



**Skilled
Trades**
Ontario

**Métiers
spécialisés**
Ontario

Apprenticeship
Curriculum Standard

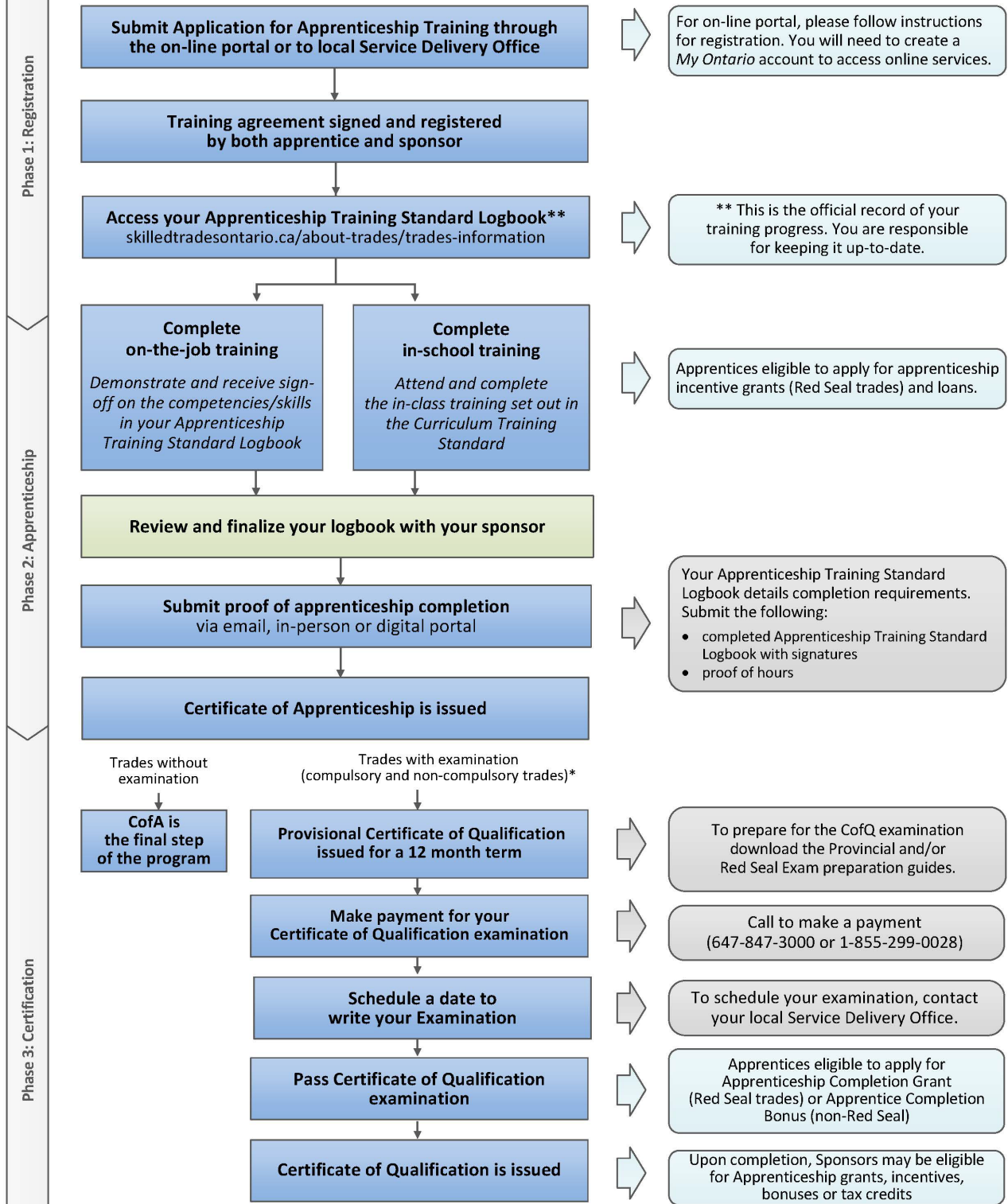
Steamfitter

Level 2

307A

2009

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 \(BOSTA\)**](#).

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Maintained with transfer to Skilled Trades Ontario 2009 (V100)

Preface

This curriculum standard for the Steamfitter 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 chart (located on page 9) summarizes the training hours for each reportable subject.

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

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

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

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

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.

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

Please note that all practices described in this standard must be performed according to the appropriate Trade and industry best practice.

Level 2

Reportable Subject Summary-Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1	Pipe Fabrication II	48	3	45
2	Steamfitting Systems II	120	95	25
3	Applied Trade Calculations II	24	12	12
4	Trade Documentation II	24	11	13
5	Welding II	24	3	21
	Total	240	124	116

Number:	S0927		
Title:	Pipe Fabrication II		
Duration:	Total Hours: 48	Theory: 3	Practical: 45
Prerequisites:	Level 1		
Contents:	S0927.1	Fabrication Layout	
	S0927.2	Tube and Pipe Bending	
	S0927.3	Steam Boiler Project	

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

Instructional and Delivery Strategies: Delivery of theory and practical will be closely aligned. Use of templates from the Trade Documentation II reportable subject to build shop projects will test the theory of template development. The use shop project pipe fittings in the Welding II reportable subject classes will reinforce the need for well fitted welding joints. The building of boiler and piping systems will reinforce theory learned in the Steamfitting Systems reportable subject.

Reference Materials: IPT Pipe Trade Handbook
Pipe Fitters and Welders Handbook
Alberta steamfitting modules

Recommended Equipment List: grinders, side and pencil
oxyacetylene cutting torches
face shields with both clear and dark lenses
wrap arounds, small for 6 inch pipe
contour marker
centre punches and cold chisels of different sizes soap stones and paint stick markers
levels, 24 inch, 48 inch and torpedo ball
pein and small sledge hammers chop saw
and cut off saw, porta-band saw with spare
blades adjustable roller stands

spacing tools and lineup clamps
squares, 24 inch and tri-square
scissors, template paper
tri stands
hydraulic pipe bender
tube benders
steam boiler with accessories and controls
zone valves
heat transfer units
steam traps

Number: S0927.1
Title: **Fabrication Layout**
Duration: Total Hours: 16 Theory: 1 Practical: 15

Cross-Reference to Training Standard: 5470.0, 5471.0, 5472.0, 5474.0, 5480.0, 5482.0, 5483.0

General Learning Outcomes

Upon successful completion the apprentice is able to use templates and pipe fabrication techniques in accordance with industry standards.

Learning Outcomes

Upon successful completion the apprentice is able to:

- 1.1 Describe template design techniques
- 1.2 Identify template Practicals
- 1.3 Describe fabrication layout techniques
- 1.4 Identify fabrication layout Practicals
- 1.5 Apply pattern drafting knowledge to fabricate assigned class projects from the following list:
 - a 2-piece 90° elbow
 - a 3-piece 90° elbow
 - a 45° lateral reducing tee
 - a full-size tee
 - a dummy leg

Number: S0927.2
Title: **Tube and Pipe Bending**
Duration: Total Hours: 16 Theory: 2 Practical: 14
Cross-Reference to Training Standard: 5470.0, 5471.0, 5472.0, 5474.0, 5480.0, 5482.0, 5483.0

General Learning Outcomes

Upon successful completion the apprentice is able to apply trade calculations involving tube bending operations in accordance with manufacturers' recommendations and accepted industry standards.

Learning Outcomes

- 2.1 Explain the following tube and pipe bending methods:
 - compression bending
 - draw bending
 - roll bending
 - tension bending
 - ram and press bending

- 2.2 Define the following terms as they relate to tube or pipe bending:
 - degree of bend
 - radius of bend
 - radii
 - developed length
 - gain
 - leg length
 - stationary bending form
 - rotating bending form
 - movable pressure form
 - ram and press bending

- 2.3 State the formula for tube bending allowance
- 2.4 Give minimum radii for bending various sized tubing
- 2.5 Perform tube bending on copper tubing and steel pipe

Number: S0927.3
Title: **Steam Boiler Project**
Duration: Total Hours: 16 Theory: 0 Practical: 16

Cross-Reference to Training Standard: 5470.0, 5471.0, 5472.0, 5474.0, 5480.0, 5482.0, 5483.0

General Learning Outcomes

Upon successful completion the apprentice is able to correctly install a steam boiler heating system.

