Skilled Trades Ontario | Métiers spécialisés Ontario

Apprenticeship Curriculum Standard

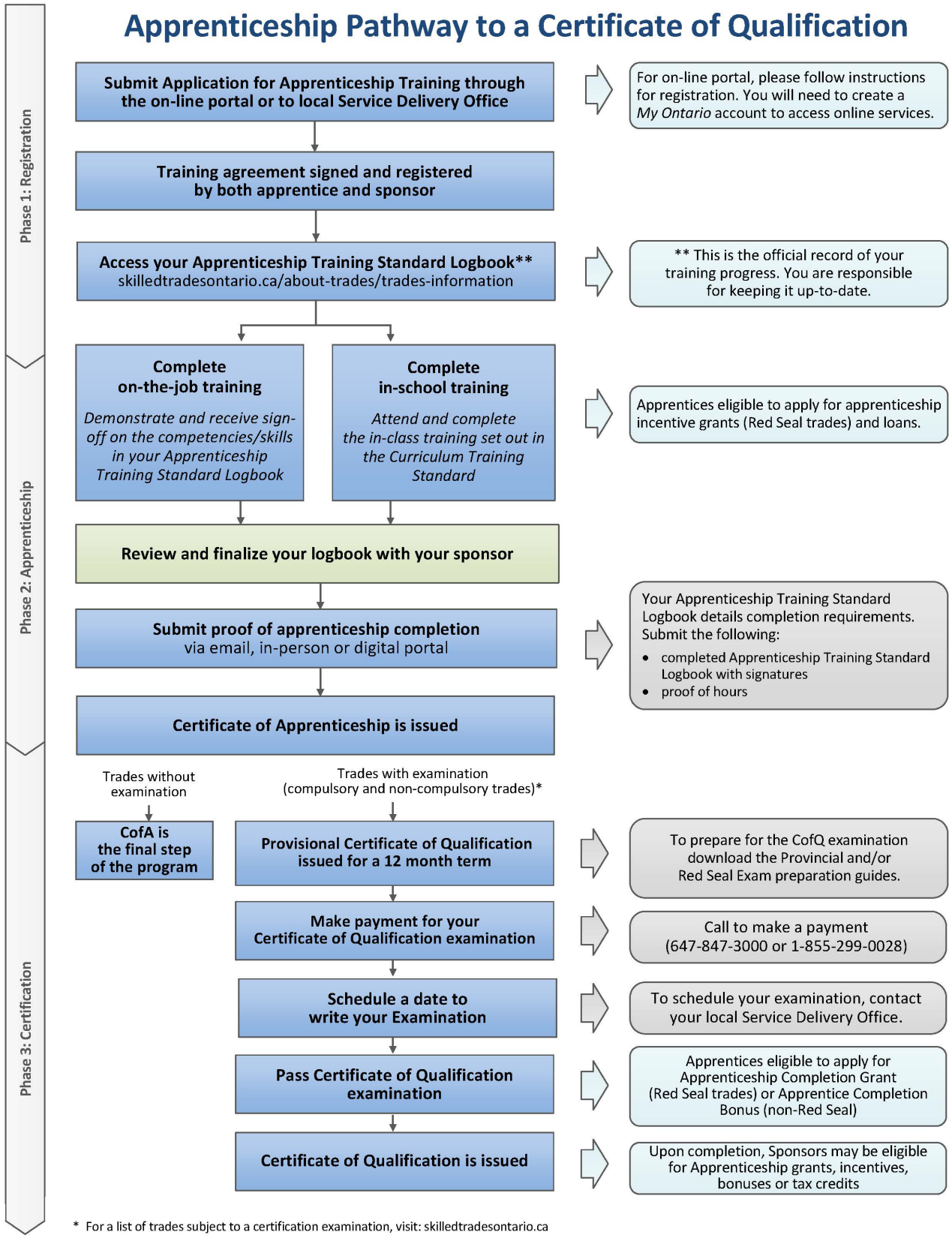
Construction Boilermaker

Level 2

428A

2008

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 2008 (V100)

Preface

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

This is the second level of 3 levels of training. The Reportable Subjects Summary chart (located on page 3) summarizes the training hours for each reportable subject.

