Skilled Trades Ontario | Métiers spécialisés Ontario

Apprenticeship Curriculum Standard

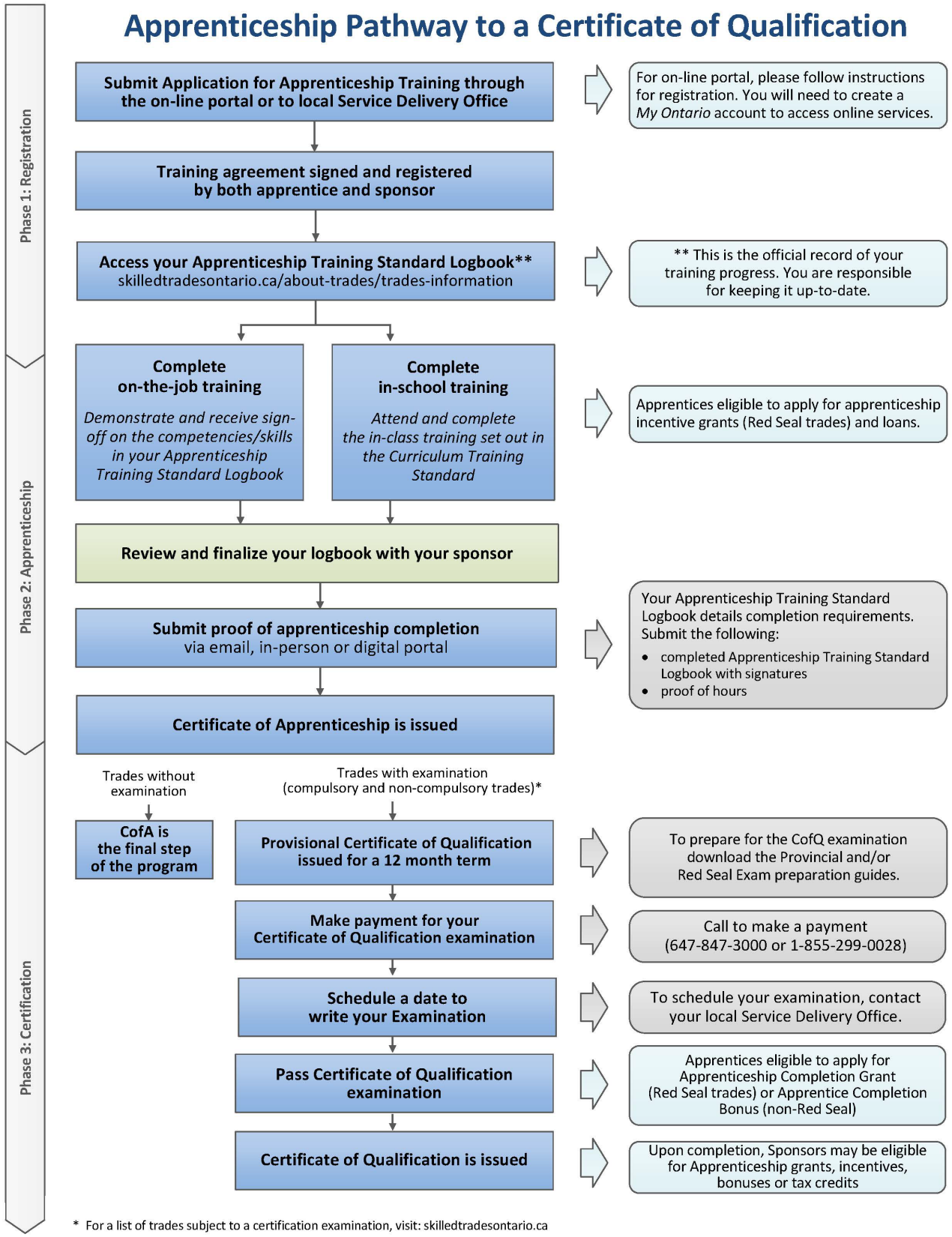
Refrigeration and Air Conditioning Systems Mechanic
Branch 1 - 313A

Residential Air Conditioning Systems Mechanic
Branch 2 - 313D

Level 1 Common Core

2008

Apprenticeship Pathway to a Certificate of Qualification



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

Draft version: 2022-03-16

Table of Contents

Preface 1

Program Summary of Reportable Subjects 3

S0731: Trade Practices 4

S0731.1 Identify regulations as applicable to the Occupational Health and Safety Act (OHSA) 6

S0731.2 Identify personal protective equipment 7

S0731.3 Identify safe working conditions 7

S0731.4 Identify procedures for handling hazardous or toxic materials 7

S0731.5 Identify fire safety procedures 8

S0731.6 Identify procedures for reporting injuries 8

S0731.7 Describe procedures to prevent personal injury 8

S0731.8 Identify lockout and tagging procedures 9

S0731.9 Identify procedures for operating material handling equipment 9

S0731.10 Identify procedures for the use of personnel lift equipment 9

S0731.11 Describe procedures for handling refrigerants and ODP requirements 9

S0731.12 Identify procedures for the containment of refrigerant 10

S0731.13 Identify safe working procedures when using hand and power tools 11

S0731.14 Identify pertinent Codes, Acts, Regulations, and Legislation 11

S0732: Mechanical Cooling Cycle Fundamentals 12

S0732.1 Describe the structure of matter, molecular motion, work and energy 14

S0732.2 Describe thermal energy and the change of state 15

S0732.3 Describe the laws of physics that relate to vapours and gases 16

S0732.4 Describe the operating principles and function of a mechanical cooling cycle 16

S0732.5 Describe operating temperatures and pressures for mechanical cooling cycles 16

S0732.6 Demonstrate procedures for plotting a mechanical cooling cycle on a mollier diagram 17

S0732.7 Describe the application of various refrigerants 18

S0732.8 Describe the utilization of cylinders or containers to transport or store refrigerants 19