Learning Outcomes

- 3.1 Build a steam boiler piping and control system including:
- a steam boiler
 - accessories and controls
 - a zone valve
 - a heat transfer unit
 - a steam trap

Mark Distribution:

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
10%	80%	10%

Steam Boilers and Accessories

- S0928.26 Steam Boilers
- S0928.27 Steam Boiler Piping
- S0928.28 Accessories and Controls
- S0928.29 Feedwater Controls and Piping

Electrical

- S0928.30 Electrical Fundamentals
- S0928.31 Stress Relieving

Evaluation & Testing: Assignments related to theory and appropriate Practical skills. Minimum of one mid-term test during the 8-week term. Final exam at end of term. Periodic quizzes.

Instructional and Delivery Strategies: Delivery of theory will be coordinated with the building of boiler and piping systems in the Pipe Fabrication II reportable subject.

Reference Materials: Alberta steamfitting modules Recommended

Equipment List:

- several small steam boilers (high & low pressure) from different manufacturers
- Steam piping systems, steam & condensate return
- condensate return pumps
- feed water and cutoff controllers low-water cut off controls steam, cast iron radiators
- water column c/w tri-cocks & sight gauges
- relief valve and drip pan elbow
- hydronic system display
- manual valve displays with all types with cutaways to show interior
- control valve display 2 way, 3 way, 4 way, zone valve
- thermostatic steam trap thermodynamic steam trap float & thermostatic steam trap bucket steam trap
- shell & tub heat exchangers & converters
- plate type heat exchangers & converters

pressure reducing valve station display

steam control valve display

blowdown tank display various types of:

- multimeters
- ammeters
- ohmmeters
- voltmeters

electrical board for testing and demonstrating:

- series circuit
- parallel circuit
- combine circuit
- motor control

Number: S0928.1
Title: **Zoning Applications**
Duration: Total Hours: 4 Theory: 3 Practical: 1

Cross-Reference to Training Standard: 5470.0, 5471.0, 5472.0, 5474.0, 5480.0, 5482.0, 5483.0

General Learning Outcomes

Upon successful completion the apprentice is able to explain the purpose and reasons for zone heating applications.

Learning Outcomes And Content

- 1.1 Explain the purpose of hot water heating zoning applications
- 1.2 Define a heating zone
- 1.3 Explain the four major reasons for zoning a heating system
- 1.4 Describe the type of building suitable for a zoned heating system
- 1.5 Define “stack effect”
- 1.6 Explain the reason a heating system would be zoned for multi-use occupancy
- 1.7 Name the five basic methods of controlling zoned hot water heating systems
- 1.8 Draw a simple one-line sketch of a single storey building zoned to alleviate stack effect
- 1.9 Draw a simple one-line sketch of a single storey building containing offices and a factory area
- 1.10 Draw a simple single-line sketch of a rectangular-shaped building divided into zones for geographical reasons

Number: S0928.2
Title: **Two-Way Valves**
Duration: Total Hours: 3 Theory: 3 Practical: 0
Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the operation and practical of two-way valves.

Learning Outcomes And Content

- 2.1 Describe the operation and Practical of a two-way valve
- 2.2 Name the two basic types of two-way zone control valves
- 2.3 Explain the type of two-way valve used for heating units subject to freezing temperatures
- 2.4 Name the three main parts of the two-way valves
- 2.5 Name the three basic types of actuating devices
- 2.6 Identify the type of seating arrangement used in balanced-type two-way valves
- 2.7 Explain the two basic methods of operation on pneumatically operated valves
- 2.8 List three advantages of using two-way valves
- 2.9 List four disadvantages of using two-way valves
- 2.10 Identify the control device used for electric motor or pneumatically actuated valves

Number:	S0928.3		
Title:	Three-Way Valves		
Duration:	Total Hours: 3	Theory: 2	Practical: 1
Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0			

General Learning Outcomes

Upon successful completion the apprentice is able to describe the operation and practical of three-way valves.

Learning Outcomes And Content

- 3.1 Describe the operation and Practical of a three-way valve
- 3.2 Identify the two basic types of three-way zone control valves
- 3.3 Illustrate the piping connections to and from each type of three-way valve
- 3.4 List the type of heating systems in which three-way control valves are usually found
- 3.5 Identify the method usually used to identify whether the valve is a mixing or diverting valve
- 3.6 Identify the two control devices used to operate three-way valves
- 3.7 Identify the two actuating methods used by three-way valves
- 3.8 List four advantages of using three-way valves in a zoned system
- 3.9 Name two disadvantages of using three-way valves in a zoned system
- 3.10 Identify two general instructions which should be followed when installing three-way valves
- 3.11 Define “common piping”
- 3.12 Describe the Practical and explain what happens in the secondary circuit when a restriction is placed in the common piping
- 3.13 Draw a single-line drawing of a mixing valve indicating the port openings by the letters “a” and “b”
- 3.14 Draw two single-line drawings showing the two locations in a zone where three-way mixing valves may be installed
- 3.15 Draw a single-line drawing of a diverting valve indicating the port openings by the letters “a” and “b”
- 3.16 Draw a single-line drawing correctly locating the diverting valve in a zone system

Number: S0928.4
Title: Four-Way Valves
Duration: Total Hours: 3 Theory: 3 Practical: 0
Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the operation and practical of four-way valves.

Learning Outcomes And Content

- 4.1 Describe the operation and Practical of a four-way valve
- 4.2 Name the basic types of four-way valves
- 4.3 Explain the operating principles of a four-way valve
- 4.4 Describe how the four-way valve contributes to the system

Number:	S0928.5		
Title:	Primary and Secondary Pumps		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0			

General Learning Outcomes

Upon successful completion the apprentice is able to describe the operation and practical of primary and secondary pumps.

Learning Outcomes And Content

- 5.1 Describe the operation and Practical of primary and secondary pumps
- 5.2 State the purpose of a primary pump
- 5.3 State the purpose of a secondary pump
- 5.4 State the purpose of a primary circuit
- 5.5 Describe the three basic system designs which may be used for primary circuits
- 5.6 Describe the two main factors which are considered when selecting the system to use for the primary circuit
- 5.7 State the number of secondary zones which may be installed on a primary circuit
- 5.8 State five systems or pieces of heat transfer equipment which can be used as secondary zones
- 5.9 Describe the two types of control used by secondary zones
- 5.10 Name the three control devices used to activate secondary zone pumps
- 5.11 Identify the extra piece of equipment (in addition to the zone pump) necessary to enable the zone to operate efficiently in zones using continuous pump operation
- 5.12 Name the two sensing devices used to activate the control valve located in the zone using continuous pump operation
- 5.13 List five advantages of zoning with pumps versus other control devices

- 5.14 Calculate the G.P.M. flow and temperatures for an intermittently operated zone when 5 G.P.M. at 250°F boiler water is supplied to the zone by-pass and the zone pump requires 15 G.P.M. and a 20°F temperature drop occurring in the secondary zone
- 5.15 Draw a single-line illustration of a one-pipe primary circuit and secondary zone locating boiler, primary pump, flow control valves and secondary pump, indicating direction of flow
- 5.16 Draw a single-line illustration showing a view of a zone using intermittent zone pump operation with pump off, indicating flow velocities and temperatures
- 5.17 Draw a single-line illustration showing a view of a zone using intermittent zone pump operation with pump on, indicating flow velocities and temperatures
- 5.18 Draw a single-line illustration showing a view of a zone using continuous pump operation with valve open, indicating flow velocities and temperatures

Number: S0928.6

Title: Injection Pumps

Duration: Total 2 hours Theory 2 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the operation and practical of injection pumps.

Learning Outcomes And Content

- 6.1 State the purpose of an injection pump
- 6.2 Describe the operation of an injection pump
- 6.3 State the definition of the term 'metering'
- 6.4 State the two main parts of an injection pump
- 6.5 State the main type of injection pumps
- 6.6 State the purpose of check valves in an injection pump
- 6.7 Describe when diaphragm and peristaltic pumps are used
- 6.8 Describe possible problems arising from use of injection pumps

Number: S0928.7

Title: **Low Pressure Steam System Principles**

Duration: Total 3 hours Theory 3 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe low pressure steam system principles.

Learning Outcomes And Content

- 7.1 Explain the main function of any heating system
- 7.2 Explain the three functions that every system should perform
- 7.3 Explain why low pressure steam is used for heating purposes
- 7.4 State the operating pressure of low-pressure steam heating systems
- 7.5 Name the three main components of a steam heating system
- 7.6 Identify the three basic features used to classify steam heating systems
- 7.7 State the four basic types of systems classified by the pressure or vacuum conditions which exist during actual operation
- 7.8 State the operating pressure used in vacuum-type systems
- 7.9 Identify two other names for a sub-atmospheric steam heating system
- 7.10 State three mechanical devices used to return condensate to the boiler Interpret the classification chart which indicates the various types of steam heating systems
- 7.11 Draw a single-line sketch of the basic steam heating cycle and identify the main components of the low-pressure steam systems
- 7.12 Draw a single-line sketch of:
 - a wet return system
 - a dry return system

Number: S0928.8

Title: Properties of Steam

Duration: Total 9 hours Theory 8 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the properties of steam.