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

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

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

Please refer to Skilled Trades Ontario website (www.skilledtradesontario.ca) for the most accurate and up-to-date information about Skilled Trades Ontario. For information on *Building Opportunities in the Skilled Trades Act, 2021 (BOSTA)*) and its regulations, please visit Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 (ontario.ca)

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 page 35 and page 36 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.

Level 2

Reportable Subject Summary – Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
S0488	Plant Systems and Ancillary Components II	57	43	14
S0489	Rigging and Hoisting II	33	23	10
S0490	Prints and Layouts II	75	54	21
S0491	Applied Trade Calculations II	15	15	0
S0492	Welding and Cutting II	60	16	44
	Total	**240**	**151**	**89**

Number:	S0488		
Title:	**Plant Systems and Ancillary Components II**		
Duration:	Total Hours: 57	Theory: 43	Practical: 14
Prerequisites:	Level I		
Content:	S0488.1	Advanced Access Structures	
	S0488.2	Introduction to Other Heavy Industry	
	S0488.3	Tanks	
	S0488.4	Quality Control Systems	
	S0488.5	Set - Up Job Site	
	S0488.6	Maintain Plant Systems, Remove and Demolish Plant Components and Equipment	

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

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
Ashton, Bruce J., Garby, Ronald G., IPT's Metal Trades Handbook, IPT Publishing and Training Ltd. 1993.

Recommended Minimum Equipment:
- Overhead, VCR, DVD, Television, Chalkboard
- Scaffold assembly and access to mechanical lift

Number:	S0488.1		
Title:	**Advanced Access Structures**		
Duration:	Total Hours: 8	Theory: 4	Practical: 4
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6001.01, 6001.02, 6001.03, 6001.04			

General Learning Outcome

Upon successful completion the apprentice is able to select use and set-up scaffolding and work platform structures according to government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

Learning Outcomes and Content

1.1 Describe the set-up of scaffolds and needle beams and erect selected types of structures.

- Plank inspection
- plank placing and securing ladder
- Swing stage scaffolding
- Suspended scaffolding
- Needle beams
- Safeway scaffolds
- Tube and clamp scaffolds
- Knee brace and clip scaffold

1.2 Describe the set up and operation of a mechanical man lift.

1.3 Set up and dismantle a scaffold assembly.

1.4 Operate a mechanical lift.

Number:	S0488.2		
Title:	**Introduction to Other Heavy Industry**		
Duration:	Total Hours: 8	Theory: 8	Practical: 0
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6010.01, 6010.02			

General Learning Outcome

Upon successful completion the apprentice is able to describe trade practices and procedures for heavy industrial installations according to according to government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

Learning Outcomes and Content

2.1 Identify practices used in the erection of penstocks and surge tanks.

2.2 Identify the function of components needed for the erection of penstocks and surge tanks.

- Footings
- Tie bars
- Spiders
- Tie straps

2.3 Identify special procedures used when working on nuclear plants and components.

- Problems specific to nuclear plants
- Material which cannot be used and special materials
- Difference in metals
- Procedures for quality control
- Radiation hazards and procedures for radiation
- Weldment and expansion requirements

2.4 Identify the boilermaker's role in the following industries:

- Oil Refineries
  - trade practices and procedures
  - safety concerns
  - equipment that is maintained and repaired (e.g., Cat Cracker, heaters, boilers, stacks, towers)

- Hydro Generating Stations
  - trade practices and procedures
  - safety concerns
  - equipment that is maintained and repaired
- Pulp and Paper Industries
  - trade practices and procedures
  - safety concerns
  - equipment that is maintained and repaired e.g., digester, boilers, surge tanks
- Hydrogen Generating Stations
  - e.g., precipitators, ash hoppers, boilers