S0732.9 Describe the application of various refrigeration lubricants 20

S0733: Mechanical Cooling System Components and Accessories 21
S0733.1 Describe the operating principles and function of compressors used in a mechanical cooling cycle 23
S0733.2 Describe the operating principles and function of metering devices used in a mechanical cooling cycle 24
S0733.3 Describe the operating principles and function of condensers used in a mechanical cooling cycle 24
S0733.4 Describe the operating principles and function of evaporators used in a mechanical cooling cycle 25
S0733.5 Describe the operating principles and function of accessories used in a mechanical cooling cycle 26
S0733.6 Identify the materials used to interconnect the components and accessories for a mechanical cooling cycle 26
S0734: Electrical Fundamentals 27
S0734.1 Describe procedures for solving problems involving current flow in a DC circuit 29
S0734.2 Describe the application of electrical measuring instruments used to start-up, troubleshoot or service refrigeration and air conditioning systems..... 31
S0734.3 Describe alternating current load devices and circuits 32
S0734.4 Describe the sequence of electrical operations in refrigeration and air conditioning systems..... 33
S0734.5 Describe procedures for installing electrical component wiring..... 34
S0735: Cutting, Soldering, Brazing, And Welding 36
S0735.1 Identify safety regulations for air-fuelled, oxy-fuelled and gas-fuelled equipment used when cutting, soldering, brazing, and welding..... 38
S0735.2 Describe the setting up of air-fuel equipment and materials used to solder or braze pipe and piping..... 38
S0735.3 Describe the setting up of oxy-fuel equipment and materials used to join or cut plate and angle steel..... 39
S0735.4 Demonstrate procedures for cutting plate or angle steel..... 40
S0735.5 Perform soldering operations 40
S0735.6 Demonstrate procedures for brazing copper joints up to 1 3/8” (1.325 mm) 40
S0735.7 Demonstrate oxy-acetylene welding processes for plate or angle steel..... 41

S0736: Installation of Mechanical Cooling Systems 43

S0736.1 Identify applicable safe work practices for the installation of mechanical air cooling systems 45

S0736.3 Demonstrate the use of hand and power tools to cut and join refrigerant tubing and to install mechanical cooling system 47

S0736.4 Identify lifting equipment and material handling equipment used during installations 48

S0736.5 Describe worksite preparation procedures 49

S0736.6 Demonstrate installation procedures for mechanical cooling systems 49

S0736.7 Demonstrate procedures for starting up and commissioning a mechanical cooling system 50

S0737: Basic Maintenance Procedures 53

S0737.1 Identify procedures for checking and inspecting mechanical cooling system components 55

S0737.2 Identify inspection and basic maintenance procedures for a system heat pump and accessories 56

S0737.4 Identify inspection and basic maintenance procedures for a mechanical cooling system air handling unit 56

S0737.5 Identify inspection and basic maintenance procedures for fans in a mechanical cooling system 56

S0737.6 Identify various cooling system mechanical or electrical failures 56

S0737.7 Identify inspection and basic maintenance procedures for heat recovery ventilators 56

S0737.8 Identify procedures for inspecting mechanical cooling system electronic air cleaners 56

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 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)

Maintained with transfer to Skilled Trades Ontario 2008 (V100)

Preface

This curriculum standard for the Level 1 – Common Core for the Refrigeration and Air Conditioning Mechanics trade program is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into 7 reportable subjects. 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.

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 1

Common Core

Program Summary of Reportable Subjects
Refrigeration and Air Conditioning Systems Mechanic
Residential Air Conditioning System Mechanic
Level 1 – Common Core

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
S0731.0	Trade Practices	15	6	9
S0732.0	Mechanical Cooling Cycle Fundamental	24	8	6
S0733.0	Mechanical Cooling Cycle Components and Accessories	45	27	18
S0734.0	Electrical Fundamentals	60	28	32
S0735.0	Cutting, Soldering, Brazing, and Welding	36	12	24
S0736.0	Installation of Mechanical Cooling Systems	45	15	30
S0737.0	Basic Maintenance Procedures	15	6	9
	Total	**240**	**112**	**128**

Number:	S0731	
Title:	**Trade Practices**	
Duration:	Total 15 hours	Theory 6 hours Practical 9 hours
Prerequisites:	Grade 12	
Content:	S0731.1	Identify regulations as applicable to the Occupational Health and Safety Act. (OHSA) (0.5 / 0 hrs)
	S0731.2	Identify personal protective equipment. (0.5 / 0 hrs)
	S0731.3	Identify safe working conditions. (0.5 / 0 hrs)
	S0731.4	Identify procedures for handling hazardous or toxic materials. (0.5 / 0 hrs)
	S0731.5	Identify fire safety procedures. (0.5 / 0 hrs)
	S0731.6	Identify procedures for reporting injuries. (0.5 / 0 hrs)
	S0731.7	Describe procedures to prevent personal injury.(0 / 0.5 hrs)
	S0731.8	Identify lockout and tagging procedures. (0 / 0.5 hrs)
	S0731.9	Identify procedures for operating material handling equipment. (1 / 1 hrs)
	S0731.10	Identify procedures for the use of personnel lift equipment. (1 / 1 hrs)
	S0731.11	Describe procedures for handling refrigerants and ODP requirements. (0 / 2 hrs)
	S0731.12	Identify procedures for the containment of refrigerant. (0 / 3 hrs)
	S0731.13	Identify safe work procedures when using hand or power tools. (0 / 1 hrs)
	S0731.14	Identify pertinent Codes, Acts, Regulations, and Legislation. (1 / 0 hrs)

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

Instructional and Delivery Strategies: Lecture
Video
Paper based material
Demonstration – Practical Lab Assignments
CBT
E-Learning

Reference Materials:

Occupational Health and Safety Manual for Refrigeration and Air Conditioning
Dangerous Goods Transportation Act
Workplace Hazardous Materials Information System
Occupational Health and Safety Act and Regulations for Construction Projects
Environmental Code of Practice for the Reduction of Chlorofluorocarbon (ODP program)
Emissions from Refrigeration and Air Conditioning Systems
Modern Refrigeration and Air Conditioning (Althouse, Turnquist & Bracciano)
Applicable Software Training Materials
Manufacturers' Literature
Applicable Acts, Regulations, Legislation, and Codes

- Ontario Fire Code
- Canadian Electrical Code
- Boiler Pressure Vessels Act
- Mechanical Refrigeration Code CSA B52
- Provincial and Federal Halocarbon Regulations
- TSSA (Technical Standards and Safety Act)
- Building Code
- Municipal Codes

Number:	S0731.0		
Title:	**Trade Practices**		
Duration:	Total: 15 hours	Theory: 6 hours	Practical: 9 hours
Cross-Reference to Training Standards: 313D: U6230.0 > U6237.0 313A: U6238.0 > U6245.0			

General Learning Outcome

Upon successful completion, the apprentice will be able to describe the responsibilities of employers and employees relating to safe working practices and protection of the environment in accordance with applicable Acts, Regulations, Legislation, and Codes.