Learning Outcomes And Content

- 8.1 Describe the properties of steam
- 8.2 List what type of heat is required to convert liquid water to steam
- 8.3 State another term for steam
- 8.4 State the number of times water expands when it is changed to steam
- 8.5 Name three different types of steam
- 8.6 Describe the location in the system where “dry” saturated steam can be found
- 8.7 Name the type of system in which superheated steam will usually be found
- 8.8 State the reason-superheated steam behaves like a true gas
- 8.9 State the names of two laws of physics governing true gases
- 8.10 State the reason “dry” saturated steam is used for steam-heating systems
- 8.11 Draw a single-line sketch showing where both “wet” and “dry” saturated steam can be found in a heating system
- 8.12 Identify the letter designations used in steam tables for each of the following:
 - heat content of liquid
 - latent heat of vaporization
 - heat content of steam
 - volume of steam

Number: S0928.9

Title: Gravity Steam Systems

Duration: Total 4 hours Theory 2 hours Practical 2 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe gravity steam systems.

Learning Outcomes And Content

- 9.1 Identify gravity steam systems
- 9.2 Explain why the design of gravity steam heating systems is extremely important
- 9.3 Explain why all heat transfer units must be located above the boiler in a gravity steam system
- 9.4 Explain why the water level in the condensate return main furthest from the boiler is higher than the boiler water line (wet return)
- 9.5 Explain why gravity steam heating systems operate at pressure below 10 PSIG
- 9.6 Explain what would happen if higher operating steam pressures were used in gravity steam systems
- 9.7 State the two locations where air vent valves are found in a gravity steam heating system
- 9.8 State the location of air vent valves installed on radiators
- 9.9 Name three advantages of using gravity steam heating systems
- 9.10 Name four disadvantages of using gravity steam heating systems
- 9.11 Explain why gravity steam heating systems are not used in large building

- 9.12 Explain why one-pipe gravity steam systems are so named
- 9.13 Describe the valve operation sequence for radiators using two connections
- 9.14 Calculate the theoretical height of the condensate water level in the condensate return main for a boiler operating at 0.25 PSIG
- 9.15 Draw and label the following sketches of gravity steam systems:
- a single-line sketch of a one-pipe, mains grading up, gravity steam system
 - a piping sketch of the risers and runouts to the main where risers are not dripped
 - a sketch of piping and fittings used when reductions are made in the steam mains
 - a sketch of piping, connecting the risers and runouts to the main when risers are dripped to a wet return
 - a single-line sketch of a two-pipe, mains grading down, (wet-return) gravity steam system indicating water legs

Number: S0928.10

Title: Mechanical Steam Systems

Duration: Total 4 hours Theory 3 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe mechanical steam systems.

Learning Outcomes And Content

- 10.1 Describe the types and operation of mechanical steam systems
- 10.2 Define “mechanical steam” systems
- 10.3 Name the four common types of mechanical steam systems
- 10.4 State the operating pressures found in the steam and condensate mains of a condensate pump system
- 10.5 State the operating pressures found in the steam and condensate mains of a vacuum pump system
- 10.6 State the operating pressures found in the steam and condensate mains of a sub-atmospheric system
- 10.7 Describe the main purpose of a steam trap
- 10.8 Explain where steam traps are usually located
- 10.9 Explain the type of radiator valves used on vacuum pump systems
- 10.10 Draw and label a sketch of a condensate pump system including heat transfer units, steam traps, radiator valves and piping

Number: S0928.11

Title: **Condensate Pump Steam Systems**

Duration: Total 3 hours Theory 2 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to define the fundamentals and operation of condensate pump steam systems.

Learning Outcomes And Content

- 11.1 Describe the operation of a condensate pump steam heating system
- 11.2 List the advantages of using a condensate pump steam heating system compared to a:
 - boiler return trap system
 - gravity system
- 11.3 Name the two valves located on the piping from the condensate pump to the boiler
- 11.4 State the maximum operating pressure used in low pressure steam systems
- 11.5 State the pressure found in the condensate return lines
- 11.6 State the reason for the steam main pitching down in the direction of steam flow
- 11.7 Explain why a valve is located at the inlet to each heat transfer unit
- 11.8 Explain what happens to any air which is in the steam system
- 11.9 State the main type of pump used in low pressure steam systems
- 11.10 State the three main components usually fitted on a common base in condensate pump systems
- 11.11 Describe the method used to size condensate receivers
- 11.12 Describe the method used to size condensate pumps

- 11.13 Identify and describe the two control methods used in condensate pump steam systems
- 11.14 State the main reason for locating the condensate pump unit at a low level
- 11.15 State the reason for using unions and valves on connections to the condensate receiver
- 11.16 State the minimum size of the vent line from the condensate receiver
- 11.17 Determine the size of the piping from the condensate pump to the boiler
- 11.18 Describe the main function of any steam heating system
- 11.19 Define the term “spring piece”
- 11.20 Define the term “runout”
- 11.21 Draw and label the following sketches of condensate pump systems:
- a single-line illustration of a condensate pump system indicating the boiler, the condensate pump and receiver, two radiators, steam traps and valves
 - a single-line illustration of a condensate pump connected to a steam boiler through a hartford loop
 - a single-line illustration of the end of a steam main correctly dripped and trapped
 - a single-line illustration of an “equalizing line” between the steam and condensate mains of a steam system
 - single-line illustration of the piping connections to a horizontal-type unit heater where steam and condensate mains are run at high level (above the heater)
- 11.22 Illustrate and explain the piping arrangement for installing a steam line around a steel beam

Number: S0928.12

Title: **Vacuum Pump Systems**

Duration: Total 3 hours Theory 2 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to define the fundamentals and operation of vacuum pump steam systems.

Learning Outcomes And Content

- 12.1 Describe the fundamentals and operation of a vacuum pump system
- 12.2 Explain the reason for the difference between the pressures in the steam and condensate piping in mechanical steam heating systems
- 12.3 Describe what causes the pressure difference in the vacuum pump steam system
- 12.4 Describe what kind of pressure condition exists in the steam lines of a vacuum pump steam system
- 12.5 Describe what kind of pressure condition exists in the condensate return lines of the vacuum pump steam system
- 12.6 Name the type of building where vacuum steam systems are usually installed
- 12.7 Explain why vacuum pump steam systems are not usually installed in small residential buildings
- 12.8 Describe the purpose of the vacuum pump in a steam system
- 12.9 State the recommended grade for piping in a vacuum pump steam heating system
- 12.10 Explain why pipe sizes in vacuum pump steam heating systems are usually smaller than those in other mechanical steam heating systems
- 12.11 State the pressure usually maintained in the steam lines of a vacuum pump steam heating system

- 12.12 State the pressure usually maintained in the condensate return lines of the vacuum pump steam heating system
- 12.13 List three advantages of the vacuum pump system compared to the condensate pump system
- 12.14 Name the two types of vacuum pump units
- 12.15 List the three main factors to consider when selecting and sizing the vacuum pump
- 12.16 Describe what causes water to be discharged from the air-separating tank to the boiler
- 12.17 State the pressure range of steam traps used in vacuum steam heating systems
- 12.18 State the type of valve used at the inlet to the radiators
- 12.19 Describe the two methods used to cool high-temperature condensate before returning it to the vacuum condensate line
- 12.20 Draw and label a single-line illustration of a vacuum pump steam system with two radiators
- 12.21 Draw and label a single-line illustration of an equalizing line showing a steam trap on the line
- 12.22 State the purpose of a flash tank
- 12.23 Draw and label a single-line illustration of a flash tank where the exhaust steam is directed to the low-pressure steam line

Number: S0928.13

Title: **Lift Fittings**

Duration: Total 1 hours Theory 1 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to define the fundamentals and operation of lift fittings.

Learning Outcomes And Content

- 13.1 Describe the purpose and Practical of lift fittings
- 13.2 Describe the installation procedures for lift fittings

Number: S0928.14

Title: **Sub-Atmospheric Systems**

Duration: Total 3 hours Theory 3 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to define the function and use of sub-atmospheric systems.

