optimum parameters
- effects of too fast or too slow travel speed
- control of weld contamination

2.2 Describe the equipment requirements for the Shielded Metal Arc Welding (SMAW) process.

- power sources
  - transformers
  - rectifiers
  - inverters
  - generators
  - engine driven
- power source controls
  - amperage (WFS)
  - duty cycle
  - voltage
  - current type
  - polarity

- arc force
- hot start
- electrode holders
  - alligator
  - pin hole
  - twist lock
- welding cables
  - cable size and condition
  - connector types and condition
  - relationship to required amperage
  - work lead
  - completion of welding circuit
  - work leads in good repair
  - work lead locations

2.3 Describe the construction and characteristics of Shielded Metal Arc Welding (SMAW) electrodes.

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

2.4 Describe the Shielded Metal Arc Welding (SMAW) procedure variables and their effect on quality and productivity.

- primary variables (conducted prior to welding)
  - joint design, preparation and fit-up
  - consumables
  - current type and polarity
  - amperage (WFS)
  - pre-heat
  - electrode size
- secondary variables (conducted during welding)
  - travel speed
  - arc length
  - work angle
  - electrode angle
  - technique
  - whipping
  - weaving
  - stringer
  - multiple passes
  - drag

Number:	S3192.3		
Title:	**Gas Metal Arc Welding (GMAW)**		
Duration:	Total Hours: 9	Theory: 9	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the fundamentals, construction features and consumables of the Gas Metal Arc Welding (GMAW) process in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

3.1 Define the fundamentals of Gas Metal Arc Welding (GMAW) process.

- models of metal transfer
  - short-circuiting transfer
  - spray arc transfer
  - globular
  - pulsed
- power source technology
  - STT
  - RMD
  - CMT
- gas shielding
  - purpose
  - types
  - effects on weld integrity
  - Argon/Helium
  - CO_2
  - mixed gases
  - triple mix gas

3.2 Explain safety concerns applicable to the Gas Metal Arc Welding (GMAW) process.

- UV radiation protection
  - appropriate helmet and filter plate
  - Personal Protective Equipment (PPE)
- spatter and PPE
- flow meters
- fumes and gases
- oxygen depletion

3.3 Explain the function of the components of the Gas Metal Arc Welding (GMAW) process.

- fundamentals and characteristics of the Constant Voltage power source
  - self-correcting arc gap
  - application of Constant Current power sources
  - wire feeders
  - spool guns
  - push type
  - push-pull type
  - drive rolls (tension adjustment)
  - liners
  - metallic
  - non-metallic
  - gas diffusers
  - contact tips/contact tubes
    - nozzles
    - water cooled guns

3.4 Explain the selection and characteristics of consumables necessary for the Gas Metal Arc Welding (GMAW) short-circuit transfer and spray-arc transfer.

- optimal wire type and size (diameter)
- filler metal classification system
  - low alloy
  - steels
  - stainless steels
  - aluminum
  - types and sizes
  - purpose of copper plating
- shielding gasses
  - types
  - flow rate

3.5 Describe the variables for Gas Metal Arc Welding (GMAW) and their effects on quality and productivity.

- primary variables (conducted prior to welding)
  - joint design, preparation and fit-up
  - consumables
  - shielding gasses
  - current type and polarity
  - amperage (WFS)
  - wire diameter
  - voltage
  - pre-heat

- secondary variables (conducted during welding)
  - travel speed
  - nozzle to work distance
  - work angle
  - gun angle to work
  - technique
  - stringer
  - multi-passes
  - weaving
  - forehand
  - backhand
  - progression

Number:	S3192.4		
Title:	**Flux Cored (FCAW) and Metal Cored (MCAW) Arc Welding**		
Duration:	Total Hours: 3	Theory: 3	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the fundamentals and the selection process of the consumables of the Flux Cored Arc Welding (FCAW) and Metal Cored Arc Welding (MCAW) 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 Flux Cored Arc Welding (FCAW) and the Metal Cored Arc Welding (MCAW) processes.

- metallic transfer
- construction of the tubular wire
  - wire types
  - flux types
- gas shielding
  - purpose
  - types

4.2 Explain the functions of the components of the Flux Cored Arc Welding (FCAW) and the Metal Cored Arc Welding (MCAW) processes.

- fundamentals and characteristics of the Constant Current power source
- fundamentals and characteristics of the Constant Voltage power source
- electrode wire classification
  - types and sizes
- mechanical feeders
  - drive rolls (tension adjustment)
  - liners
  - contact tips/contact tubes
  - nozzles
- gas shielding
  - gas diffusers

4.3 Describe the selection of welding parameters and consumable necessary for the Flux Cored Arc Welding (FCAW) and the Metal Cored Arc Welding (MCAW).

- (post and pre-heat) material thickness
- position of welding
- voltage
- wire type and size
- drive rolls (tension adjustment)
- contact tips
- selection of shielding gasses
- types
- flow rate
- gun angle
- direction of travel

Number:	S3192.5		
Title:	**Thermal Cutting**		
Duration:	Total Hours: 9	Theory: 9	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the fundamentals and the selection process of the consumables of Oxy-Fuel Cutting, Plasma Arc Cutting and Air Carbon Arc Gouging processes in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

5.1 Define safety related concepts.

- PPE
  - clothing
  - safety glasses
  - cutting goggles
  - noise protection
  - fumes protection
  - protection against falling material
  - electrical safety
  - grounding
  - bonding
  - radiation
  - high open circuit voltage
  - preparing the work site
- cylinders
  - basic construction and features
  - fusible plugs
  - rupture disk
  - flashback arrestors
  - reverse flow check valves
  - compressed air pressure
  - high pressure cylinders
- fire hazards
  - flammable distances of sparks/dross
  - fire prevention
  - fire blankets
  - fire extinguishers
  - oxygen hazards
  - heat

5.2 Describe the characteristics, applications and controls of gases.

- manifold systems
- arrestors (manufacturers' recommendations)
- fuel gases
  - acetylene
  - maximum safe pressure
  - safe withdrawal rates
  - cylinder handling
  - type of piping
  - propane
  - polypropylene
  - MAPP
  - natural gas
  - flammable ranges
  - oxygen
  - fire hazard
  - explosion hazard
- liquid bulk storage
- cylinder handling
- preparing the work site
  - fire hazards
- cutting closed containers
  - cleaning
  - water filling
  - purging
- cutting in confined spaces