Learning Outcomes

31.1 Identify regulations as applicable to the Occupational Health and Safety Act (OHSA).
(0.5 / 0 hrs)

Describe the applicable terms from the OHSA including:
- committee
- competent person
- constructor
- construction site
- designated substance
- employer
- factory
- hazardous material
- minister and ministry
- occupational illness/accidents
- project
- supervisor
- worker

Identify pertinent sections of the OHSA including:
- selection and powers of health and safety representatives
- joint health and safety committees
- enforcement of the act

Identify applicable sections of the OHSA including:
- duties of constructor, employer, supervisor and worker
- outline procedures to report unsafe conditions
- the right to refuse or stop work

Describe the application of codes of practice in the OHSA.

31.2 Identify personal protective equipment.
(0.5 / 0 hrs)

Identify personal protective equipment including:
- hearing protection
- safety glasses
- protective headgear
- goggles
- hand protection
- safety boots
- protective clothing
- respirators
- fall arrest systems
- electrical safety gloves
- chemical gloves
- welding gloves

31.3 Identify safe working conditions.
(0.5 / 0 hrs)

Identify procedures for maintaining a safe work including:
- first aid equipment
- work area clear of obstructions and debris
- storage of tools and equipment
- handling soldering, brazing and welding equipment
- storing gas cylinders
- clean and store all equipment
- protection from protruding sharp objects
- piling of material
- storage of corrosive or toxic substances
- containers for flammable materials
- material safety data sheets
- ventilation requirements
- working in enclosed spaces
- reporting unsafe conditions
- rules of safe conduct
- handling of reaction impairing drugs

31.4 Identify procedures for handling hazardous or toxic materials.
(0.5 / 0 hrs)

Identify hazardous or toxic materials including:

- acids
- cleaners
- solvents
- refrigerants
- refrigerant oil
- contaminated lubricants
- welding gases

Identify approved storage methods and containers for hazardous materials.

Identify procedures for storing and disposing of recovered refrigerants and lubricants.

Identify regulations regarding the transport of refrigerants.

31.5 Identify fire safety procedures.
(0.5 / 0 hrs)

Identify fire suppression equipment.

Identify common fire hazards including:
- explosion hazards
- electrical wiring hazards
- open flame

List types of fires including:
- class A, ordinary combustibles
- class B, flammable hydrocarbon fluids
- class C, electrical equipment
- class D, combustible metals

Identify the procedures for assessing and suppressing fires including:
- types of fire extinguishers
- hoses and hose cabinets Identify evacuation procedures.

31.6 Identify procedures for reporting injuries.
(0.5 / 0 hrs)

Identify situations where first aid may be required.

Identify Workplace Safety and Insurance Board (WSIB) reporting requirements.

Identify requirements of a completed safety or injury report.

31.7 Describe procedures to prevent personal injury.
(0 / 0.5 hrs)

Determine safe physical limits.

Describe manual lifting techniques.

Describe methods to transport heavy equipment or materials.

31.8 Identify lockout and tagging procedures.
(0 / 0.5 hrs)

Identify electrical hazards that can occur with the power source and the system.

Identify situations when lockout and tagging are required.

Identify procedures for locking out and tagging potentially hazardous sources of energy including:
- electrical
- mechanical
- hydraulic
- pneumatic
- rotating equipment

31.9 Identify procedures for operating material handling equipment.
(1 / 1 hrs)

Describe application, functions, and capabilities of material handling equipment including:
- hoists
- rollers
- carts
- dollies
- slings
- cables

Identify material handling equipment required for picking up and moving equipment and components.

31.10 Identify procedures for the use of personnel lift equipment.
(1 / 1 hrs)

Identify sections of Safety Regulations that relate to worker and public safety when using personnel lift equipment.

Describe the application and capabilities of personnel lift equipment including:
- ladders
- scaffolds
- elevating work platforms

31.11 Describe procedures for handling refrigerants and ODP requirements.
(0 / 2 hrs)

Describe the occurrence of stratospheric ozone.

Identify the consequences of atmospheric ozone depletion.

Describe the term Ozone Depletion Potential as it applies to refrigerants.

Identify the Ozone Depletion Potential value for various refrigerants.

Describe the process that causes refrigerants to produce a depletion of stratospheric ozone.

Describe the term Global Warming and Refrigerant Global Warming Potential.

Describe the term Total Equivalent Warming Impact (TEWI).

List the consequences of global warming.

Identify the global warming potential value for various refrigerants.

Identify terms of the Montreal Protocol that relate to the decreased production or phase-out of various refrigerants.

31.12 Identify procedures for the containment of refrigerant.
(0 / 3 hrs)

Identify the code of practice for the reduction of chlorofluorocarbon emissions from refrigeration and air conditioning systems.

Describe the four R's used to explain refrigerant containment options including:
- recover
- reuse
- recycle
- reclaim

Describe methods employed to recover refrigerants including:
- passive recovery
- recovery machines

Describe the operating cycle and system connection procedures for various types of refrigerant recovery machines.

Demonstrate the application of a refrigerant recovery machine by removing the refrigerant charge from a refrigeration or air conditioning system.

Describe procedures for removing the refrigerant charge from a refrigeration or air conditioning system employing water cooled condensers or liquid coolers.

Describe contaminants that may be contained in refrigerants that are recovered from operating or burned out systems.

Describe methods employed to determine whether or not a refrigerant removed from a system can be re-introduced into the same system.

Describe methods employed to recycle refrigerants.

Describe the operating cycle for various types of refrigerant recycling machines.

31.13 Identify safe working procedures when using hand and power tools.
(0 / 1 hrs)

Identify typical causes of hand and power tool accidents.