2.5 Describe the functions of Pollution Control Devices.

- Ash hoppers
- Wet/ Dry scrubbers
- Bag houses
- Cyclone dust removers
- Stacks

Number:	S0488.3		
Title:	**Tanks**		
Duration:	Total Hours: 30	Theory: 20	Practical: 10
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6007.01, 6007.02, 6007.03, 6007.04, 6007.05			

General Learning Outcome

Upon successful completion the apprentice is able to describe the function, construction features, types, and application and perform layout and fit up erection procedures of Tanks according to government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

Learning Outcomes and Content

3.1 Identify and describe types of materials used for tanks.

- Carbon steel
- Alloy steel
- Nonferrous metals
- Gauges and plates
- Mesh and screen

3.2 Determine the tank steel plate standard used for shells and decks.

- Reference A.P.I. specification

3.3 Distinguish between the scope of A.P.I. 650 and A.P.I. 620 standard.

3.4 Prepare materials for welding.

- Prepare spacing
- Alignment

3.5 Identify the type of welding and joint preparation for a tank bottom, shell and deck.

3.6 Determine type of welding required for tanks.

- Roof to the top angle
- Bottom to shell
- Shell to the top angle

3.7 Describe the differences between vertical and horizontal (cylindrical) tanks.

- Closed top or open (vented)
- Spheres

3.8 Identify typical tank settings.

- Horizontal
- Vertical

3.9 State the difference between the penstock and scroll or spiral casing.

3.10 Describe the environmental and economical advantages of closed top tank design.

3.11 Describe types of roofs used in tanks and explain terms associated with floating roofs.

- Cone
- Hemispherical
- Floating
- Explain terms
  - hard top floater
  - pontoon floater
  - double-deck floater

3.12 Describe types of floors and describe basic steps in laying out flat tank floor.

- Flat (butt or lap)

3.13 Describe the procedures involving minimum flat lap welding and flushing lapped plates.

3.14 Describe the application and construction features of tanks.

- Strong backs
- Knee braces
- Key plates
- Clamps
- Dogs and wedges
- Shims and wedges

3.15 Describe tank erection procedures of selected components.

- Site preparation and procedures for floor
- First shell ring and succeeding rings
- Top angle
- Roof supports and roof
- Ladders, Stairways and platforms
- Shell fittings
- describe testing and repair procedures (if required)

3.16 State the condition of tank foundation and list negative effects encountered during an erection due to uneven surfaces.

3.17 Describe how to test tank bottom, shell and roof.

- use one or two of the approved methods of testing

3.18 Differentiate inspection requirement for large and small tanks.

- Specify by the API 620 and the API 650.

3.19 Perform the fit up and alignment of tank horizontal and vertical seams.

- State the rule for vertical and horizontal seam openings.

3.20 Perform fit up procedures for:

- Key plates
- Leaf springs
- Finger bars and pins
- Wedges and dogs
- Clamps and nuts

3.21 Perform Layout and Fit Up procedures for:

- Key plate lugs on the shell plate sections.
  - layout key plate lugs prior to being set up in position
- Erect typical tank scaffolding
- Typical flat bottom lap joint
- First shell ring and erect and space the succeeding rings
- The top angle
- A conical self supported roof
- Shell, roof and bottom openings
  - gaskets for a given manway
  - cleanout
  - water or fluid drawoff elbow
  - drawoff sump
  - inlet outlet
  - overflow venting
  - walkway, stairway and ladders

Number:	S0488.4		
Title:	**Quality Control Systems**		
Duration:	Total Hours: 4	Theory: 4	Practical: 0
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6006.11, 6006.12, 6006.13, 6007.05 6008.07			

General Learning Outcome

Upon successful completion the apprentice is able to describe Quality Control Systems according to job requirements, government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