5.3 Explain the operation and handling of oxy-fuel and plasma arc cutting equipment.

- power supplies
  - amperage (WFS)
  - voltage
- secure cylinders
- gauges
- hoses
  - sizes
  - colour
  - length
- torches
  - manual and machine
  - heating equipment
  - fittings
  - tips
  - installing

  - types
  - size selection
  - cleaning
  - gas pressures
  - maintenance
- electrode selection
  - diameter
  - shapes
- fittings
- tips
- pressures
- speed of travel
- types of cuts
- material types
- material thickness
- piercing
- quality control

5.4 Set up, light and shut down equipment.

- safe set up
- correct lightning procedure
- correct shut down procedure

5.5 Perform manual oxy-fuel gas and plasma arc cutting.

- set-up parameters
  - square cuts
  - bevel cuts
  - piercing
  - straight cutting
  - shape cutting
  - depth of cut
  - material types
  - gas pressures
  - speed of travel
  - quality control
  - tip to metal distance
  - shut down

5.6 Correct common cutting faults.

- cut edge quality
- kerf lines
- cutting direction based on square side of cut
- dross adherence (slag)

Number:	S3193		
Title:	**Material and Process Quality I**		
Duration:	Total Hours: 27	Theory: 27	Practical: 0
Prerequisites:	None		
Content:	S3193.1	Distortion	
	S3193.2	Welds Quality	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3193.1		
Title:	**Distortion**		
Duration:	Total Hours: 12	Theory: 12	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the fundamental causes, effects and correction procedures of distortion in accordance with the effects of heat and stress of metals in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

1.1 Define the fundamental causes of distortion.

- types of shrinkages
  - transverse
  - longitudinal
  - volumetric
  - shape change
  - stress/strain
  - unbalanced shrinkage stress

1.2 Describe the factors affecting distortion.

- types of metal
- physical properties affecting distortion
- thermal conduction
- thermal expansion
- carbon vs. austenitic stainless steel
- aluminums
- type of joints
  - T joints
  - single
  - double
  - prepared T
  - lap joints
  - single sided groove joints
  - double sided groove joints
- joint volumes
  - effect of bevel angle
  - effect of included angle
  - J-grooves
  - U-grooves
  - material thickness

- welding process
  - Shielded Metal Arc Welding (SMAW)
  - Gas Metal Arc Welding (GMAW)
  - Flux Cored Arc Welding (FCAW)
  - Submerged Arc Welding (SAW)
  - heat input
  - deposit rate
  - manual vs. automatic processes
  - travel speed

1.3 Explain the methods used to prevent distortion.

- welding sequence
- back step
- weld progression
- vertical up
- vertical down
- continuous
- intermittent welding
- pre-setting joint
- preheating
- jigs and fixturing
- weld size
- effects of over welding
  - multiple passes
  - single pass
  - effects of bead size
  - selection of preventative method
  - distortion allowances

1.4 Describe actions used to correct distortion.

- measuring distortion
- heat wedges
- heat spots
- back welding
- stress relief
- mechanical straightening
- stress/strain
- restraint
- work hardening

Number:	S3193.2		
Title:	**Weld Quality**		
Duration:	Total Hours: 15	Theory: 15	Practical: 0

General Learning Outcomes

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.

Learning Outcomes and Content

2.1 Define welding discontinuities and their effect on weld quality.

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

2.2 Explain the types and causes of dimensional and/or geometric discontinuities.

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

2.3 Identify the types and causes of structural soundness discontinuities.

- cracks
  - inclusions
  - porosity
  - lack of fusion
  - incomplete fusion
  - undercut
  - overlap

2.4 Explain how weld quality is assured through documented welding procedures.

- specification of welding variables within permissible tolerances
  - specification of material type
  - preparation and joint fit-up
  - pre-heat, interpass and post-heat temperature requirements
  - electrical characteristics
  - consumables
  - filler metals
  - fluxes
  - shielding gasses
  - welding position
  - welding technique

2.5 Describe the need for other functions to assure weld quality.

- qualification of welding personnel
  - welding procedure qualification requirements
  - in-process weld monitoring
  - techniques to avoid arc blow
  - post-weld inspection
  - non-destructive testing requirements

2.6 Define procedures for correction of defective weld quality.

- defect excavation procedures
- inspection of cavity prior to weld repair
- weld repair procedures

Number:	S3194		
Title:	**Shielded Metal Arc Welding (SMAW) Practical I**		
Duration:	Total Hours: 69	Theory: 0	Practical: 69
Prerequisites:	None		
Content:	S3194.1	Fillet Welds with Shielded Metal Arc Welding (SMAW) on Mild Steel	
	S3194.2	Groove Welds with Shielded Metal Arc Welding (SMAW) on Mild Steel	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3194.1		
Title:	**Fillet Welds with Shielded Metal Arc Welding (SMAW) on Mild Steel**		
Duration:	Total Hours: 36	Theory: 0	Practical: 36

General Learning Outcomes

Upon successful completion the apprentice is able to perform fillet welding with the Shielded Metal Arc Welding (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 C.S.A. W47–4F position regarding weld quality.

Learning Outcomes and Content

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

- power source
- equipment
- consumables
- safety
- PPE
- material
- technique
- type of welds

1.2 Set-up and maintain equipment for Shielded Metal Arc Welding (SMAW) applications.

- electrode selection
  - type
  - size
- power sources
  - transformers
  - rectifiers
  - inverters
  - generators
  - engine driven
  - motor driven

- power source controls
  - amperage (WFS)
  - voltage
  - current type
  - polarity
- electrode holders
  - jaw types
- welding cables
  - size and condition
  - relationship to required amperage
  - work lead
  - completion of welding circuit
  - clamps in good repair
  - work lead locations
  - safety concerns

1.3 Fillet weld on mild steel using the Shielded Metal Arc Welding (SMAW) process.

- striking the arc
- running beads
- stops and restarts
- filling crater
- fillet welds
  - T joint
  - lap joint
- material
  - plate
  - structural shapes
  - structural shapes to plate
- positions
  - 1F
  - 2F
- electrodes
  - cellulose
  - rutile
  - basic

1.4 Perform post-weld operations.

- methods of cleaning and finishing of completed weld to specifications
  - removing all slag
  - removing all spatter
  - wire brushing
  - filing
  - grinding
  - hand and power tools
  - measuring welds to meet specifications
- visual examination of weld for discontinuities
  - porosity
  - cracks
  - slag inclusion
  - undercut
  - overlap

Number:	S3194.2		
Title:	**Groove Welds with Shielded Metal Arc Welding (SMAW) on Mild Steel**		
Duration:	Total Hours: 33	Theory: 0	Practical: 33

General Learning Outcomes

Upon successful completion the apprentice is able to perform groove welding procedures with the Shielded Metal Arc Welding (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 C.S.A. W47–3GF position regarding weld quality.