Identify safe work practices when using hand and power tools including:
- eye protection
- correct tool for the task
- manufacturers' recommendations
- maintenance of tools
- grounding of tools

31.14 Identify pertinent Codes, Acts, Regulations, and Legislation.
(1 / 0 hrs)

Identify applicable Codes, Acts, Regulations, and Legislation including:
- OHSA (Ontario Health and Safety Act)
- WCA (Workers' Compensation Act)
- EPA (Environmental Protection Act)
- DGTA (Dangerous Goods Transportation Act)
- WHMIS (Workplace Hazardous Materials Information System)
- OFC (Ontario Fire Code)
- CEC (Canadian Electrical Code)
- BPVA (Boiler Pressure Vessels Act)
- MOE (Ministry of the Environment)
- ODP (Ozone Depletion Prevention Program/Refrigerant Environmental Awareness Program)
- Provincial and Federal Halocarbon Regulations
- TSSA (Technical Standards and Safety Act)
- Building Code
- Municipal Codes

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	60%	100%

Number:	S0732		
Title:	**Mechanical Cooling Cycle Fundamentals**		
Duration:	Total: 24 hours	Theory: 18 hours	Practical: 6 hours
Prerequisites:	Grade 12		

Content:

S0732.1	Describe the structure of matter, molecular motion, work and energy. (2 / 0 hrs)
S0732.2	Describe thermal energy and the change of state. (2 / 0 hrs)
S0732.3	Describe the laws of physics that relate to vapours and gases. (2 / 0 hrs)
S0732.4	Describe the operating principles and function of a mechanical cooling cycle. (3 / 0 hrs)
S0732.5	Describe operating temperatures and pressures for mechanical cooling cycles. (3 / 0 hrs)
S0732.6	Demonstrate procedures for plotting a mechanical cooling cycle on a mollier diagram. (0 / 6 hrs)
S0732.7	Describe the application of various refrigerants. (2 / 0 hrs)
S0732.8	Describe the utilization of cylinders or containers to transport or store refrigerants. (2 / 0 hrs)
S0732.9	Describe the application of various refrigeration lubricants. (2 / 0 hrs)

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

Instructional and Delivery Strategies: Lecture
Video
Paper based material
Demonstration – Practical Lab Assignments
CBT
E-Learning

Reference Materials:

Occupational Health and Safety Manual for Refrigeration and Air Conditioning
Dangerous Goods Transportation Act
Workplace Hazardous Materials Information System
Occupational Health and Safety Act and Regulations for Construction Projects
Environmental Code of Practice for the Reduction of Chlorofluorocarbon (ODP program) Emissions from Refrigeration and Air Conditioning Systems
Modern Refrigeration and Air Conditioning (Althouse, Turnquist & Bracciano)
Applicable Software Training Materials
Manufacturers' Literature
Applicable Acts, Regulations, Legislation, and Codes

- Ontario Fire Code
- Canadian Electrical Code
- Boiler Pressure Vessels Act
- Mechanical Refrigeration Code CSA B52
- Provincial and Federal Halocarbon Regulations
- TSSA (Technical Standards and Safety Act)
- Building Code
- Municipal Codes

Number:	S0732.0		
Title:	**Mechanical Cooling Cycle Fundamentals**		
Duration:	Total: 24 hours	Theory: 18 hours	Practical: 6 hours

Cross-Reference to Training Standard: U6231; U6232; U6233; U6234; U6235;U6236; U6239; U6240; U6241

General Learning Outcome

Upon successful completion, the apprentice will be able to describe in detail the fundamentals of a mechanical cooling cycle.

Learning Outcomes

32.1 Describe the structure of matter, molecular motion, work and energy. (2 / 0 hrs)

Describe the features of:
- atom
- molecule
- compounds

Describe molecular movements and heat. Describe measurement of matter:
- volume
- density

Solve problems involving the measurement of matter.

Solve problems involving the effects of heat on matter.

Describe classifications of energy including:
- kinetic energy
- potential energy
- heat energy
- definition of heat

Describe energy sources including:
- mechanical
- electrical
- chemical
- heat

Describe expenditure of energy including:
- work and horsepower
- units of work
- work equivalents
- energy efficiency

Describe pressures including:
- atmospheric pressure
- units of pressure and vacuum measurement
- pressure-temperature relationships-saturation tables

Solve problems which involve units of pressure.

32.2 Describe thermal energy and the change of state.
(2 / 0 hrs)

Describe heat transfer including:
- direction of flow
- conduction
- convection
- radiation
- factors that effect rate of heat flow

Describe heat transfer air and water medium.

Describe insulation including:
- types of insulation
- insulating values
- vapour barrier

Describe states of matter including:
- solid
- liquid
- gas

Describe intensity of heat including:
- temperature sensation
- temperature scales
- types of temperature measuring instruments

Solve problems involving temperature scale conversions.

Describe quantity of heat including:
- difference between intensity and quantity
- define BTU

Solve problems involving latent heat.

Describe heat energy and the change of state including:
- latent heat
  - vaporization
  - fusion
  - condensation
  - sublimation
  - crystallization
- saturated and superheated vapour

- sub-cooled liquid

Describe the effect of heat on matter including:
- expansion
- linear
- volumetric
- coefficients of expansion

Solve problems which involve the effects of heat on matter.

32.3 Describe the laws of physics that relate to vapours and gases.
(2 / 0 hrs)

Describe gas laws including:
- converting units to absolute scale
- Charles' law for constant pressure processes
- Boyle's law for constant temperatures processes
- Lussac's law for constant volumes processes
- general gas law (Perfect Gas Equation)

Solve problems involving gas laws.

Describe Dalton's law of partial pressures.

32.4 Describe the operating principles and function of a mechanical cooling cycle.
(3 / 0 hrs)

Describe saturated pressure temperature relationships for various refrigerants.

Describe the function of the four main system components and the inter-connecting piping.

Describe the change in refrigerant conditions that occur including:
- during passage through the compressor
- during passage through the condenser
- during passage through the metering device
- during passage through the evaporator

Describe the division between the high pressure side and the low pressure side of a mechanical cooling cycle.

Describe the operational differences between a fixed metering device critically-charged system and a modulating liquid flow control system.

Describe condensing units, condensing medium, and standard ton conditions.

32.5 Describe operating temperatures and pressures for mechanical cooling cycles.
(3 / 0 hrs)

Describe condensing unit construction, operation, and nameplate data.