Learning Outcomes and Content

4.1 Define the features of a Quality Control System.

- Inspection check list
- Clean up process
- Testing

Number:	S0488.5		
Title:	**Set Up Job Site**		
Duration:	Total Hours: 2	Theory: 2	Practical: 0
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6004.01, 6004.02, 6004.03			

General Learning Outcome

Upon successful completion the apprentice is able to describe how to set up job sites according to government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

Learning Outcomes and Content

5.1 Describe job site set up procedures.

- Site clean up and organization
- Scaffolding and Work platform set up
- Material storage

Number:	S0488.6		
Title:	**Maintain Plant Systems and Remove and Demolish Plant Components and Equipment**		
Duration:	Total Hours: 5	Theory: 5	Practical: 0
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6011.01, 6011.02, 6012.01, 6012.02, 6012.03, 6012.04			

General Learning Outcome

Upon successful completion the apprentice is able to describe how to maintain plant systems and remove and demolish plant components and equipment according to job requirements, manufacturer's recommendations and specifications and approved industry standards.

Learning Outcomes and Content

6.1 Describe plant system maintenance procedures.

6.2 Describe plant component and equipment removal procedures.

6.3 Describe plant component and equipment demolition procedures.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
55%	15%	30%

Number:	S0489		
Title:	**Rigging and Hoisting II**		
Duration:	Total Hours: 33	Theory: 23	Practical: 10
Prerequisites:	Level I		
Content:	S0489.1	Wire Rope Drums	
	S0489.2	Basic Block and Tackle	
	S0489.3	Cranes	
	S0489.4	Hoisting and Jacking Equipment	

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

Instructional and Delivery Strategies:
Lecture and assignment work

Recommended Minimum Equipment:
- Tuggers, wire rope

Number:	S0489.1		
Title:	**Wire Ropes and Drums**		
Duration:	Total Hours: 4	Theory: 3	Practical: 1
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6009.01, 6009.02, 6009.03, 6009.04			

General Learning Outcome

Upon successful completion the apprentice is able to describe the construction and design features of wire rope drums and spooling procedures according to manufacturer's recommendations and specifications.

Learning Outcomes and Content

1.1 Describe fleet angles for grooved and smooth drums.

1.2 Determine required wire rope drum capacity.

1.3 Describe procedures for spooling.

1.4 Perform spooling procedures.

Number:	S0489.2		
Title:	**Basic Block and Tackle**		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6009.01, 6009.02, 6009.03, 6009.04			

General Learning Outcome

Upon successful completion the apprentice is able to describe block and tackle systems used for reeving and perform square reeving procedures according to government safety regulations and manufacturer's recommendations and specifications.

Learning Outcomes and Content

2.1 Name three types of sheaves, friction bearings, and the co-efficient of friction.

- express co-efficient of friction in percent

2.2 Identify factors that determine the amount of wire rope needed for reeving systems.

2.3 Describe safe work practices of block and tackle involving reeving techniques for:

- Square
- Skip
- Tandem
- Equalizer sheaves
- Lacing

2.4 Determine lead line force/pull.

- When the number of parts and load weight including rope size are known.

2.5 Set up and perform square reeving on:

- Two parts
- Three parts
- Five parts

Number:	S0489.3		
Title:	**Cranes**		
Duration:	Total Hours: 15	Theory: 12	Practical: 3
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6009.01, 6009.02, 6009.03, 6009.04			

General Learning Outcome

Upon successful completion the apprentice is able to describe the types and operation of cranes according to job requirements, government safety regulations, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