Learning Outcomes and Content

2.1 Prepare base metal for groove welding.

- type of groove joint
- welding symbol
- type of metal
- backing requirement
- method of joint preparation
- surface finish
- joint opening
- placement of tacks
- pre-heat requirement

2.2 Perform groove welding of mild steel using the Shielded Metal Arc Welding (SMAW) process.

- single bevel
  - backing bar
- single V-groove
  - backing bar
  - flat position (1G)
  - structural shapes
- GF combination test plates
  - 1GF
  - 2GF
  - 3GF
- electrodes
  - cellulose
  - rutile
  - basic

2.3 Perform post-weld operations.

- methods of cleaning completed weld to specifications
  - removing all slag
  - removing all spatter
  - wire brushing
  - filing
  - grinding
  - hand and power tools
  - measuring welds to meet specifications
- visual examination of weld for discontinuities
  - porosity
  - cracks
  - slag inclusion
  - undercut
  - overlap
  - incomplete penetration
- inspect of welds
  - non-destructive test methods
  - destructive test methods

Number:	S3195	
Title:	**Gas Shielded Semi-Automatic Welding Practical I**	
Duration:	Total Hours: 54	Theory: 0 Practical: 54
Prerequisites:	None	
Content:	S3195.1	Fillet Welds with Gas Metal Arc Welding (GMAW)
	S3195.2	Groove Welds with Gas Metal Arc Welding (GMAW)
	S3195.3	Fillet Welds with Flux Cored Arc Welding (FCAW)
	S3195.4	Groove Welds with Flux Cored Arc Welding (GCAW)
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.	

Number:	S3195.1		
Title:	**Fillet Welds with Gas Metal Arc Welding (GMAW)**		
Duration:	Total Hours: 21	Theory: 0	Practical: 21

General Learning Outcomes

Upon successful completion the apprentice is able to perform fillet welding with the Gas Metal Arc Welding (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 C.S.A. W47–2F position regarding weld quality.

Learning Outcomes and Content

1.1 Review equipment set-up and the process of the Gas Metal Arc Welding (GMAW).

- power source
- wire feeder
- shielding gasses
- consumables
- safety
- PPE
- material
- technique
- type of welds

1.2 Set-up and maintain equipment for a variety of Gas Metal Arc Welding (GMAW) applications.

- consumables for the application
  - wire type
  - size
  - gas type
- welding parameters
  - voltage
  - amperage (WFS)
  - gas flow rate
- demonstrate mode of metal transfer
  - short circuit
  - globular
  - spray transfer

- maintenance of equipment
  - work lead connection
  - mechanical feeders
  - drive rolls (tension adjustment)
  - spool axle tension
  - contact tip
  - gun nozzle
  - gun liner
  - wear
  - restriction
  - loops
  - circulator
  - changing shielding gas cylinders
  - gas leaks

1.3 Perform fillet welding on mild steel using the Gas Metal Arc Welding (GMAW) process.

- pre-cleaning and preparation
- modes of metal transfer
  - short circuit
  - spray
  - globular
- fillet welds
  - lap joint
  - T joint
  - corner joint
  - flat position (1F)
  - horizontal position (2F)
  - plate and sheet
  - structural shapes
  - structural shapes to plate
- consumables
  - wire
  - shielding gasses

1.4 Perform post weld operations.

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

Number:	S3195.2		
Title:	**Groove Welds with Gas Metal Arc Welding (GMAW)**		
Duration:	Total Hours: 15	Theory: 0	Practical: 15

General Learning Outcomes

Upon successful completion the apprentice is able to perform groove welding with the Gas Metal Arc Welding (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 C.S.A. W47–2G position regarding weld quality.

Learning Outcomes and Content

2.1 Prepare base metal for groove welding.

- type of groove joint
- welding symbol
- type of metal
- backing requirements
- method of joint preparation
- surface finish
- joint opening
- placement of tacks
- pre-heat requirement

2.2 Perform groove welding on mild steel using the Gas Metal Arc Welding (GMAW) process.

- pre-cleaning and preparation
- modes of metal transfer
  - short circuit
  - spray
  - globular
- single level
  - backing
- double level
  - single V groove
  - flat position (1G)
  - horizontal position (2G)
  - plate
  - structural shapes

- consumables
  - wire
  - shielding gasses

2.3 Perform post weld operations.

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

Number:	S3195.3		
Title:	**Fillet Welds with Flux Cored Arc Welding (FCAW)**		
Duration:	Total Hours: 9	Theory: 0	Practical: 9

General Learning Outcomes

Upon successful completion the apprentice is able to perform fillet welding with the Flux Cored Arc Welding (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 C.S.A. W47–2F position regarding weld quality.

Learning Outcomes and Content

3.1 Review equipment and the process of the Flux Cored Arc Welding (FCAW).

- power source
- wire feeder
- shielding gasses
- consumables
- safety
- PPE
- material
- technique
- type of welds

3.2 Set-up equipment for a variety of Flux Cored Arc Welding (FCAW) applications.

- consumables for the application
  - wire type
  - gas shielded
  - self-shielded
  - size
  - gas type
- welding parameters
  - voltage
  - amperage (WFS)
  - gas flow rate
- demonstrate mode of metal transfer
  - short circuit
  - globular
  - spray transfer

- maintenance of equipment
  - work lead connection
  - wire feeders
  - drive rolls (tension adjustment)
  - spool axle tension
  - contact tip
  - gun nozzle
  - gun liner
  - wear
  - restriction
  - loops
  - water cooled guns
  - circulator
  - changing shielding gas cylinders
  - gas leaks

3.3 Perform fillet welding on mild steel using the Flux Cored Arc Welding (FCAW) process.

- fillet welds
  - lap joint
  - T joint
  - corner joint
  - flat position (1F)
  - horizontal position (2F)
  - plate
  - structural shapes
  - structural shapes to plate
- consumables
  - wire
  - shielding gasses

3.4 Perform post weld operations.

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

Number:	S3195.4		
Title:	**Groove Welds with Flux Cored Arc Welding (FCAW)**		
Duration:	Total Hours: 9	Theory: 0	Practical: 9

General Learning Outcomes

Upon successful completion the apprentice is able to perform groove welding with the Flux Cored Arc Welding (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 C.S.A. W47–2G position regarding weld quality.