Describe the operating principles and function of a compressor including:

- characteristics of common refrigerant thermodynamic
  - entering, within, and leaving all components
- specific volume of vapour
- density of liquid
- condition of refrigerant vapour
- discharge temperature and pressure
- calculated superheat

Describe the operating principles and function of a condenser including:
- condition of refrigerant vapour
- saturated condensing temperature and pressure
- calculated sub-cooling

Describe the operating principles and function of a receiver including:
- pressure losses in condenser and piping
- saturation pressure and temperature
- loss of sub-cooling

Describe the operating principles and function of metering devices including:
- condition of entering refrigerant
- pressure and temperature of entering refrigerant
- importance of sub-cooling
- pressure reduction
- flash gas
- temperature reduction

Describe the operating principles and function of an evaporator including:
- condition of refrigerant entering evaporator
- saturated suction temperature and pressure
- evaporator superheat
- operating evaporator superheat
- suction line superheat
- total suction superheat

32.6 Demonstrate procedures for plotting a mechanical cooling cycle on a mollier diagram.
(0 / 6 hrs)

Describe the construction of a pressure enthalpy chart including:
- pressure scale
- enthalpy scale
- sub-cooled sections
- saturated sections
- superheated sections
- saturated vapour line
- saturated liquid line
- temperature lines
- critical temperature

- lines of constant quality
- constant volume lines
- entropy lines

Demonstrate procedures for the plotting of mechanical cooling cycles on a pressure enthalpy chart including:
- heat absorbed by evaporator
- heat of compression
- superheat in compressor discharge vapour
- heat rejected by condenser
- sub-cooling in liquid line
- flash gas

32.7 Describe the application of various refrigerants.
(2 / 0 hrs)

Describe characteristics of refrigerants.

Identify empirical refrigerant formulas including:
- CFC's – Chlorofluorocarbon
- HCFC's – Hydrochlorofluorocarbon
- HFC's – Hydrofluorocarbon
- PFC's – Per fluorocarbon
- HC's – Hydro Carbon
- CO2 – Carbon Dioxide
- non-carbon based refrigerants
- natural refrigerants

Describe chemical composition and formula of common refrigerants including:
- single element
- azeotropic mixtures
- near azeotropic refrigerant mixtures

Describe factors effecting the safe application of refrigerants including:
- B-52 toxicity classification numbering system
- B-52 flammability classification numbering system
- material safety data sheets

Identify refrigerant nomenclature (numbering system) including:
- ANSI / ASHRAE standard 34
- methane-based
- ethane-based
- zeotropes
- azeotropes
- natural refrigerants

Describe refrigerant properties including:
- environmental
- saturation tables

- toxicity
- flammability
- stability
- material compatibility
- moisture solubility
- dielectric strength
- leak detection
- efficiency
- pressure
- temperature
- specific volume
- density
- enthalpy
- entropy
- glide
- bubble point
- dew point
- critical point

32.8 Describe the utilization of cylinders or containers to transport or store refrigerants. (2 / 0 hrs)

Interpret identification data that appear on cylinders or containers used to transport refrigerants including:

- U.S. department of transport (DOT)
- Canadian transport commission (CTC)
- transportation of dangerous goods (TDG)
- tare weight (tw)
- water capacity (wc)
- cylinder type
- container
  - type
  - containment devices
- service pressure (sp)
- working pressure (wp)
- test pressure (tp)
- bursting pressure (bp)
- liquid capacity
- test date

Describe types of valves/devices including:

- access valves installed on cylinders or containers
- pressure relief devices installed on cylinders or containers

Describe the colour code used to identify the type and use of containers including:

- existing
- new

- recovered
- reclaimed refrigerants
- ARI guideline N

32.9 Describe the application of various refrigeration lubricants.
(2 / 0 hrs)

Describe the function of oil in a compressor including:
- fluid seal
- noise dampening
- coolant
- lubricant

Identify the classifications of oil including:
- animal
- vegetable
- mineral
- synthetic

Describe the properties of oil including:
- viscosity
- specific gravity
- refractive index
- pour point
- dielectric strength
- foaming
- floc point
- chemical stability
- moisture content
- moisture absorption

Describe oil-refrigerant affinity and the effect on oil return.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
75%	25%	100%

Number:	S0733		
Title:	**Mechanical Cooling System Components and Accessories**		
Duration:	Total: 45 hours	Theory: 27 hours	Practical: 18 hours
Prerequisites:	Grade 12		

Content:	S0733.1	Describe the operating principles and function of compressors used in a mechanical cooling cycle. (7 / 4 hrs)
	S0733.2	Describe the operating principles and function of metering devices used in a mechanical cooling cycle. (6 / 5 hrs)
	S0733.3	Describe the operating principles and function of condensers used in a mechanical cooling cycle. (2 / 3 hrs)
	S0733.4	Describe the operating principles and function of evaporators used in a mechanical cooling cycle. (3 / 3 hrs)
	S0733.5	Describe the operating principles and function of accessories used in a mechanical cooling cycle. (3 / 3 hrs)
	S0733.6	Identify the materials used to interconnect the components and accessories of a mechanical cooling cycle. (6 / 0 hrs)

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

Instructional and Delivery Strategies: Lecture
Video
Paper based material
Demonstration – Practical Lab Assignments
CBT
E-Learning

Reference Materials:

Occupational Health and Safety Manual for Refrigeration and Air Conditioning
Dangerous Goods Transportation Act
Workplace Hazardous Materials Information System
Occupational Health and Safety Act and Regulations for Construction Projects
Environmental Code of Practice for the Reduction of Chlorofluorocarbon (ODP program)
Emissions from Refrigeration and Air Conditioning Systems
Modern Refrigeration and Air Conditioning (Althouse, Turnquist & Bracciano)
Applicable Software Training Materials
Manufacturers' Literature
Applicable Acts, Regulations, Legislation, and Codes

- Ontario Fire Code
- Canadian Electrical Code
- Boiler Pressure Vessels Act
- Mechanical Refrigeration Code CSA B52
- Provincial and Federal Halocarbon Regulations
- TSSA (Technical Standards and Safety Act)
- Building Code
- Municipal Codes

Number:	S0733.0
Tittle:	**Mechanical Cooling System Components and Accessories**
Duration:	Total 45 hours Theory 27 hours Practical 18 hours
Cross-Reference to Training Standard:	U6231; U6232; U6233; U6234; U6235; U6236; U6239; U6240; U6241

General Learning Outcome

Upon successful completion, the apprentice will be able to describe the operating principles and function of the mechanical cooling system components and accessories.