Learning Outcomes And Content

- 14.1 Define the sub-atmospheric steam system
- 14.2 State the purpose of sub-atmospheric steam system
- 14.3 List the three major factors to be considered when designing or installing any heating system
- 14.4 Name the two recognized methods of control used by steam heating systems
- 14.5 Describe the method of control used in sub-atmospheric steam heating systems
- 14.6 Explain why the sub-atmospheric steam system is similar to a vacuum steam system
- 14.7 Compare the range of pressures used by the sub-atmospheric steam system to those used by the vacuum system
- 14.8 Describe the weather conditions which would cause the sub-atmospheric steam system to operate at 2 PSIG
- 14.9 Describe the weather conditions which would cause the sub-atmospheric steam system to operate at 25 inches of mercury
- 14.10 Name the type of pump usually used by sub-atmospheric steam heating systems
- 14.11 List three advantages of sub-atmospheric steam systems

- 14.12 Name two disadvantages of sub-atmospheric steam systems
- 14.13 List five pieces of equipment used exclusively on the sub-atmospheric steam heating system
- 14.14 State the pressure range of steam traps used in sub-atmospheric steam systems
- 14.15 State the only location where a lift fitting is permitted in a sub-atmospheric steam system
- 14.16 Describe the effect on the boiling point of water when the pressure is decreased
- 14.17 Describe the effect on the volume of steam when the pressure is decreased
- 14.18 Describe the effect on the heat content of one pound of steam when the pressure is decreased
- 14.19 State the methods used to control heat during periods of mild weather (60°F to 65°F outside temperatures)
- 14.20 Describe the features of sub-atmospheric controls and equipment

Number: S0928.15

Title: **Steam Traps**

Duration: Total 4 hours Theory 3 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the fundamentals and operation of steam traps.

Learning Outcomes And Content

- 15.1 State the purpose of steam traps
- 15.2 State the basic requirement for all steam traps
- 15.3 Define steam trap
- 15.4 Name the three basic classifications of steam traps
- 15.5 Name the two types of thermodynamic steam traps
- 15.6 Name the three types of mechanical steam traps
- 15.7 Explain why the corrugated bellows trap is sometimes referred to as a “balanced pressure trap”
- 15.8 Name the type of volatile liquid usually found inside the bellows or disc of a thermostatic steam trap
- 15.9 Describe where thermostatic steam traps are usually installed
- 15.10 State the purpose of the thermostatic element in the float and thermostatic steam trap
- 15.11 State the purpose of the float mechanism in the float and thermostatic steam trap
- 15.12 State the usual operating pressure range of float and thermostatic steam traps
- 15.13 Describe where float and thermostatic steam traps are usually installed

- 15.14 State the two reasons the upright bucket trap has fallen into disfavour
- 15.15 Describe how air is vented from beneath the bucket of an inverted bucket trap
- 15.16 Identify the other name by which thermodynamic steam traps are known
- 15.17 State the operating pressure range of thermodynamic steam traps
- 15.18 State the maximum superheated steam temperature the thermodynamic steam trap is able to withstand
- 15.19 Explain the principle by which the thermodynamic steam trap operates
- 15.20 Draw and label a single-line illustration of steam traps connected to three blast coils
- 15.21 Draw and label a single-line illustration of the condensate return piping arrangement required by a heat transfer unit located below the condensate return lines
- 15.22 State the height of a water column supported by a given pressure
- 15.23 Name five considerations when selecting a steam trap

Number: S0928.16

Title: Converters and Heat Exchangers

Duration: Total 9 hours Theory 8 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the fundamentals, practical, construction and operation of converter and heat exchanger heat transfer units.

Learning Outcomes And Content

- 16.1 Describe the following terms as they apply to heat transfer units:
- heat exchanger
 - converter
 - pass
- 16.2 List the three main components of heat exchangers and converters
- 16.3 State three materials used in the manufacture of heat exchanger and converter “shells” and “tube bundles”
- 16.4 Describe plate type heat exchangers
- 16.5 List four Practicals where heat exchangers or converters are used
- 16.6 Identify the three main types of tube bundles
- 16.7 Name the end of heat exchangers or converters into which tubes are inserted
- 16.8 State the purpose of the bowed design of tube bundles
- 16.9 Identify the component of the converter or heat exchanger that determines the number of passes
- 16.10 State three important factors used to select the type and size of heat exchanger or converter
- 16.11 Explain the two main reasons why shell and tube heat exchangers and converters should pitch upward at the front

- 16.12 Identify the device used to regulate the steam control valve on the inlet to the shell of the converter
- 16.13 Identify the type and size of valve used as a vacuum breaker on the converter shell
- 16.14 Explain why heated water from a boiler is usually piped into the bottom tapping of the heat exchanger or converter shell
- 16.15 Describe the operating principles of double wall heat exchangers and converters with or without leak detection
- 16.16 Describe the installation procedures of double wall heat exchanger and converter system components
- 16.17 State the reason for installing a vacuum breaker on the shell of the converter
- 16.18 Draw single-line sketches of the following:
- a heat exchanger shell indicating inlets and outlets
 - a heat exchanger or converter with a two-pass head
 - a heat exchanger or converter with a four-pass head
 - a heat exchanger correctly installed on a steam boiler
 - a converter complete with piping connections to both the shell and tubes to supply heat for a hot water heating system
 - a plate type heat exchanger

Number: S0928.17

Title: **High Pressure Steam System Principles**

Duration: Total 3 hours Theory 2 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe high pressure steam systems.

Learning Outcomes And Content

- 17.1 Describe features of high-pressure steam systems
- 17.2 State the three recognized subdivisions of high-pressure steam
- 17.3 Identify the maximum pressure recommended for high-pressure steam heating systems
- 17.4 Identify the two basic pressure classifications for saturated steam
- 17.5 Describe where the high and low pressure classifications can usually be found
- 17.6 State the purpose of generating low-pressure steam
- 17.6 Identify four uses for process steam
- 17.8 Describe two important advantages of using high pressure steam
- 17.9 Calculate the latent heat in one cubic foot of steam at a given pressure using a steam table

Number: S0928.18

Title: **High Pressure Steam Plants**

Duration: Total 2 hours Theory 1 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe high pressure steam plants.

Learning Outcomes And Content

- 18.1 State the purpose of high-pressure steam plants
- 18.2 State two main considerations which will ultimately determine the type of high-pressure steam plant installed
- 18.3 Identify three types of heat transfer equipment
- 18.4 Explain the prime reason for installing additional pieces of equipment in condensing and non-condensing steam plants
- 18.5 State the two basic types of high-pressure steam plants
- 18.6 Explain the fundamental operation of the following steam plants:
 - a condensing steam plant
 - a non-condensing steam plant
 - a steam-driven nuclear power plant
 - a coal-driven power plant
- 18.7 State two main reasons for installing a non-condensing steam plant
- 18.8 Describe the type of feedwater heater usually found in the following:
 - a condensing steam plant
 - a non-condensing steam plant

18.9 Draw a single-line sketch of the main components including equipment required for efficient operation of following steam plants:

- a condensing steam plant
- a non-condensing steam plant
- a nuclear power plant
- a coal power plant

Number: S0928.19

Title: **Pressure Reducing Valves and Stations**

Duration: Total 3 hours Theory 3 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe pressure reducing valves and stations.

Learning Outcomes And Content

- 19.1 Describe the fundamentals of pressure reducing valves and stations
- 19.2 Explain the purpose of a pressure-reducing valve
- 19.3 Identify the two basic types of pressure reducing valves used to reduce high-pressure steam
- 19.4 Define a pilot operated pressure-reducing valve
- 19.5 Describe where a spring-operated type of pressure reducing valve is used
- 19.6 Describe which type of pressure reducing valve has a larger diaphragm chamber
- 19.7 Describe the two valve body designs used for pressure reducing valves
- 19.8 Explain where single-seated pressure reducing valves are used
- 19.9 Explain where double-seated pressure reducing valves are used
- 19.10 Explain the two important considerations when selecting a pressure-reducing valve
- 19.11 Describe reducing valve installation procedures
- 19.12 Identify the minimum distance between reducing valves installed in series
- 19.13 Identify parallel pressure reducing valve installations
- 19.14 State where series or parallel pressure reducing valve installations would be used

- 19.15 Identify the size of pressure reducing valve control-line piping
- 19.16 State the purpose of by-pass piping and valves installed with pressure reducing valves
- 19.17 Explain the reason for priming the control-line piping before putting the pressure-reducing valve into operation
- 19.18 Explain the reason for installing a safety valve on the low-pressure piping of a pressure-reducing valve
- 19.19 Identify the type of reducing coupling used to increase pipe size on the downstream side of the pressure-reducing valve
- 19.20 Draw an isometric sketch of a pressure-reducing valve installed in a pipeline, together with equipment and piping needed to ensure efficient operation of the valve

Number: S0928.20

Title: **Economizers**

Duration: Total 2 hours Theory 1 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe economizers.