Learning Outcomes and Content

4.1 Prepare base metal for groove welding.

- type of groove joint
- welding symbol
- type of metal
- backing requirements
- method of joint preparation
- surface finish
- joint opening
- placement of tacks
- pre-heat requirement

4.2 Perform groove welding on mild steel using the Flux Cored Arc Welding (FCAW) process.

- single level
  - backing bar
- double level
  - single V groove
  - backing bar
  - flat position (1G)
  - plate
- consumables
  - wire
  - shielding gasses

4.3 Perform post weld operations.

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

Number:	S3196		
Title:	**Thermal Cutting**		
Duration:	Total Hours: 18	Theory: 0	Practical: 18
Prerequisites:	None		
Content:	S3196.1	Oxy-Fuel Gas Cutting	
	S3196.2	Plasma Arc Cutting	
	S3196.3	Air Carbon Arc Gouging	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3196.1		
Title:	**Oxy-Fuel Gas Cutting**		
Duration:	Total Hours: 6	Theory: 0	Practical: 6

General Learning Outcomes

Upon successful completion the apprentice is able to perform safe set-up and shut down operation and correction of common cutting faults for the Oxy-Fuel Cutting equipment applications in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

1.1 Set-up, light and shut down equipment.
- safe set-up
- correct lighting procedure
- correct shut down procedure

1.2 Perform manual Oxy-Fuel gas cutting.
- square cuts
- bevel cuts
- piercing
- straight cutting
- shape cutting
- gas pressures
- speed of travel
- tip to metal distance

1.3 Correct common cut faults.
- cut edge quality
- kerf lines
- dross adherence (slag)

Number:	S3196.2		
Title:	**Plasma Arc Cutting**		
Duration:	Total Hours: 6	Theory: 0	Practical: 6

General Learning Outcomes

Upon successful completion the apprentice is able to perform safe set-up and shut down operation and correction of common cutting faults for the Plasma Arc Cutting equipment applications in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

2.1 Cut manually using Plasma Arc equipment.

- Set-up parameters
  - square cuts
  - bevel cuts
  - piercing
  - straight cutting
  - shape cutting
  - shut down

2.2 Correct common cutting faults.

- cut edge quality
- kerf lines
- cutting direction based on square side of cut
- dross adherence (slag)

Number:	S3196.3		
Title:	**Air Carbon Arc Gouging**		
Duration:	Total Hours: 6	Theory: 0	Practical: 6

General Learning Outcomes

Upon successful completion the apprentice is able to perform safe set-up and shut down operation and correction of common cutting faults for the Air Carbon Arc Gouging equipment applications in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

3.1 Gouging manually using Air Carbon Arc equipment.

- defect excavation
  - weld removal
  - back gouging to sound metal
  - weld joint preparation

3.2 Correct common cutting faults.

- cut edge quality
- post cleaning

Metal Fabricator Level 2

Reportable Subject Summary Level 2

#	Unit	Hours		
		Theory	Practical	Total
S3230: Blueprint Advanced				
S3230.1	Blueprint Advanced	30	30	60
Sub Totals		**30**	**30**	**60**
S3231: Fabrication I				
S3231.1	Fabrication	9	39	48
Sub Totals		**9**	**39**	**48**
S3232: Gas Tungsten Arc Welding (GTAW) Practical				
S3232.1	Gas Tungsten Arc Welding (GTAW) Practical	1	20	21
Sub Totals		**1**	**20**	**21**
S3233: Machine Operation				
S3233.1	Machine Operation	6	18	24
Sub Totals		**6**	**18**	**24**
S3234: Material and Process Quality II				
S3234.1	Metallurgy	12	0	12
S3234.2	Distortion II	6	0	6
S3234.3	Inspection and Codes	6	0	6
Sub Totals		**24**	**0**	**24**
S3235: Patterns and Templates Development I				
S3235.1	Patterns and Templates I	8	25	33
Sub Totals		**8**	**25**	**33**
Level 2 Totals		**78**	**132**	**210**

Number:	S3230		
Title:	**Blueprint Advanced**		
Duration:	Total Hours: 60	Theory: 30	Practical: 30
Prerequisites:	Level 1		
Content:	S3230.1	Blueprint Advanced	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3230.1		
Title:	**Blueprint Advanced**		
Duration:	Total Hours: 60	Theory: 30	Practical: 30

General Learning Outcomes

Upon successful completion the apprentice is able to interpret blueprints, produce basic drafting drawings and bills of materials in accordance with government safety regulations, manufacturer's recommendations and accepted industry standards.

Learning Outcomes and Content

1.1 Interpret dimensioning systems, methods and tolerances to determine true object sizes and shapes

- notes and specifications
  - title block
  - specification attachments
- dimensioning
  - tolerances
  - unilateral
  - bilateral
  - limit dimensioning
- holes
  - countersink
  - counter bore
- threads
  - internal and external
  - classifications
  - metric and imperial
  - diameter and pitch
- welding symbols
  - locating of welds
  - plug and slot
  - surfacing
  - spot and projection welds
  - stud welds
  - welding procedures and specifications, notes
  - testing methods

1.2 Produce detail item sketches from engineered structural and plate fabrication drawings in preparation for fabrication

- applicable codes
- elevation data
- structural shapes
- structural connections
- erection clearances
- erection aids
- center line position
- hole patterns
- gauge
- machined surfaces
- welding symbols
  - section views
  - sub-assemblies