3.1 Describe types of cranes and booms.

- Rubber mount
- Crawler
- Ultra high capacity
- Hydraulic and Conventional

3.2 Describe the operating procedures of cranes.

- Describe general uses, components, safety precautions
- Use charts

3.3 Demonstrate signals.

3.4 Determine the basic procedures for crane boom installation and removal.

3.5 List the basic conditions for counterweight installation and removal.

3.6 Determine positioning of all pins at boom assembly.

3.7 Describe the reason for and load reduction when jib is fitted on the boom.

3.8 Determine in degrees the jib offset allowance in reference to the centerline.

3.9 List three negative implications when crane is only 3 degrees out of level.

Number:	S0489.4		
Title:	**Hoisting and Jacking Equipment**		
Duration:	Total Hours: 8	Theory: 4	Practical: 4
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6009.01, 6009.02, 6009.03, 6009.04			

General Learning Outcome

Upon successful completion the apprentice is able to perform rigging, hoisting and jacking operations using recommended equipment according to government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

Learning Outcomes and Content

4.1 Describe the use of chain falls, tirfors and come alongs.

4.2 Calculate stress and explain the uses and safety hazards of high lines.

4.3 Explain the use and anchorage of air tuggers in a power house or block location, and the use of signals.

4.4 Perform rigging, hoisting and jacking operations.

- Perform operations safely in accordance with the Health and Safety Act and other applicable regulations.

4.5 Rig loads safely for straight lifts, drifting & turning.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
55%	15%	30%

Number:	S0490		
Title:	**Prints and Layout II**		
Duration:	Total Hours: 75	Theory: 54	Practical: 21
Prerequisites:	Level I		
Content:	S0490.1	Drawing Interpretations	
	S0490.2	Basic Computer Aided Design (CAD)	
	S0490.3	Layout and Fabricating	

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

Recommended Minimum Equipment:
- Computer lab, CAD software.
- layout tools

Number:	S0490.1		
Title:	**Drawing Interpretation**		
Duration:	Total Hours: 24	Theory: 24	Practical: 0
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6003.01, 6003.02			

General Learning Outcome

Upon successful completion the apprentice is able to identify information on fabrication and erection drawings according to manufacturer's recommendations and specifications.

Learning Outcomes and Content

1.1 Use drawing interpretation skills in a drawing of:

- Fabricate vessels
- Tanks
- Boilers and related structures.

1.2 Use drawing interpretation skills in a drawing, erect vessels, tanks, boilers and related structures.

1.3 Identify information on structural steel erection drawings.

Number:	S0490.2		
Title:	**Basic Computer Aided Design**		
Duration:	Total Hours: 15	Theory: 15	Practical: 0
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6000.02, 6003.01, 6003.02			

General Learning Outcome

Upon successful completion the apprentice is able to identify and use Computer Aided Drawing programs including AutoCAD and/or Auto Sketch and/or Quick Pen according to manufacturer's recommendations and specifications.

Learning Outcomes and Content

2.1 Identify and describe CAD programs

- Describe AutoCAD and/or Auto Sketch, and/or Quick Pen.

2.2 Draw simple objects to scale in orthographic projection fully dimensioned, using AutoCAD.

2.3 Produce an isometric drawing of a simple object, using AutoCAD.

- Given the corresponding three views

Number:	S0490.3		
Title:	**Layout and Fabricating**		
Duration:	Total Hours: 36	Theory: 15	Practical: 21
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6000.04, 6003.01, 6003.02, 6003.04, 6003.05			

General Learning Outcome

Upon successful completion the apprentice is able to perform layout and fabricating skills according to government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

Learning Outcomes and Content

3.1 Read a drawing and describe the component(s) used in the development and fabrication process.

3.2 List and describe the types, uses and care of plate layout tools.

3.3 Identify layout angles to meet the requirements of fabrication from the drawing.

3.4 Develop a pattern for a rectangular piece of ducting cut at an angle using the parallel line development method.

3.5 Develop a pattern for a two piece 90 degree elbow using the parallel line development method.

3.6 List and describe the abbreviations applicable to plate layout and development.

3.7 Calculate problems on squares, rectangles and circles for transfer to the plate for development and fabrication.

3.8 Read a drawing; determine the materials required and layout the pattern on the plate.

3.9 Describe the operation of a press brake and plate rolls to form the plate.

3.10 Set-up oxygen/acetylene equipment and cut bevels and pierce holes on different thicknesses of plate.

3.11 Set-up plasma-arc equipment and cut mild and stainless steel plate.

3.12 Layout and fabricate:

- Ladders and platforms
- A davit for vertical and horizontal opening
- A header
- Pipe turns and offsets
- Square ducts
- Cylinders and cones
- Pressure vessel shells