Learning Outcomes And Content

- 20.1 Describe the fundamentals of economizers
- 20.2 Explain the main reason for using economizers
- 20.3 State the two main metals used in the manufacture of economizers
- 20.4 Explain why cast-iron economizers are selected for some installations
- 20.5 Explain why steel economizers are selected for some installations
- 20.6 State the reason for keeping the feedwater temperature to each economizer above a specified minimum temperature
- 20.7 Describe how economizer's internal and external surfaces are kept clean
- 20.8 Explain why forced draft must be used when economizers are installed
- 20.9 Draw a single-line sketch showing the correct location of the following:
 - an integral economizer
 - a separate unit economizer

Number: S0928.21

Title: **Condensers**

Duration: Total 1 hours Theory 1 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe condensers.

Learning Outcomes And Content

- 21.1 Describe the basic function of a condenser
- 21.2 Identify the two basic categories of condensers
- 21.3 Describe the main difference in the operation of a direct contact condenser and a surface condenser
- 21.4 State the three main classifications of direct contact condensers
- 21.5 Explain “counterflow” condensers
- 21.6 Explain “parallel flow” condensers
- 21.7 Identify the type of medium traveling through the tubes of a surface condenser
- 21.8 Calculate the velocity at which cooling water travels through the tubes of the surface condenser
- 21.9 Explain the reason for even distribution of steam over the cooling tubes in the surface condenser
- 21.10 Describe how surface condensers are supported

Number: S0928.22

Title: **Feedwater Heaters and Deaerators**

Duration: Total 6 hours Theory 5 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe feedwater heaters and deaerators.

Learning Outcomes And Content

- 22.1 Describe the fundamentals of feedwater heaters and deaerators
- 22.2 Identify the three classifications of impurities found in water
- 22.3 Describe the method usually used to remove suspended matter from water
- 22.4 Identify the types of solids in solution which form soft sludge-like scale when precipitated
- 22.5 Identify the types of solids in solution which form hard scale when precipitated
- 22.6 Explain the reason for removing sulphates and bicarbonates from feedwater List the three main types of dissolved gases usually found in feedwater
- 22.7 List the materials that are attacked by the ammonia gas carried along with the steam
- 22.8 Calculate the percentage increase in efficiency when feedwater temperature is raised by 5°C
- 22.9 Define the term “thermal shock”
- 22.10 List four advantages of installing feedwater heaters which tend to increase the efficiency of the high-pressure steam plant
- 22.11 Identify the three basic types of feedwater heaters
- 22.12 Describe the method used to control the level of the feedwater in the storage tank at the bottom of the open heater

22.13 Explain the reason why contaminated exhaust steam may be used to heat feedwater in a closed feedwater heater

22.14 Identify the two types of deaerators used in high-pressure steam plants

22.15 Explain feedwater treatment methods

22.16 Draw single-line sketches of the following feedwater heaters correctly located in a high-pressure system in relation to the boiler and feed pump:

- an open-type feedwater heater
- a closed-type feedwater heater

Number: S0928.23

Title: **Superheaters**

Duration: Total 3 hours Theory 2 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the construction features and operation of superheaters.

Learning Outcomes And Content

- 23.1 Describe the fundamental construction features and operation of superheaters
- 23.2 Define the term “superheated steam”
- 23.3 State the main reason for the increased use of superheated steam for power plants
- 23.4 State the main reason for using superheated steam for turbines
- 23.5 Identify the two basic types of superheaters
- 23.6 Explain the meaning of “integral-type unit” as it relates to superheaters
- 23.7 Describe where the convection-type superheater coils are located within the boiler
- 23.8 Describe where the radiant-type superheater coils are located within the boiler
- 23.9 Describe the relationship in convection-type superheater coils between the temperature and enthalpy per pound of superheated steam and the demands and output from the boiler or generator
- 23.10 Describe a combination-type superheater
- 23.11 Explain the main advantage of using the combination-type superheater
- 23.12 Identify the two main reasons for using superheated steam
- 23.13 Illustrate a water-tube boiler showing a convection-type pendent superheated coil located within the boiler

Number: S0928.24

Title: **Desuperheaters**

Duration: Total 2 hours Theory 1 hours Practical 3 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the construction features and operation of desuperheaters.

Learning Outcomes And Content

- 24.1 Describe the fundamental construction features and operation of desuperheaters
- 24.2 Describe the purpose of a desuperheater
- 24.3 Identify the two basic types of desuperheaters
- 24.4 Explain the reason for using baffles in the spray-type desuperheater
- 24.5 Describe the method of heat transfer in the surface-type desuperheater
- 24.6 Identify the two reasons for using desuperheaters
- 24.7 State the main reason for reducing superheated steam to saturated steam
- 24.8 Identify the fluid which operates the diaphragm valve on the water line to the spray-type desuperheater
- 24.9 Identify the type of water that should be sprayed into the superheated steam in a spray-type desuperheater
- 24.10 Draw a single-line sketch of a spray-type desuperheater

Number: S0928.25

Title: **Blowdown Tanks and Piping**

Duration: Total 3 hours Theory 2 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the construction features and operation of blowdown tanks and piping.

Learning Outcomes And Content

- 25.1 Describe the construction features and operation of blowdown tanks and piping
- 25.2 State the purpose of a blowdown tank
- 25.3 Identify another term for a blowdown tank
- 25.4 Explain the main reason for installing a blowdown system
- 25.5 Describe various methods used to blowdown high-pressure steam boilers
- 25.6 Explain the ideal time to perform boiler blowdowns
- 25.7 State the frequency and the length of time a valve should be opened during intermittent blowdowns
- 25.8 Explain why the blowdown line for continuous blowdowns is taken from just below the boiler water line
- 25.9 Identify the conditions which can be relieved by surface blowdowns
- 25.10 Identify the type and schedule of steel pipe used on blowdown lines between the boiler and the blowdown valves
- 25.11 Describe the reason for sleeving the blowdown pipe as it passes through the brickwork or exterior casing of the boiler
- 25.12 Identify the minimum and maximum size tapings in the boiler for blowdown piping
- 25.13 State the boiler code requirements regarding blowdown valves for steam boilers operating at over 15 P.S.I.

25.14 Identify four types of valves and cocks used in blowdown service

25.15 Describe the correct procedure for opening blowdown valves

25.16 State the minimum plate thickness used in blowdown tank construction

25.17 Draw and label single-line sketches of the following:

- three boilers showing blowdown piping, valves and tank
- a blowdown valve installation (one quick opening and one slow opening)
- a blowdown tank installation from given sizes

Number: S0928.26

Title: **Steam Boilers**

Duration: Total 6 hours Theory 6 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the construction features and operation of steam boilers.

Learning Outcomes And Content

- 26.1 Describe fundamental construction features and operation of steam boilers
- 26.2 Describe the construction features of a cast-iron boiler
- 26.3 Describe the construction features of a fire-box boiler
- 26.4 Describe the use of the Scotch marine boiler
- 26.5 Explain the main difference between water-tube boilers and fire-tube boilers
- 26.6 Explain the term “package boiler”
- 26.7 List the advantages of a packaged boiler
- 26.8 Describe the construction of a water-tube boiler
- 26.9 Describe the operation and types of water-tube boilers
- 26.10 State the advantage of a water-tube boiler as compared to fire-tube boiler
- 26.11 List the components of a large steam generator
- 26.12 State the features of a well designed boiler
- 26.13 Identify the factors to be considered when calculating net load of a boiler
- 26.14 State the factor to be considered when calculating the “square feet of equivalent direct radiation (EDR)” of a boiler
- 26.15 State the factors to be used when calculating boiler horsepower
- 26.16 State how boiler horsepower relates to heating surface ratings

26.17 Explain terminologies related to parts, construction and usage of boilers

26.18 Interpret the standards pertaining to boilers as specified by the Ontario Boiler and Pressure Vessels Act and Technical Safety Standards Authority (TSSA)

Number: S0928.27

Title: **Steam Boiler Piping**

Duration: Total 3 hours Theory 2 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the construction features of steam boiler piping.