1.3 Interpret and/or produce computer-aided detail drawings from engineered structural and plate fabrication drawings

- applicable codes
- elevation data
- structural shapes
- structural connections
- erection clearances
- erection aids
- hole patterns
- gauge
- machining allowance
- welding symbols
- section views
- sub-assemblies

1.4 Interpret pressure vessel and associated piping drawings

- applicable codes
- top center line
- quarter line
- seam orientation
- radial locations
- non-radial locations
- circumferential centre line
- dished and radiused heads
- miscellaneous attachments

- non-pressure parts
- pipe drawings types
- pipe and their schedules
- pipe fittings
- types of valves
- symbols to identify piping systems components

1.5 Calculate developed lengths for rolled and bent components

- type of metal
- neutral axis shift
- mean diameter
- bend allowance
- hot/cold bending and rolling
- lead and trail allowances

1.6 Produce bill of materials from a variety of drawings

- structural
- vessels
- piping
- plate

Number:	S3231		
Title:	**Fabrication I**		
Duration:	Total Hours: 48	Theory: 9	Practical: 39
Prerequisites:	Level 1		
Content:	S3231.1	Fabrication	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3231.1		
Title:	**Fabrication I**		
Duration:	Total Hours: 48	Theory: 9	Practical: 39

General Learning Outcomes

Upon successful completion the apprentice is able to plan and perform practical fitting projects in accordance with government safety regulations, manufacturer's recommendations and accepted industry standards.

Learning Outcomes and Content

1.1 Plan and set-up workspace

- sufficient space available for the duration of the project
- safe working area
- adequate lighting
- appropriate ventilation and air flow
- equipment allocation and set-up
- material handling availability
- environmental hazards
- overhead hazards
- work process flow

1.2 Select materials from specifications

- material
  - heat numbers
  - receiving documentation
  - structural shape identification
- fasteners
  - bolts, nuts and stud attachments
  - types of washers
  - types of rivets

1.3 Analyze and describe structural fitting techniques

- actual dimensions
- symbols
- access holes
- code references
- stiffener details

- end plates
- hole punch guides
- elevation data
- erection clearance

1.4 Perform assigned practical fitting projects

- plan and prepare worksite
- structural steel projects
  - channel, angle or beam
- cope and fit
  - 45° cope
    - layout
    - cut
    - fit parts
    - tack parts
  - 90° cope
    - layout
    - cut
    - fit parts
    - tack parts
- pipe projects
  - use wrap-around tool
  - form lateral branch
  - T connection
  - layout
  - cut
  - fit parts
  - tack parts
- box construction project
  - layout parts
  - bend
  - fit box
  - tack parts
- elbows
  - layout
  - cut
  - fit parts
  - tack parts
- storage tank
  - layout
  - cut
  - fit parts
  - tack parts

Number:	S3232		
Title:	**Gas Tungsten Arc Welding (GTAW) Practical**		
Duration:	Total Hours: 21	Theory: 1	Practical: 20
Prerequisites:	Level 1		
Content:	S3232.1	Gas Tungsten Arc Welding (GTAW) Practical	
Evaluation and Testing:		Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.	

Number:	S3232.1		
Title:	**Gas Tungsten Arc Welding (GTAW) Practical**		
Duration:	Total Hours: 21	Theory: 1	Practical: 20

General Learning Outcomes

Upon successful completion the apprentice is able to perform welding procedures using Gas Tungsten Arc Welding (GTAW) process in accordance with government safety regulations, manufacturer's recommendations and accepted industry standards.

Learning Outcomes and Content

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

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

1.2 Set-up equipment for the Gas Tungsten Arc Welding (GTAW) process

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

- filler material
  - type (alloy)
  - size

1.3 Perform welds using the gas Tungsten Arc Welding (GTAW) process

- materials
  - mild steel
- fillet welds
  - T joints in 1F and 2F
  - lap joint in 1F and 2F
  - open corner joint in 1F
- groove welds
  - square butt in 1G
- visual examination of weld for discontinuities

Number:	S3233		
Title:	**Machine Operation**		
Duration:	Total Hours: 24	Theory: 6	Practical: 18
Prerequisites:	Level 1		
Content:	S3233.1	Machine Operation	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3233.1		
Title:	**Machine Operation**		
Duration:	Total Hours: 24	Theory: 6	Practical: 18

General Learning Outcomes

Upon successful completion the apprentice is able to use fabrication equipment for forming plate and structural shapes in accordance with government safety regulations, manufacturer's recommendations and accepted industry standards.

Learning Outcomes and Content

1.1 Describe operation and maintenance of common fabrication equipment

- plate shears
- iron worker
- drills
  - sensitive drill press
  - radial arm drill
  - mechanically clamped air drill
  - magnetic base drill
- portable punches
- band saws
- benders
- brake press
- maintenance
  - power supply
  - lubrication
  - clutch operation
  - levelling
  - actuation systems
  - cutting tool sharpening

1.2 Select and demonstrate the operation and functions of common fabrication machinery and their safety systems

- plate shears
  - capacity
  - rake angle
  - blade clearance
  - back gauge
  - safety devices
  - safe retrieval of drops and marking piece/part number

- roll bending machines
  - capacity
  - rolling radii limits
  - safety devices
- brake press
  - capacity
  - die sets/tooling
  - bending limits
- drill presses
  - safety devices
  - feeds and speeds
- band saws
  - capacity
  - cutting speeds and feeds
  - blade selection
  - safe retrieval of drops and marking piece/part number
- iron workers
  - capacities
  - punching
  - notching
  - cutting
  - back gauges
  - safe retrieval of drops and marking piece/part number
- safety systems
  - guards
  - safety curtains
  - palm buttons
  - emergency stops
  - manufacturer’s recommendations

Number:	S3234		
Title:	**Material and Process Quality II**		
Duration:	Total Hours: 24	Theory: 24	Practical: 0
Prerequisites:	Level 1		
Content:	S3234.1	Metallurgy	
	S3234.2	Distortion II	
	S3234.3	Inspection and Codes	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3234.1		
Title:	**Metallurgy**		
Duration:	Total Hours: 12	Theory: 12	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the characteristics of metals and their alloys, classifications and effects of welding heat in accordance with metallurgical principles to comply with manufacturer's recommendations and accepted industry standards.