Learning Outcomes

33.1 Describe the operating principles and function of compressors used in a mechanical cooling cycle.
(7 / 4 hrs)

Describe basic air distribution, basic air properties, and basic air measurements

Identify operating principles and functions of compressors including:
- reciprocating
- rotary
- scroll
- centrifugal
- screw (helical rotary)

Describe advantages and disadvantages of compressor construction including:
- open
- serviceable-hermetic
- hermetic

Describe the operating functions and characteristics of compressors including:
- compressor or system service valves
- system pump down procedures
- compression ratio
- volumetric efficiency
  - theoretical displacement
  - actual volume displaced
- coefficient of performance
- compressor lubrication systems

Identify problems that can causes compressor failure including:
- refrigerant flood-back
- flooded starts
- off-cycle refrigerant migration
- liquid slugging/contamination
- overheating

- loss of oil
- electrical problems
- selection or sizing procedures

33.2 Describe the operating principles and function of metering devices used in a mechanical cooling cycle.
(6 / 5 hrs)

Describe procedures for the sizing of metering devices including:
- liquid temperature entering valve
- pressure differential across valve
- effects of a distributor

Describe the function of a metering device in a mechanical cooling cycle

Describe capillary tube and fixed orifice metering devices including:
- operation
- applications
- advantages and disadvantages
- critical charge
- capacity considerations

Describe automatic expansion valves including:
- operation
- applications
- advantages and disadvantages

Describe thermostatic expansion valves including:
- operation
- TXV components
- operating forces
- superheat measurement
- valve modulation
- valve charges
- external equalizers
- hunting

Describe electronic metering devices including:
- superheat measurement
- operation
- applications
- sizing of metering devices
- advantages and disadvantages

33.3 Describe the operating principles and function of condensers used in a mechanical cooling cycle.
(2 / 3 hrs)

Describe the function of a condenser in a mechanical cooling cycle.

Describe factors that determine the capacity of a condenser.

Identify condenser coil terminology including:
- construction
- temperature difference
- logarithmic mean temperature differential
  - split
  - coil TD
- approach

Describe air-cooled condensers including:
- construction
- condenser versus condensing unit
- low ambient operation
- sub cooling
- operation

Describe the function of water-cooled tubes used in tube condensers including:

- operation
- construction
- applications

Describe factors effecting condenser operation.

33.4 Describe the operating principles and function of evaporators used in a mechanical cooling cycle.
(3 / 3 hrs)

Describe the function of an evaporator in a mechanical cooling cycle.

Describe factors that determine the capacity of an evaporator.

Describe evaporator temperature difference and approach temperature including:
- logarithmic mean temperature differential
  - split
  - coil TD

Describe sensible heat factor and the effect on evaporator operation.

Describe distributors that supply refrigerant to direct expansion evaporators.

Describe factors that effect evaporator operation.

Describe the operation of air handling units and fans.

Describe drive systems for fans with pulleys and belts.

Identify problems that can occur regarding pulley diameters and driven-driver speed.

Describe installation procedures for V-belts.

33.5 Describe the operating principles and function of accessories used in a mechanical cooling cycle.
(3 / 3 hrs)

Describe the operating principles and function of system accessories including:
- receiver
- subcooler
- check valve
- pressure relief devices
  - valves
  - rupture discs
  - fusible plugs
- liquid moisture indicator
- drier
- suction filter
- discharge muffler
- vibration eliminator
- water-regulating valve

33.6 Identify the materials used to interconnect the components and accessories for a mechanical cooling cycle.
(6 / 0 hrs)

Identify materials and fittings used to connect components of a refrigeration or air conditioning system including:
- grades of copper tubing
- grades of pipe
- isolating valves
- pipe assembly methods
- pipe fittings

Identify fundamental requirements for:
- suction line piping
- discharge line piping
- liquid line piping

Identify support equipment and materials including:
- hangers
- wall sleeves
- clamps

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
65%	35%	100%

Number:	S0734		
Title:	**Electrical Fundamentals**		
Duration:	Total: 60 hours	Theory: 28 hours	Practical: 32 hours
Prerequisites:	Grade 12		

Content:	S0734.1	Describe procedures for solving problems involving current flow in a DC circuit. (5 / 5 hrs)
	S0734.2	Describe the application of electrical measuring instruments used to start-up, troubleshoot or service refrigeration and air conditioning systems. (2 / 4 hrs)
	S0734.3	Describe alternating current load devices and circuits. (8 / 2 hrs)
	S0734.4	Describe the sequence of electrical operations in refrigeration and air conditioning systems. (10 / 16 hrs)
	S0734.5	Describe procedures for installing electrical component wiring. (3 / 5 hrs)

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

Instructional and Delivery Strategies: Lecture
Video
Paper based material
Demonstration – Practical Lab Assignments
CBT
E-Learning

Reference Materials:

Occupational Health and Safety Manual for Refrigeration and Air Conditioning
Dangerous Goods Transportation Act
Workplace Hazardous Materials Information System
Occupational Health and Safety Act and Regulations for Construction Projects
Environmental Code of Practice for the Reduction of Chlorofluorocarbon (ODP program)
Emissions from Refrigeration and Air Conditioning Systems
Modern Refrigeration and Air Conditioning (Althouse, Turnquist & Bracciano)
Applicable Software Training Materials
Manufacturers' Literature
Applicable Acts, Regulations, Legislation, and Codes

- Ontario Fire Code
- Canadian Electrical Code
- Boiler Pressure Vessels Act -Mechanical Refrigeration Code CSA B52
- Provincial and Federal Halocarbon Regulations
- TSSA (Technical Standards and Safety Act)
- Building Code
- Municipal Codes

Number: S0734.0

Title: Electrical Fundamentals

Duration: Total: 60 hours Theory: 28 hours Practical: 32 hours

Cross-Reference to Training Standard: U6231; U6232; U6233; U6234; U6235; 6236; U6239; U6240; U6241; U6242; U6243; U6244

General Learning Outcome

Upon successful completion, the apprentice will be able to describe the operating principles and fundamentals of an electrical system and components used in refrigeration and air conditioning systems.

Learning Outcomes

34.1 Describe procedures for solving problems involving current flow in a DC circuit. (5 / 5 hrs)

Describe electrical terms and elements including:
- matter
- energy
- element
- molecule

Describe the basic relationship between the structure of the atom and electron flow.

Describe static electricity.

Describe conventional current flow versus electron flow.

Identify the units of measurement used to describe electricity including:
- ohms
- volts
- coulombs
- amps
- watts
- kilowatt-hour

Describe the difference between conductors and insulators including:
- conductivity
- resistively

Describe wire size (AWG) and wiring resistance.

Identify different classes of insulation used for wire.

Calculate voltage drop through conductors.

Describe the difference between AC current and DC current.