3.13 Perform radial nozzle installation.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
50%	20%	30%

Number:	S0491		
Title:	**Applied Trade Calculations II**		
Duration:	Total Hours: 15	Theory: 15	Practical: 0
Prerequisites:	Level I		
Content:	S0491.1 Mathematics for Layout and Fitting		

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

Instructional and Delivery Strategies:
Lecture and assignment work for layout and fitting calculations.

Recommended Minimum Equipment:
- Calculator
- Samples of typical layouts

Number:	S0491.1		
Title:	**Mathematics for Layout and Fitting**		
Duration:	Total Hours: 15	Theory: 15	Practical: 0
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6003.01, 6003.02, 6007.01, 6007.05			

General Learning Outcome

Upon successful completion the apprentice is able to apply mathematics required to perform layout and fitting according to manufacturer's recommendations and specifications and approved industry standards.

Learning Outcomes and Content

1.1 Compute squares and square roots of numbers.

1.2 Applying square root calculations solve right angle triangle problems using Pythagorean Theorem.

1.3 Compute areas of flat planes:

- Rectangles
- Squares
- Parallelograms
- Triangles
- Circles
- Sectors

1.4 Compute areas of selected shapes.

- Surface areas of regular shaped solids
- Tanks and cylinders
- Pyramids and cones
- Prisms and cylinders
- Radii,
- Arc length
- Circumferences
- Central angles and diameters of circles

1.5 Calculate altitudes and bases of common polygons

1.6 Calculate areas of circular sectors and segments

- Common polygons
- Given bases and altitudes
- More complex figures consisting of two or more common polygons

1.7 Using basic formulas and constants compute volumes of:

- Prisms and cylinders
- Pyramids and cones
- Spheres

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
55%	15%	30%

Number:	S0492		
Title:	**Welding and Cutting II**		
Duration:	Total Hours: 60	Theory: 16	Practical: 44
Prerequisites:	Level I		
Content:	S0492.1	Cutting and Welding Procedures	
	S0492.2	Metallurgy and the Welding Process	

Evaluation Structure:
Assignments related to theory and appropriate application skills.
Minimum of one mid-term test during an 8 week term.
Final exam at end of term.
Periodic quizzes.

Reference Materials:
Use of material samples and manufacturer's specifications (CD's, manuals, and internet)

Number:	S0492.1		
Title:	**Cutting and Welding Procedures**		
Duration:	Total Hours: 52	Theory: 10	Practical: 42
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6005.02, 6005.03, 6006.01, 6006.02, 6006.03, 6006.04, 6006.05, 6006.10, 6006.11, 6006.12, 6006.13, 6006.14			

General Learning Outcome

Upon successful completion the apprentice e is able to select materials used in the trade.

Perform cutting and welding procedures using cutting and heating processes and Shielded Metal Arc Welding equipment according to ASME code government safety requirements, manufacturer's recommendations and approved industry standards.

Learning Outcomes and Content

1.1 Describe cutting processes involved in cutting alloy steels and non-ferrous metals (plasma-arc).

1.2 Perform flame cutting.

- Radial cuts.
- Flame cutting skills on pressure vessel heads
- Pressure vessel shells
- Structural shapes

1.3 Determine if metal conditions require special cleaning methods.

1.4 Explain the manufacturing specification control

1.5 List the functions of coating and slag and explain effects of alloy additions to the coating.

1.6 Explain static and dynamic loading.

1.7 Explain the proper storage of low hydrogen electrodes.

1.8 Weld stringer beads.

- Weld on mild steel, in the horizontal and vertical position, using E6010 or E6011 and E7018 filler material, with 1/8, and 5/32 rod.