Learning Outcomes and Content

1.1 Define metals and their properties

- metals
- properties of metals affecting weldability
  - alloys
  - tensile strength
  - impact strength
  - hardness
  - ductility
  - chemical properties
  - corrosion resistance

1.2 Describe the processes used to produce metals and alloys

- blast furnace
  - pig-iron
  - cast iron
- steel
  - continuous casting
- steel refining furnaces
  - basic oxygen furnace
  - electric arc furnace
- material forming methods
  - wrought
  - cast metals
- structural shapes
  - HSS
  - plate
  - hot rolled
  - cold rolled

1.3 Identify steel types and classification systems

- characteristics
  - low carbon steel
  - medium carbon steel
  - high carbon steel
  - stainless steel
- classification numbering systems of plain carbon steels
  - AISI
  - ASTM
  - CSA
- steel and metal identification methods
  - appearance
  - hardness test
  - magnetic test
  - chisel test
  - fracture test
  - flame test
  - spark test
  - weight test

1.4 Explain the purpose and effects of heat-treatment of steel

- annealing
- normalizing
- quenching
- hardening
- tempering
- stress relieving

1.5 Describe properties of metals and their effect on material selection, fabrication and welding considerations

- physical properties
  - mass
  - melting point
  - thermal conductivity
  - coefficient of expansion
  - electrical conductivity
- mechanical properties
  - tensile strength
  - yield strength
  - ductility
  - impact strength

1.6 Discuss the significance of metallurgical properties of common metals

- crystalline structures
- carbon steel microstructures
  - ferrite
  - pearlite
  - martensite
  - austenite
- stainless steels
  - austenitic
  - martensitic
  - ferritic
  - duplex
  - precipitation hardening

1.7 Identify factors influencing the formability and weldability of metals

- carbon and low alloy steels
  - High Strength, Low Alloy steels (HSLA)
  - factors influencing weld cracking susceptibility
  - carbon equivalent formulae
  - considerations for steel with limited weldability
  - filler metal selection
  - pre-heat
  - post-heating
  - temperature indicating crayons
  - electro/mechanical temperature indicators
  - post-weld heat treatment
- stainless steels
  - precipitation hardening
  - loss of corrosion resistance
- aluminum and aluminum alloys
- cast iron and non-ferrous metals
  - factors influencing weldability

Number:	S3234.2		
Title:	**Distortion**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to perform correction procedures for weld distortion in accordance with manufacturer's recommendations and accepted industry standards.

Learning Outcomes and Content

2.1 Define the fundamentals of distortion control

- selection of preventative method
- distortion allowances
- pre-heating
- pre-setting joints
- jigs and fixtures
- effects of joint configuration
- effects of travel speed
- effects of weld size
- effects of bead size
- effects of over welding
- multiple pass Vs. single pass

2.2 Select and perform methods of weld distortion correction

- application of localized heat
- mechanical straightening

Number:	S3234.3		
Title:	**Inspection and Codes**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to explain the function and application for destructive and non-destructive examination along with inspection methods and qualifications to codes and standards in accordance with government safety regulations, manufacturer's recommendations and accepted industry standards.

Learning Outcomes and Content

3.1 Explain the function and application of destructive test methods
- tensile testing
- impact testing
- bend testing

3.2 Explain the function and application of non-destructive examination methods
- visual inspection method
- penetrant testing
- magnetic particle testing
- radiography
- ultrasonic testing
- pressure testing

3.3 Explain the requirements for welding performance qualification testing
- format of tests
- welding of test assemblies
- witnessed by inspector
- visual inspection of test assemblies
- bend testing or radiography
- issuing of welder performance qualification document
- range of process variables qualified
- need for re-qualification
- duration of qualification
- reason for loss of qualification

3.4 Explain the requirements for welding procedure qualification testing

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

3.5 Identify final welding requirements

- need for access to welding procedures by production personnel
- purpose and content of welding procedure documents

3.6 Describe the requirements of welding codes and standards

- pressure welding applications to ASME Boiler and Pressure Vessel Code
- base and filler metal requirements to ASME Section II
- product design and manufacture requirements to ASME Section III and VIII
- welding procedure and performance qualification requirements to ASME Section IX
- structural welding applications to the CSA Structural Welding Standards
- filler metal requirements to CSA W47.1
- product design and manufacture requirements to CSA W59
- other codes and standards applicable to the project

Number:	S3235		
Title:	**Patterns and Templates Development I**		
Duration:	Total Hours: 33	Theory: 8	Practical: 25
Prerequisites:	Level 1		
Content:	S3235.1	Patterns and Templates I	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3235.1		
Title:	**Patterns and Templates I**		
Duration:	Total Hours: 33	Theory: 8	Practical: 25

General Learning Outcomes

Upon successful completion the apprentice is able to develop the ability to layout templates and patterns, through the interpretation of drawings, using common layout and measuring tools, applying shop formula and performing calculations to ensure the accuracy and functionality to meet the tolerances specified in the drawings and specifications of the manufactured item.

Learning Outcomes and Content

1.1 Identify the purpose and fundamentals of layout development
- classes of geometric forms
- manual layout development

1.2 Describe the methods of pattern development
- radial line
- parallel line
- triangulation
- mathematical

1.3 Develop patterns for rectangular tapered shapes employing triangulation method
- layout method for flat surfaces
- bend allowance
- flat, angled (sloping) surfaces
- hoppers, chutes, pyramidal shapes
- truncated pyramidal shape
- verify accuracy
- classification numbering systems of plain carbon steels

1.4 Develop patterns for conical shapes employing radial line development
- concentric cones
- scalene cones (offset cones)
- truncated cones
- verify accuracy

1.5 Develop patterns for cylindrical shapes employing parallel line development
- straight, round, rolled shells and tanks
- circular ducting
- circular elbows
- circular branches
- piping intersections
- verify accuracy

1.6 Select materials for templates including but not limited to:
- paper
- cardboard
- wood
- metal

1.7 Develop templates for checking flat and curved surfaces
- radius
- diameter
- angles
- parallel bar
- squaring methods
- verify accuracy

1.8 Use mathematical problem solving to support the development of patterns
- slopes
- offsets
- dimensions
- locations
- verify accuracy