Describe the functions of components in a simple electrical circuit including:
- conductors in a simple electrical circuit
- manual and automatic switches
- load devices in a simple electrical circuit
- over-load devices in a simple electrical circuit
- over-current devices in a simple electrical circuit

Describe the relationship between resistance, voltage and current in a simple electric circuit. (Ohm's law)

Solve problems for DC series circuits using electrical laws including:
- total resistance
- total voltage
- voltage drop across individual loads
- total current

Demonstrate the principles of series circuits by connecting loads in series and taking measurements including:
- total resistance
- total voltage
- voltage drop across individual loads

Solve problems with DC parallel circuits using electrical laws including:
- total resistance
- total voltage
- total current
- current through each load

Demonstrate the principles of parallel circuits by connecting loads in parallel and taking measurements including:
- total resistance
- total voltage
- total current
- current through each load

Solve problems for DC combination circuits using electrical laws including:
- total resistance
- total current
- current through each load

Describe power in a direct current application.

Solve problems involving power.

Determine the cost of operating an electrical load over a period of time.

Solve problems involving line loss and voltage drop.
Identify the pertinent requirements of the Canadian Electrical Codes including:
- wire sizing
- current carrying capacity

34.2 Describe the application of electrical measuring instruments used to start-up, troubleshoot or service refrigeration and air conditioning systems.
(2 / 4 hrs)

Identify personal protective equipment including:
- electrical safety gloves
- face shields
- non-conductive mats
- safety boots

Identify classifications of electrical test instruments.

Demonstrate the application of a voltmeter to measure potential difference in an energized circuit including:
- meters measuring range
- scale values
- calibration procedures
- check instrument
- test lead condition
- common hazards

Demonstrate the application of a clamp-on ammeter to measure current flow in an energized electrical circuit including:
- meters measuring range
- multimeter
- scale values
- calibration procedures
- check instrument
- test lead condition
- common hazards

Demonstrate the application of a multimeter to measure small currents.

Demonstrate the application of an ohmmeter to measure resistance in a de-energized electrical circuit including:
- meters measuring range
- scale values
- calibration procedures
- check instrument
- test lead condition
- common hazards

Demonstrate the application of a wattmeter to measure power consumed by a single-phase inductive load including:
- meters measuring range
- scale values
- calibrate instrument
- check instrument
- test lead condition
- common hazards

Demonstrate the application of a capacitance meter to evaluate start and run capacitors.

Demonstrate the application of a megohm meter to measure the condition of the winding insulation in an electric motor including:
- scale values
- calibration procedures
- check instrument
- test lead condition
- common hazards

Identify instruments or devices used to measure including:
- potential difference in an energized electrical circuit
- electrical current in an energized electrical circuit
- resistance to current flow in a de-energized electrical circuit
- power consumed in an energized single-phase electrical circuit containing an inductive load device
- capacitance
- condition of the winding insulation in an electric motor

Describe the application of instruments used to record system electrical characteristics over a period of time.

34.3 Describe alternating current load devices and circuits.
(8 / 2 hrs)

Describe the fundamental principles of magnetism including:
- laws of magnetism
- magnetic field
- flux density
- permeability
- reluctance

Describe the fundamental principles of electromagnetism.

Identify the methods that are used to produce electro motive force.

Describe instantaneous, peak and RMS values for voltage and current.

Describe inductive reactance and the effect on current flow.

Describe the construction and characteristics of an elementary capacitor.

Describe capacitive reactance and the effect on current flow.

Describe impedance and unit of measure for impedance.

Describe power in an alternating circuit application.

Identify the units of measurement and symbols for power. Describe the power factor.

Describe the operating principles and application of electrical components including:
- transformers
- relays
- contactors
- thermostats
- pressure controls
- electronic temperature controllers
- flow controls
- timers
- circuit breakers
- fuses
- overloads
- crankcase heater
- run-capacitor

Demonstrate the application of relays by constructing circuits in which relays control various loads.

Describe the operating principles and application of single phase motors including:
- shaded pole
- split phase
- capacitor start
- permanent split capacitor
- capacitor start
- capacitor run

34.4 Describe the sequence of electrical operations in refrigeration and air conditioning systems. (10 / 16 hrs)

Identify types of electrical diagrams used to install and service refrigeration and air conditioning systems including:
- pictorial
- installation
- schematic

Identify the symbols used to represent electrical devices on a typical schematic diagram including:
- temperature-activated switches
- pressure-activated switches

- manual switches
- flow-activated switches
- timers
- liquid level-activated switches
- momentary switches
- disconnects
- solid-state components
- capacitors
- circuit breakers
- relay coils
- relay contacts
- fuses
- grounds
- transformers
- overloads
- motors
- factory and field installed wiring

Demonstrate sketching procedures to convert simple pictorial wiring diagrams to schematic diagrams.

Interpret schematic diagrams to determine the sequence of operation for air conditioning systems including:
- add-on air conditioning systems for fossil fuel heating units
- add-on air conditioning systems for electric heating units
- add-on air conditioning systems for high efficiency heating units
- single-phase rooftop heat-cool units

Demonstrate procedures for constructing schematic wiring diagrams for various cooling power and control circuits.

34.5 Describe procedures for installing electrical component wiring.
(3 / 5 hrs)

Identify conductor size using:
- Canadian Electrical Code
- manufacturers' specifications
- engineering drawings
- site specifications

Identify hand and power tools used to install conductors for the wiring of the components.

Demonstrate procedures for terminating and splicing stranded and solid conductors including:
- single-phase rooftop heat-cool units
- solder-less wire connectors
- crimp-on devices

- terminal screws
- manufacturers' specifications

Demonstrate installing procedures for component wiring including:
- manufacturers' specifications
- design specifications
- electrical layout
- schematic drawings

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
45%	55%	100%

Number:	S0735		
Title:	**Cutting, Soldering, Brazing, And Welding**		
Duration:	Total: 36 hours	Theory: 12 hours	Practical: 24 hours
Prerequisites:	Grade 12		

Content:

S0735.1	Identify applicable safety regulations for air- fuelled, oxy-fuelled and gas-fuelled equipment used for cutting, soldering, brazing, and welding. (1 / 0 hrs)
S0735.2	Describe the setting up of air-fuel equipment and materials used to solder or braze pipe and piping. (2 / 0 hrs)
S0735.3	Describe the setting up of oxy-fuel equipment and materials used to join or cut plate and angle steel. (2 / 0 hrs)
S0735.4	Demonstrate procedures for cutting plate or angle steel. (0 / 2 hrs)
S0735.5	Perform soldering operations. (0 / 2 hrs)
S0735.6	Demonstrate procedures for brazing copper joints up to 1 3/8” (1.325 mm). (4 / 13 hrs)
S0735.7	Demonstrate oxy-acetylene welding processes for plate or angle steel. (3 / 7 hrs)