Learning Outcomes And Content

- 27.1 Describe the construction features of steam boiler piping
- 27.2 State why the size of tappings on a steam boiler should not be reduced at the outlet
- 27.3 Explain why the piping to and from each boiler must be suitably valved
- 27.4 Name a term used for the thermal movement that occurs when the boiler is in operation
- 27.5 State the minimum size of the bleeder piping below the waterline on a given low pressure steam boiler Practical
- 27.6 Identify two basic considerations when installing steam piping above the boiler
- 27.7 State the reason for installing an equalizing line between the steam and condensate return piping
- 27.8 Explain how the Hartford loop got its name
- 27.9 State the purpose of a Hartford loop in steam boiler piping
- 27.10 Describe the reasons for the Hartford loop entering the bleeder pipe 2 to 4 inches below the boiler waterline
- 27.11 State two other names for the bleeder portion of boiler piping
- 27.12 Explain the term “priming”
- 27.13 Describe three conditions that could cause steam boiler priming
- 27.14 Explain three methods that can be used to prevent or overcome a priming condition

27.15 Illustrate a typical dry-pipe arrangement for the outlet of a steam boiler

27.16 Explain the term “foaming” in relation to steam boilers

27.17 Identify three causes of the oily scum-like substance that covers the surface of the boiler water and could result in a foaming condition

27.18 Describe two remedies for foaming

27.19 Draw the following sketches of steam boiler piping systems:

- a single-line illustration of a small cast-iron steam boiler piped to supply a gravity steam system
- a single-line illustration of a two boiler installation with the boiler piping arranged to supply low pressure steam with a condensate pump return

Number: S0928.28

Title: **Steam Boiler Accessories and Controls**

Duration: Total 8 hours Theory 6 hours Practical 2 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the construction features of steam boiler accessories and controls.

Learning Outcomes And Content

- 28.1 Describe the fundamentals of steam boiler accessories and controls
- 28.2 Identify the maximum size for a single safety valve installed on a steam boiler
- 28.3 Identify the maximum size safety valve that can be fitted on a steam boiler where two or more safety valves are required
- 28.4 Explain the reason for cutting off the end of the discharge pipe at a 60° angle
- 28.5 Illustrate the reason for fitting a drip-pan elbow on the discharge piping from a safety valve on a high pressure safety valve
- 28.6 Identify the certifying agency whose initials are on the identification plate of the safety valve
- 28.7 Explain the purpose of seals on safety valves
- 28.8 Explain why the safety valve is referred to as a “pop” safety valve
- 28.9 Explain how the related pressure opens and closes the “pop” safety valve
- 29.10 Explain the main function of a pressure gauge on a steam boiler
- 28.11 Identify the name of the most common type of dial gauge
- 28.12 Identify the main component of the dial gauge
- 28.13 Describe the dial gauge that records pressure above and below atmospheric pressure

- 28.14 Describe the unit of measurement used for pressures below atmospheric
- 28.15 Explain the reason for installing a siphon between the gauge and the steam boiler
- 28.16 Illustrate the three basic designs of siphons used on steam boilers
- 28.17 State the reasons for locating a plugged tee above the siphon
- 28.18 Identify the two boiler accessories used to measure the correct boiler water level
- 28.19 Draw a single-line illustration of the typical piping connections between a watercolumn and a boiler showing gauge glass and gauge glass mountings
- 28.20 Determine how many inches of water remain over the top row of tubes or crown sheet when the water in the water gauge glass is at its lowest visible point
- 28.21 State the reason for installing a diagonally striped board behind the gauge glass
Identify the type of valves used in the piping between the boiler and the water column
- 28.22 State the minimum size of piping required for the connection between the:
- water column and the boiler
 - drain pipe from the water column
- 28.23 Describe the location and function of the try cocks on the water column
- 28.24 Describe the two basic types of fusible plugs
- 28.25 Identify the alloy filler metal used in fusible plugs
- 28.26 State the melting temperature of the filler metal used in fusible plugs
- 28.27 Explain the purpose and operation of a non-return (stop and check) valve
- 28.28 Identify correct location for a non-return (stop and check) valve
- 28.29 Describe the operating principle of a steam separator
- 28.30 Identify the two main types of steam separators
- 28.31 Describe the main purpose and location of soot blowers (steam lances)
- 28.32 Describe the types and purposes of low water cut-offs
- 28.33 Describe where the “built-in” type cut-off is located
- 28.34 Describe how the “built-in” cut-off is tested
- 28.35 Describe where the float and chamber low water cut-off is located

- 28.36 Describe how the float and chamber low water cut-off is tested
- 28.37 State the size of pipe used to connect a low water cut-off to a steam boiler
- 28.38 Identify three types of flame failure devices used to protect steam boilers
- 28.39 Explain three reasons why flame rods or electrodes are not favoured flame failure devices
- 28.40 Identify the type of rays emitted by the flame that activates electronic controls of modern burner installations
- 28.41 Draw the following illustrations of boiler accessories and controls:
- a fireside and waterside fusible plug
 - a single-line illustration of the steam piping connecting three steam boilers with a common header, indicating the correct location of the stop and check and gate valves
 - a single-line illustration of a low water cut-off installed at the appropriate location adjacent to the boiler it protects using 1-inch pipe and fittings
 - a typical high pressure safety valve installation, indicating its location on the steam drum and the discharge piping to atmosphere
 - the disc of the “pop” safety valve, indicating the skirt port holes and adjustable (angular) ring

Number: S0928.29

Title: **Steam Boiler Feedwater Controls and Piping**

Duration: Total 3 hours Theory 2 hours Practical 1 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the construction features of steam boiler feedwater controls and piping.

Learning Outcomes And Content

- 29.1 Describe the fundamentals of steam boiler feedwater controls and piping
- 29.2 State the boiler code requirement pertaining to where feed or make-up water should be introduced into a steam boiler
- 29.3 Identify the valves and their location on feedwater piping to the steam boiler
- 29.4 Describe the function of the check valve on feedwater piping
- 29.5 Describe the function of the stop valve on feedwater piping
- 29.6 State the boiler code requirements pertaining to a boiler of 15 horsepower or more with a working pressure exceeding 25 P.S.I.
- 29.7 State the minimum size feedwater connection to a steam boiler having less than 100 square feet of heating surface
- 29.8 Identify the two possible locations for float-operated controls that add make-up water to the low and low-high pressure systems
- 29.9 State the recommended location for the feedwater controller on the receiver tank of a multiple low pressure steam boiler installation
- 29.10 Identify the three types of feedwater controls that regulate feedwater to high pressure steam boilers

- 29.11 Describe the function of the thin metal fins on the outer casing of the thermohydraulic generator type feedwater regulator
- 29.12 Explain the action of the thermohydraulic generator type feedwater regulator when the boiler water level drops
- 29.13 Explain the action of the thermostatic expansion type feedwater regulator when the boiler water level rises
- 29.14 Identify the parts of an injector that changes steam pressure to velocity Identify the three sources of water supply to an injector
- 29.15 Describe and illustrate the pipe requirement for lifting water higher than 10 feet with an injector
- 29.16 Draw the following illustrations for feedwater piping Practicals:
- a single-line illustration of the feedwater connection entering the top of the boiler shell, locating the necessary piping and valves
 - a single-line illustration of the feedwater/cut-off combination control installed on a low pressure steam boiler
 - a single-line illustration of a high pressure steam boiler with a pump and cut-off control located at the boiler waterline and the make-up water control valve installed on the receiver tank, indicating the piping and electrical wiring
 - a thermohydraulic generator type feedwater regulator installed and connected to the feedwater regulator valve
 - a thermostatic expansion type feedwater regulator installed and connected to the feedwater regulator valve
 - a single-line illustration of the injector installed on a high pressure steam boiler, indicating the piping and valves when the source of feedwater is a hot well

Number: S0928.30

Title: **Electrical Fundamentals**

Duration: Total 9 hours Theory 7 hours Practical 2 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to explain and apply basic electrical theory including laws, circuits, use of electrical measuring instruments, common hazards, protective measures in accordance with government safety regulations, manufacturers' recommendations and approved industry standards.

Learning Outcomes And Content

30.1 Explain basic electrical theory as follows:

- electron theory of matter
- concept of electrical current

30.2 Define the following electrical units:

- ohms
- volts
- amps
- watts
- resistance
- voltage
- current

30.3 Explain Ohm's Law

30.4 State the safe-working rules to be followed when working with electrical equipment including:

- lockout
- tagging

- 30.5 Describe the particular components of simple electric circuits, including fundamentals of operation of:
- fuse
 - switch
 - resistance or load
- 30.6 State three purposes of a motor control centre
- 30.7 Demonstrate the operation of the following electrical measuring instruments:
- ammeter
 - voltmeter
 - ohmmeter
 - multimeter
 - clamp-on volt/ammeter
- 30.8 Interpret two simple wiring diagrams
- 30.9 Draw circuit diagrams for series, parallel and combined circuits using resistance and variable voltage supply
- 30.10 Solve problems using Ohm's Law on simple series, parallel and equivalent circuit

Number: S0928.31

Title: **Stress Relieving**

Duration: Total 2 hours Theory 2 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5474.0, 5475.0, 5476.0, 5481.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe the fundamentals, application, construction and operation of stress relieving.