Metal Fabricator Level 3

Reportable Subject Summary Level 3

#	Unit	Hours		
		Theory	Practical	Total
S3236: Patterns and Templates Development II				
S3236.1	Patterns and Templates Development II	8	40	48
Sub Totals		**8**	**40**	**48**
S3237: Fabrication II				
S3237.1	Fabrication II	10	101	111
Sub Totals		**10**	**101**	**111**
S3238: Project Planning				
S3238.1	Project Planning	15	0	15
Sub Totals		**15**	**0**	**15**
S3239: Preparation for Shipping				
S3239.1	Preparation for Shipping	6	0	6
Sub Totals		**6**	**0**	**6**
S3240: Installation				
S3240.1	Site Installation Planning	6	0	6
S3240.2	Lifting, Rigging and Working at Heights	14	10	24
Sub Totals		**20**	**10**	**30**
Level 3 Totals		**59**	**151**	**210**

Number:	S3236		
Title:	**Patterns and Templates Development II**		
Duration:	Total Hours: 48	Theory: 8	Practical: 40
Prerequisites:	Levels 1 & 2		
Content:	S3236.1	Patterns and Templates Development II	
Evaluation and Testing:		Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.	

Number:	S3236.1		
Title:	**Patterns and Templates Development II**		
Duration:	Total Hours: 48	Theory: 8	Practical: 40

General Learning Outcomes

Upon successful completion the apprentice is able to create and use patterns and templates in accordance with accepted industry standards.

Learning Outcomes and Content

1.1 Create patterns and templates employing triangulation method
- rectangle to round
- rectangle to elliptical
- hoppers and chutes
- mismatched shapes
- truncated shapes

1.2 Use mathematical problem solving techniques including but not limited to: trigonometry, ration and proportion and Pythagorean Theorem to support the development of patterns
- rectangular to round
- tapered rectangular shapes
- tapered conical shapes

1.3 Utilize a computer to create surface development patterns
- computer literacy
- access software
- input data
- plot pattern
- apply pattern to metal

Number:	S3237		
Title:	**Fabrication II**		
Duration:	Total Hours: 111	Theory: 10	Practical: 101
Prerequisites:	Levels 1 & 2		
Content:	S3237.1	Fabrication II	
Evaluation and Testing:	Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3237.1		
Title:	**Fabrication II**		
Duration:	Total Hours: 111	Theory: 10	Practical: 101

General Learning Outcomes

Upon successful completion the apprentice is able to prepare fabrication and detail materials by utilizing machinery and equipment in accordance with government safety regulations, manufacturer's recommendations and accepted industry standards.

Learning Outcomes and Content

1.1 Demonstrate safe operation of fabrication machinery
- rolls
- ironworkers
- shears
- benders
- brake press
- drilling machines

1.2 Operate thermal cutting processes to generate shapes
- free-hand shape cutting
- machine profile cutting

1.3 Assemble components and sub-assemblies
- sequence of assembly
- alignment
- seam alignment tools
- jigs and fixtures
- tack welds
- fasteners
- bracing
- torque values
- pre-weld dimensional check

1.4 Develop jigs and fixtures

- critical dimensions
- datum locations
- material selection
- clamping
- part removal
- accessibility

1.5 Demonstrate complex assembly techniques

- evaluate prepared joint data
- proper seam alignment on vessels
- tack location and process
- temporary restraint
- pipe diameter alignment
- backing rings
- oblique pipe intersections
- structural intersections/hollow structural steel intersections
- tightening sequence/bolting
- alignment of multi-segment cones
- dimensional and geometric control of framed structural platform
- manufacturer’s tolerance structural shapes
- economic and safe sequencing
- pre-welding requirements
- accessibility of weld joints
- ongoing third party checks
- accommodation of part variation while maintaining overall dimensions
- correction of alignment and dimensions using heat or mechanical means
- trial assembly of completed sub-components using match marking

Number:	S3238		
Title:	**Project Planning**		
Duration:	Total Hours: 15	Theory: 15	Practical: 0
Prerequisites:	Levels 1 & 2		
Content:	S3238.1	Project Planning	
Evaluation and Testing:	Mark distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.		

Number:	S3238.1		
Title:	**Project Planning**		
Duration:	Total Hours: 15	Theory: 15	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to demonstrate a working knowledge of planning for project completion in accordance with accepted industry standards.

Learning Outcomes and Content

1.1 Analyze shop drawings and specifications
- dimensions
- estimation of time, materials and equipment
- fabrication sequence
- communication with supervision
- parts to be pre and/or post-machined
- identification of parts supplied by others

1.2 Determine workspace requirements
- sufficient and accessible space available
- safe working area
- equipment allocation and set-up
- material handling capacity and availability
- work process flow

1.3 Identify labour availability
- competency
- qualification

1.4 Identify specified welding process (es)
- power availability
- consumables requirement and availability

1.5 Establish sequence of assembly
- sub-assembly
- final assembly
- stability of components
- supports
- shipping orientation

1.6 Apply quality control
- follow applicable procedures
- route sheets
- inspection
- corrective action

1.7 Estimate project progress
- degree of completion
- expected date of completion

Number:	S3239		
Title:	**Preparation for Shipping**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Prerequisites:	Levels 1 & 2		
Content:	S3239.1	Preparation for Shipping	
Evaluation and Testing:		Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.	

Number:	S3239.1		
Title:	**Preparation for Shipping**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to explain appropriate actions required for the preparation and shipping of final products in accordance with government safety regulations and accepted industry standards.

Learning Outcomes and Content

1.1 Prepare surfaces
- shot/sand blasting
- finish grinding
- machining

1.2 Protect machined surfaces
- mechanical coverage
- applied coatings

1.3 Apply coatings to assembly
- component dipping
- painting

1.4 Identify for shipping or storage
- drawings
- bill of material
- identification stamping/marking/tagging

1.5 Calculate component weight for rigging methods
- size
- shape
- configuration

1.6 Protect surfaces for shipping or storage
- blocking
- softeners
- spacers
- wrapping

1.7 Install shipping components
- temporary braces
- temporary lifting devices

1.8 Verify shipping documentation
- bill of lading
- export documentation

1.9 Describe final shipping preparations
- site installation plan
- sequence of delivery of multiple lots
- legal considerations

Number:	S3240		
Title:	**Installation**		
Duration:	Total Hours: 30	Theory: 20	Practical: 10
Prerequisites:	Levels 1 & 2		
Content:	S3240.1	Site Installation Planning	
	S3240.2	Lifting, Rigging and Working at Heights	
Evaluation and Testing:		Grade distribution proportionate to theory and practical hours. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.	