1.9 Weld lap joints.

- Weld on mild steel, in the horizontal and vertical position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.10 Weld butt joints.

- Weld on mild steel, in the horizontal and vertical position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.11 Weld tee joints.

- Weld on mild steel, in the horizontal and vertical position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.12 Weld a corner joint

- Weld on mild steel, in the horizontal and vertical position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.13 Perform a fillet weld to install a metal pad.

- Deposit weld metal pad on mild steel, in the horizontal and vertical position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.14 Perform a fillet weld using a weaving pattern by applying crescent, figure 8, and rotary motion.

- Create weaving pattern on mild steel, in the vertical position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.15 Perform a single pass fillet weld.

- Weld on mild steel, in the horizontal and vertical position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.16 Perform a multiple pass fillet weld.

- Weld on mild steel, in the horizontal and vertical position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.17 Perform a single pass corner joint weld.

- Weld on mild steel, in the horizontal position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.18 Perform a multiple pass corner joint weld.

- Weld on mild steel, in the horizontal and vertical position, using E6010 and E7018 filler material, with 1/8, and 5/32 rod.

1.19 Demonstrate acceptable safe welding procedures.

- Prevent distortion and produce a sound weld without visible defects, for all joints.

Number:	S0492.2		
Title:	**Metallurgy and the Welding Process**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Prerequisites:	Level I		
Cross-Reference to Training Standard: 6006.04, 6006.11, 6006.12, 6006.13, 6006.14			

General Learning Outcome

Upon successful completion the apprentice is able to describe concepts in metallurgy, including physical and mechanical properties and control of expansion and contraction according to sound scientific and physics principles.

Learning Outcomes and Content

On successful completion, the apprentice is able to:

2.1 List the mechanical and physical properties of metal.

2.2 Identify metals by spark testing using a grinder.

- White cast iron
- Grey cast iron
- Low carbon steel
- High carbon steel
- Chromium-nickel steel (stainless)
- High manganese steel

2.3 Determine the hardness of metal.

- Use a file and the Brinnell scale to determine hardness.

2.4 Determine the weldability of plain carbon steel:

- Apply spark test
- Hardness test

2.5 Describe how welding processes (heating) influence steel structures.

2.6 Describe how heat from welding causes residual stresses and structural stresses.

2.7 Describe methods of preventing or reducing distortion.

2.8 Describe methods of controlling distortion.

- Apply specified welding procedures and preheat.

2.9 Describe methods of correcting distortion.

- Peening
- Grooving and re-welding
- Straightening
- Clamping and stress relieving
- Welding on opposite side
- Local heating

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
20%	50%	30%

APPENDIX A: Tools and Equipment List

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

Fabrication Machines **(1 each per shop)**

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

Basic Hand Tools and Equipment **Tool Crib to Cover Class Size**

- Adjustable wrenches (various sizes)
- Allen wrenches (metric and imperial)
- Bench 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, claw, sledge, various sizes)
- Hand shears
- Layout table
- Magnets
- Metal markers
- Pipe clamps
- Pipe cutter
- Pipe wrenches
- 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	Tool Crib to Cover Class Size
Drafting equipment	Square
Combination square	Straight edge
Fillet gauges	Scriber
Spirit level	Micrometer
Vernier caliper	Tape measure

Safety Equipment	Tool Crib to Cover Class Size
Earplugs and muffs	Leather gloves
Face shields	Leather jackets
Fire blankets	Masks (particle, vapour)
Fire extinguishers	Respirators
Goggles	Safety glasses
Leather aprons	

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Boilermaker