Learning Outcomes And Content

- 31.1 Describe three types of residual stress in metals
- 31.2 Define the following terms as they apply to stress relieving:
 - contraction
 - stress due to higher surface cooling
 - stress due to phase transformation
- 31.3 Explain the effects of residual stress
- 31.4 Identify three methods of relieving stress in welds
- 31.5 Describe the following three methods of stress relieving:
 - mechanical
 - heat
 - electromagnetic
- 31.6 Explain the advantages and disadvantages of
 - preheating welded joints
 - postheating welded joints

Mark Distribution:

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
60%	10%	30%

Number:	S0929		
Title:	Applied Trade Calculations II		
Duration:	Total Hours: 24	Theory: 12	Practical: 12
Prerequisites:	Level 1		
Contents:	S0929.1	Cube and Cube Root Calculations	
	S0929.2	Angles and Degrees	
	S0929.3	Volumes of Tanks and Cylinders	
	S0929.4	Boyle's Law	
	S0929.5	Simple and Compound Interest	
	S0929.6	List Price, Trade Discounts and Net Price	

Evaluation & Testing: Assignments related to theory and appropriate Practical skills.
Minimum of one mid-term test during the 8-week term.
Final exam at end of term.
Periodic quizzes.

Instructional and Delivery Strategies: Use steamfitting related examples in all math problem solving situations. Allowing the use of a simple calculator will be encouraged for all but estimation exercises.

Reference Materials: IPT Pipe Trades Handbook
IPT Electronics Handbook
Alberta steamfitting modules

Recommended Equipment List: simple calculator

Number: S0929.1

Title: **Cube and Cube Root Calculations**

Duration: Total 1 hours Theory 0.5 hours Practical 0.5 hours

Cross-Reference to Training Standard: 5471.0, 5472.0, 5473.0, 5474.0, 5475.0, 5476.0, 5480.0, 5483.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to solve problems involving cube and cube root with the aid of a calculator.

Learning Outcomes And Content

- 1.1 Define “Cube”
- 1.2 Define “Cube Root”
- 1.3 Describe methods of estimating the “Cube” and “Cube Root” of a number
- 1.4 Calculate cube and cube roots using a calculator to solve piping problems

Number: S0929.2

Title: Angles and Degrees

Duration: Total 7 hours Theory 3.5 hours Practical 3.5 hours

Cross-Reference to Training Standard: 5471.0, 5472.0, 5473.0, 5474.0, 5475.0, 5476.0, 5480.0, 5483.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to solve problems involving angles and degrees with the aid of a calculator.

Learning Outcomes And Content

- 2.1 Define “Angle”
- 2.2 Define “Degree”
- 2.3 Define “Trigonometry”
- 2.4 Explain the use of trigonometry charts
- 2.5 Explain how trigonometry can be used to solve steamfitting related programs
- 2.6 Use applied trigonometry to solve steamfitting related programs
- 2.7 State the formula for tube bending allowance
- 2.8 Perform calculations related to bending tubing and pipe

Number: S0929.3

Title: **Volumes of Tanks and Cylinders**

Duration: Total 7 hours Theory 3.5 hours Practical 3.5 hours

Cross-Reference to Training Standard: 5471.0, 5472.0, 5473.0, 5474.0, 5475.0, 5476.0, 5480.0, 5483.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to calculate volumes of tanks and cylinders to piping system Practicals with the aid of a calculator.

Learning Outcomes And Content

3.1 State the formulas for the volume of the following shaped tanks:

- square
- rectangular
- cylindrical
- spherical
- hemispherical
- combinations of the above

3.2 Identify weight and volume units contained in the following systems:

- Imperial
- U.S.
- metric

3.3 Calculate the capacity, in Imperial gallons, of a square or rectangular tank of given dimensions

3.4 Calculate the weight of water, in pounds, contained in a square or rectangular tank of given dimensions

3.5 Calculate the capacity, in Imperial gallons, contained in a cylinder (flat ends) of given dimensions

3.6 Calculate the weight of water, in pounds, contained in a cylinder (dished ends) of given dimensions

- 3.7 Convert three given volumes and three given weights in Imperial units to equivalent metric units
- 3.8 Convert three given volumes and three given weights in metric units to equivalent Imperial units
- 3.9 Calculate the average weight per pipe hanger to support a length of pipe during a hydrostatic test given:
- size of pipe
 - type of pipe material
 - pipe schedule
 - length of pipe
 - minimum number of pipe hangers per linear unit
 - appropriate charts giving the weights of various pipe per linear unit
- 3.10 Calculate the force on each of four legs of a spherical tank half filled with water, given:
- the inside diameter of the tank
 - the weight of the tank when empty
 - the surface area at the bottom of each leg

Number: S0929.4

Title: **Gas Laws**

Duration: Total 7 hours Theory 3.5 hours Practical 3.5 hours

Cross-Reference to Training Standard: 5471.0, 5472.0, 5473.0, 5474.0, 5475.0, 5476.0, 5480.0, 5483.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to solve trade related problems involving gas laws with the aid of a calculator.

Learning Outcomes And Content

- 4.1 Define Boyle's Law
- 4.2 State the formula for Boyle's Law
- 4.3 Apply Boyle's Law to solve trade-related gas volume and pressure problems
- 4.4 Define Charles Law I and II
- 4.5 State the formula for Charles Law I
- 4.6 State the formula for Charles Law II
- 4.7 Apply Charles Law I and II to solve trade related gas, volume and pressure problems related to steamfitting

Number: S0929.5

Title: **Gas Laws**

Duration: Total 1 hours Theory 0.5 hours Practical 0.5 hours

Cross-Reference to Training Standard: 5471.0, 5472.0, 5473.0, 5474.0, 5475.0, 5476.0, 5480.0, 5483.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to solve simple and compound interest with the aid of a calculator.

Learning Outcomes And Content

- 5.1 Define “simple and compound interest”
- 5.2 Solve given trade-related problems involving simple and compound interest

Number: S0929.6

Title: **List Price, Trade Discount and Net Price**

Duration: Total 1 hours Theory 0.5 hours Practical 0.5 hours

Cross-Reference to Training Standard: 5471.0, 5472.0, 5473.0, 5474.0, 5475.0, 5476.0, 5480.0, 5483.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to solve trade related problems involving list price and trade discounts with the aid of a calculator.

Learning Outcomes And Content

6.1 Define the following:

- list price
- trade discount
- selling (net) price

6.2 Calculate the selling (net) price of trade-related items given the list price and trade discount

Mark Distribution:

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

Number:	S0930		
Title:	Trade Documentation II		
Duration:	Total Hours: 24	Theory: 11	Practical: 13
Prerequisites:	Level 1		
Contents:	S0930.1	Template Development	
	S0930.2	Drawings and Blueprints	
	S0930.3	Applied Business Practices	

Evaluation & Testing: Assignments related to theory and appropriate Practical skills.
Minimum of one mid-term test during the 8-week term.
Final exam at end of term.
Periodic quizzes.

Instructional and Delivery Strategies: Use of templates in shop projects will test the theory of template development and reinforce the need for accuracy.

Reference Materials: Template Development for the Pipe Trades
IPT Pipe Trades Handbook
Pipe Fitters and Pipe Welders Handbook

Recommended Equipment List: drafting tables
T" square
template
paper
compass
30°, 60° and 45° set squares
protractors
french curve

Number: S0930.1

Title: **Template Development**

Duration: Total 15 hours

Theory 6 hours

Practical 9 hours

Cross-Reference to Training Standard: 5471.0, 5472.0, 5473.0, 5474.0, 5475.0, 5475.0, 5476.0, 5480.0, 5483.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe and illustrate template development.