Number:	S3240.1		
Title:	**Site Installation Planning**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to explain the process of site installation in accordance with government safety regulations and accepted industry standards.

Learning Outcomes and Content

1.1 Review erection drawings and critical plan path
- cross reference plans, sections and elevations
- mark numbers
- site plan
- list sequence of erection
- consumables
- equipment

1.2 Locate site installation area
- locate laydown area
- field dimensions
- work site layout
- accessibility

1.3 Evaluate possible workplace hazards
- electrical
- water
- housekeeping
- fire

1.4 Effectively assign and direct the work of others
- supervision of work crew
- distribute assignments
- communication with others
- coordinate with others

1.5 Evaluate project progress
- estimating work progress
- expediting work progress in compliance with critical path

1.6 Define the process of quality control
- company procedure
- sign off sheets
- visual inspection

Number:	S3240.2		
Title:	**Lifting, Rigging and Working at Heights**		
Duration:	Total Hours: 24	Theory: 14	Practical: 10

General Learning Outcomes

Upon successful completion the apprentice is able to select and safely operate lifting and rigging equipment utilizing Working at Heights (WAH) procedures in accordance with government safety regulations, manufacturer's recommendations and specifications and accepted industry standards.

Learning Outcomes and Content

2.1 Select appropriate lifting devices

- overhead crane
- jib crane
- chain block hoists

2.2 Inspect and maintain lifting and rigging equipment to manufacturer's procedures

- chains
- wire rope (cables, slings, chokers)
- tuggers
- cable clamps
- connectors
- ropes
- clevices
- plate clamps
- grab hooks
- spreader bars
- portable booms
- come alongs
- nylon web slings
- hoists

2.3 Identify Working Load Limits (WLL) for lifting and hoisting equipment
- calculate weight load
- total weight
- centre of gravity
- overall size of load
- balance of load
- identify the WLL
- ensure the WLL is equal or greater than the project load
- determine safety requirements for lifting and hoisting equipment

2.4 Perform appropriate signalling methods for lifting and hoisting to CSA safety standards
- hand signals
- voice signals

2.5 Operate appropriate lifting and hoisting equipment to Ontario and CSA safety regulations
- overhead crane
- jib crane

2.6 Identify good housekeeping and lifting equipment storage requirements
- ropes
- slings
- chains
- cleaning and lubricating
- storing

2.7 Prevent damage while lifting
- sharp corner protection
- machined surfaces
- painted surfaces
- crated products
- soft materials

2.8 Select and inspect appropriate scaffolding components to all relevant safety standards
- appropriate for the task
- correct size
- connectors in good repair

2.9 Demonstrate appropriate scaffolding set-up technique in accordance with all safety legislation

- firm footing
- proper support for levelling
- sufficient height
- proper decking (walking surface area)

2.10 Comply with Working at Heights Legislation

- hazards and control
- ladders
- scaffolds
- work platforms
- powered elevated work platforms
- guardrails
- restraint systems

APPENDIX C: Tools and Equipment List

Mandatory Equipment List for Training Delivery Agents

Power Sources and Equipment	Quantity
SMAW (CC) (AC/DC) power source and equipment	1 per apprentice
GMAW/FCAW/MCAW (CV) power source and equipment (capable of spray-transfer)	1 per apprentice
GMAW-PULSED power source and equipment	1 per 5 apprentices
Pulsed power source and equipment	1 per 5 apprentices
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

Basic Hand Tools and Equipment (1 per Apprentice)

Adjustable wrenches (various sizes)	Pliers (needle, nose, slip joint)
Allen wrenches (metric and imperial)	Positioners
Bench 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)
Grinding and sanding disks (for carbon, aluminum and stainless steel)	Temperature indicating crayons
Hacksaw	Tip cleaners
Hammers (chipping, ball, peen, claw, sledge, various sizes)	Toolboxes
Hand shears	Tungsten sharpening grinders
Layout table	Vice grips (various sizes and types)
Magnets	Wire brushes (for carbon, aluminum and stainless steel)
Metal markers	Wire cutters
Pipe clamps	Work bench
Pipe cutter	Wrench sets (open and close ends, metric and imperial)
Pipe wrenches	

Measuring Tools (1 per apprentice)	
Drafting equipment	Combination square
Fillet gauges	Spirit level
Vernier caliper	Square
Micrometer	Straight edge
Scriber	Tape measure

Power Tools And Equipment (1 per 5 apprentices)	
Electric drills (9mm-3/8” to 12.5mm-1/2”) chuck size	Wire wheel (angle grinder with wire brush)
Grinders, electric and/or pneumatic (wire brush, angle grinders)	Sanders

Hoisting And Lifting Equipment (1 per shop)	
Rope	Come-along (cable or chain)
Slings	Forklift
Chains	Overhead hoist or crane

Safety Equipment (1 per apprentice)	
Earplugs and muffs	Leather gloves (provided by apprentice)
Face shields	Leather jackets (provided by apprentice)
Fire blankets	Masks (particle, vapor)
Fire extinguishers	Respirators
Goggles	Safety glasses
Leather aprons	

Fabrication Machines (1 each per shop)	
Plate shear	Pedestal grinders
Brake press	Cut-off abrasive wheel saw
Roll bending machine	Weld-bevel preparation equipment for plate and pipe
Band saw	Weld-coupon bending apparatus
Nibbler	Approved smoke extraction/air make-up unit
Ironworker	

Optional Equipment List for Training Delivery Agents

Power Sources and Equipment	Quantity
Plasma Arc Welding power source and equipment	1 per shop
Sub Arc Welding power source and equipment	1 per shop
Stud Welding power source and equipment	1 per shop

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

Resource Materials

Codebooks

Engineering specifications

Manufacturer’s specifications, manuals and charts

Safety manuals

Reference Material

ILM Alberta Learning Modules

Modern Welding Technology Text

Blueprint Reading for Welders, A.E. Bennett

Practical Problems in Mathematics for Welders, Frank R. Schell & Bill J. Matlock

Welding Handbook, American Welding Society

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