Learning Outcomes And Content

- 1.1 Describe template development for a two-piece 45° elbow
- 1.2 Describe the uses for a two-piece 45° elbow
- 1.3 Illustrate lines, angles and circles, and bisect and divide them into equal divisions
- 1.4 Define drawing reference points
- 1.5 Describe template development for a two-piece 90° elbow
- 1.6 Describe the uses for a two-piece 90° elbow
- 1.7 Explain why two-piece 90° elbows are seldom used to convey liquids
- 1.8 State the internal measurement of a 6-inch two-piece 90° elbow at its widest point
- 1.9 Calculate the developed lengths of the template for a 6-inch pipe (6 5/8-inch O.D.) using 1/16-inch gasket material
- 1.10 Calculate the developed length of the template for a 2 1/2-inch pipe (2 7/8-inch O.D.) using 1/8-inch gasket material
- 1.11 Describe template development for a three-piece 90° elbow
- 1.12 State the angle of cut for a three-piece 90° elbow
- 1.13 State the angle of cut for a four-piece 90° elbow
- 1.14 Name the three main factors to be considered in developing a template for a multi-piece elbow

- 1.15 State the center-line dimensions for a three-piece 90° elbow with a specific radius
- 1.16 State the developed length of the template for a 3-inch pipe
- 1.17 Describe template development for a 45° lateral
- 1.18 Explain the reason fabricated lateral tees are used instead of manufactured lateral tees
- 1.19 State the main disadvantage of using a lateral tee in a run of pipe
- 1.20 Name two procedures which will minimize the bending of the pipe
- 1.21 State the developed length of the template for a 3-inch pipe (3 ½-inch O.D.)
- 1.22 Describe the complete template development for a 45° lateral tee using 3-inch pipe (3 ½-inch O.D.)
- 1.23 Describe template development for reducing 45° lateral
- 1.24 Explain the main difference between the cut lines for a full-size lateral tee and a reducing lateral tee
- 1.25 Explain two reasons for the recommendation that the inside diameter be used for the plan view of the branch
- 1.26 Explain the main difference between the development of the hole in the run for a full-size lateral and the development of the hole for a reducing lateral
- 1.27 Develop templates necessary to fabricate shop projects such as a 45° lateral reducing tee using 4-inch pipe for the run and 3-inch pipe for the branch

Number: S0930.2

Title: Drawings and Blueprints

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Cross-Reference to Training Standard: 5471.0, 5472.0, 5473.0, 5474.0, 5475.0, 5475.0, 5476.0, 5480.0, 5483.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe and illustrate the use of drawings and blueprints.

Learning Outcomes And Content

- 2.1 Describe the use of isometric drawings
- 2.2 State the purpose of a pictorial drawing
- 2.3 Identify the three most common types of pictorial drawings
- 2.4 Identify the type of pictorial drawing most frequently used
- 2.5 State the angle at which lines representing lengths and widths are drawn and labeled
- 2.6 State the angle at which lines representing heights are drawn and labeled
- 2.7 Describe how you would begin an isometric drawing
- 2.8 Illustrate how overall dimensions are drawn and labeled
- 2.9 Illustrate how non-isometric lines are drawn and labeled
- 2.10 Illustrate how extension lines are laid out for length and height
- 2.11 Illustrate how dimension lines are drawn and labeled
- 2.12 Illustrate how horizontal pipes are shown on an isometric drawing
- 2.13 Illustrate how vertical pipes are shown on an isometric drawing
- 2.14 Describe how to identify piping elevation drawings
- 2.15 Explain the reason piping systems are drawn and labelled in elevation
- 2.16 Describe the procedure for laying out a piping elevation drawing

- 2.17 Explain the reason for darkening the piping and fitting lines on a drawing
- 2.18 State the purpose of sleeving for a piping system
- 2.19 List the different types of sleeves required prior to a concrete pour
- 2.20 Define the following terms:
- temporary sleeving
 - permanent sleeve
 - waterproof or water tight sleeve
 - sleeve template
 - fire stopping
 - insulation
- 2.21 Describe the construction features and Practicals of sleeves including:
- types of materials for temporary, permanent, water tight joints
 - recommended lengths for temporary and permanent sleeves
 - sleeve sizes for given pipe sizes
 - use of a sleeve template
- 2.22 Describe the recommended securing procedure for sleeves prior to a concrete pour
- 2.23 Develop a plan view showing the location, number and diameter of sleeves for a given steamfitting practical

Number: S0930.3

Title: Applied Business Practices

Duration: Total 3 hours Theory 1 hours Practical 2 hours

Cross-Reference to Training Standard: 5471.0, 5472.0, 5473.0, 5474.0, 5475.0, 5475.0, 5476.0, 5480.0, 5483.0

General Learning Outcomes

Upon successful completion the apprentice is able to prepare applied business practice documents.

Learning Outcomes And Content

- 3.1 Prepare trade related reports, forms and business letters
- 3.2 Prepare a trade-related technical report for oral presentation
- 3.3 Complete a workers' compensation form given relevant information
- 3.4 Complete an industrial accident report form given relevant information
- 3.5 Fill out a sample work order form for hypothetical work done, given an appropriate set of conditions and parameters
- 3.6 Write business letters pertaining to:
 - customer job enquiries
 - acknowledgment of orders
 - claims for goods damaged in shipment
- 3.7 Interpret a given sample purchase order including “fine print” items
- 3.8 Prepare a hypothetical purchase order identifying the following products (including model or part number)
 - quantities
 - price
 - discounts
 - taxes
 - freight charges
 - delivery terms

Mark Distribution:

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

Number:	S0931		
Title:	Welding II		
Duration:	Total Hours: 24	Theory: 3	Practical: 21
Prerequisites:	Level 1		
Contents:	S0931.1	Electrical Arc Safety	
	S0931.2	Shielded Metal Arc Welding Procedures	
	S0031.3	Butt Weld Mild Steel	

Evaluation & Testing: Assignments related to theory and appropriate Practical skills.
Minimum of one mid-term test during the 8-week term. Final exam at end of term.
Periodic quizzes.

Instructional and Delivery Strategies: Delivery of theory and practical will be closely aligned. Use of templates from the Trade Documentation II reportable subject to build shop projects will test the theory of template development. The use shop project fabricated pipe fittings from Pipe Fabrication II reportable subject classes will reinforce the need for well fitted welding joints.

Reference Materials: IPT Metal Trades Handbook IPT Pipe Trades Handbook Alberta steamfitting modules

Recommended Equipment List: shielded metal arc welding equipment and supplies
protective safety equipment including goggles, hearing and breathing protection
approved ventilated welding area welding booths
grinders files wire brushes

Number: S0931.1

Title: **Electrical Arc Safety**

Duration: Total 1 hours Theory 1 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5473.0, 5474.0, 5475.0, 5476.0, 5479.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to describe electrical arc welding safety precautions in accordance with government safety regulations and approved industry standards.

Learning Outcomes And Content

1.1 Describe the safety factors regarding electrical arc protection:

- protective clothing
- eye protection
- hand protection
- safety footwear
- electrical current hazard
- fumes
- effects of moisture

Number: S0931.2

Title: **Shielded Metal Arc Welding Procedures**

Duration: Total 2 hours Theory 2 hours Practical 0 hours

Cross-Reference to Training Standard: 5472.0, 5473.0, 5474.0, 5475.0, 5476.0, 5479.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to identify, state and apply shielded metal arc welding procedures in accordance with government safety regulations, manufacturers' recommendations and approved industry standards.

Learning Outcomes And Content

- 2.1 Describe the fundamentals of shielded metal arc welding
- 2.2 State the difference between straight and reverse polarity
- 2.3 Comprehend welding symbols
- 2.4 Describe the construction features and operation of shielded metal arc welding equipment and supplies
- 2.5 State how to test for polarity
- 2.6 Identify the meaning of the numbers in the AWS electrode code classification
- 2.7 Name four types of electrodes commonly used in the trade
- 2.8 List two common sizes of electrodes
- 2.9 State what determines electrodes size
- 2.10 State the purpose of the coating on electrodes
- 2.11 List factors to consider when selecting an electrode for a specific job Practical
- 2.12 Describe the storage procedure for electrode
- 2.13 Identify common arc welding faults and describe methods of control
- 2.14 State five causes of poor welds
- 2.15 State two reasons for removing slag from weld
- 2.16 State three reasons for fusing one bead in with another

2.17 List four factors that determine weld quality

2.18 State reasons for polarity changes

Number: S0931.3

Title: **Butt Weld Mild Steel**

Duration: Total 21 hours Theory 0 hours Practical 21 hours

Cross-Reference to Training Standard: 5472.0, 5473.0, 5474.0, 5475.0, 5476.0, 5479.0, 5484.0

General Learning Outcomes

Upon successful completion the apprentice is able to butt weld mild steel in the flat, horizontal and overhead positions using shielded metal arc welding equipment.

Learning Outcomes And Content

- 3.1 Select the correct electrode according to factors governing job requirements
- 3.2 Set up and adjust the welding machine prior to welding
- 3.3 Check equipment for safe operating condition
- 3.4 Prepare, tack and butt weld mild steel plate in the flat, horizontal and overhead positions
- 3.5 Strike and maintain an arc on mild steel plate
- 3.6 Lay beads on steel plate or pipe
- 3.7 Weld the pipe projects from the Pipe Fabrication II reportable subject

Mark Distribution:

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



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