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

Instructional and Delivery Strategies: Lecture
Video
Paper based material
Demonstration – Practical Lab Assignments
CBT
E-Learning

Reference Materials:

Occupational Health and Safety Manual for Refrigeration and Air Conditioning
Dangerous Goods Transportation Act
Workplace Hazardous Materials Information System
Occupational Health and Safety Act and Regulations for Construction Projects
Environmental Code of Practice for the Reduction of Chlorofluorocarbon (ODP program)
Emissions from Refrigeration and Air Conditioning Systems
Modern Refrigeration and Air Conditioning (Althouse, Turnquist & Bracciano)
Applicable Software Training Materials
Manufacturers' Literature
Applicable Acts, Regulations, Legislation, and Codes

- Ontario Fire Code
- Canadian Electrical Code
- Boiler Pressure Vessels Act -Mechanical Refrigeration Code CSA B52
- Provincial and Federal Halocarbon Regulations
- TSSA (Technical Standards and Safety Act)
- Building Code
- Municipal Codes

Number:	S0735.0		
Title:	**Cutting, Soldering, Brazing, and Welding**		
Duration:	Total: 36 hours	Theory: 12 hours	Practical: 24 hours
Cross-Reference to Training Standard: U6231.0, U6232.0, U6235.0, U6239.0, U6240.0, U6241.0, U6242.0, U6243.0			

General Learning Outcome

Upon successful completion, the apprentice will be able to braze or solder pipe and piping and cut or weld plate and angle steel.

Learning Outcomes

35.1 Identify safety regulations for air-fuelled, oxy-fuelled and gas-fuelled equipment used when cutting, soldering, brazing, and welding.
(1 / 0 hr)

Identify safety regulations for air fuelled, oxy-fuelled and gas-fuelled equipment used when cutting, soldering, brazing, and welding including:

- safety legislations
- applicable regulations and legislation
  - B52
  - B51
  - B31
  - B35
  - ASME 9
- protective clothing
- protective equipment and gear
- handling of equipment
- power source
- grounding requirements
- set-up procedures
- tear down procedures
- lighting procedures
- handling of cylinders
- storing of cylinders

35.2 Describe the setting up of air-fuel equipment and materials used to solder or braze pipe and piping.
(2 / 0 hrs)

Describe the setting up of air-fuel equipment and materials used to solder or braze pipe and piping including:

- safety legislations
- protective clothing, equipment, and gear
- job documentation and drawings
- precautions regarding fuel cylinders
- operation of fuel pressure regulators
- assembly procedures for air-fuel outfit
- methods for checking for fuel leaks
- air-fuel torch lighting procedures
- adjusting of regulator
- normal and emergency torch shut-down procedures
- sequence for de-pressurizing the fuel gas system.
- documentation of work

35.3 Describe the setting up of oxy-fuel equipment and materials used to join or cut plate and angle steel.
(2 / 0 hrs)

Describe the setting up of oxy-fuel equipment and materials used to join or cut plate and angle steel including:

- safety legislations
- protective clothing, equipment and gear
- job documentation and drawings
- products of oxy-fuel combustion
- procedures to reduce welding fire hazards
- precautions regarding gas cylinders
- handling fuel gases
- purpose of gas pressure regulators
- difference between primary and secondary flame
- oxidizing, neutral, and carbonizing flames
- operation of gas pressure regulators
- colours used to identify oxy-fuel gas hoses
- difference between oxygen and fuel hose connections
- assembly of an oxy-fuel cutting outfit
- methods for checking for oxygen or fuel leaks
- use of reverse-flow check valves
- transportation procedures for oxy-fuel cylinders
- procedures to adjust the regulators
- conditions that cause flame colour change, backfire, flashback
- methods to clean an oxy-fuel gas tip
- normal and emergency torch shut-down procedures

- sequence for de-pressurizing oxy-fuel gas system
- documentation of work

35.4 Demonstrate procedures for cutting plate or angle steel.
(0 / 2 hrs)

Identify applicable safe working procedures when cutting plate or angle steel including:
- safety legislations
- protective clothing
- protective equipment and gear
- job documentation and drawings

Describe procedures for using oxy-fuel equipment to cut plate or angle steel materials.

Demonstrate procedures for cutting plate and angle steel including:
- torch set-up procedure
- lighting procedures
- cutting techniques

35.5 Perform soldering operations.
(0 / 2 hrs)

Demonstrate soldering techniques to produce leak-proof joints for copper to copper, or copper to non-similar materials including:
- pipe measuring procedures
- pipe cutting procedures
- joint cleaning and preparation
- application of flux
- torch set-up procedures
- torch lighting procedures
- type of solder

Demonstrate soldering using lead free (95/5) solder that will pass visual and destructive testing including:
- vertical position
- horizontal position
- inverted position

35.6 Demonstrate procedures for brazing copper joints up to 1 3/8” (1.325 mm).
(4 / 13 hrs)

Identify applicable safe working procedures when brazing including:
- safety legislations
- protective clothing, equipment and gear

- job documentation and drawings

Identify requirements for TSSA Brazing certification.
Identify environmental protocols for brazing materials and equipment.

Describe procedures for purging refrigerant piping with nitrogen during brazing operations.

Demonstrate silver brazing using oxy-acetylene or air-fuel equipment to produce joints for copper to copper or copper to steel various size materials including:

- base metals
- tubing design
- pipe measuring procedures
- pipe cutting procedures
- joint cleaning and preparation
- reasons for purging with an inert gas
- application of the flux
- torch set-up procedure
- torch lighting procedure
- selection of the filler rod
- braze using silver brazing alloy that will pass visual and destructive testing
  - vertical position
  - horizontal position inverted position

Demonstrate phosphorous flux brazing alloy (silfos™) brazing techniques using oxy-acetylene or air-fuel equipment to produce 1 3/8″ copper to copper joints including:

- pipe measuring and cutting procedures
- joint cleaning and preparation
- reasons for purging with an inert gas
- torch set-up procedures
- torch lighting procedures
- selecting the filler rod

Demonstrate brazing using phosphorous flux brazing alloy (silfos™) that will pass visual inspection and sectioning of the joint including:

- vertical up position
- horizontal position

35.7 Demonstrate oxy-acetylene welding processes for plate or angle steel.
(3 / 7 hrs)

Identify applicable safe working procedures when welding plate or angle steel including:

- safety legislations

- protective clothing
- protective equipment and gear
- job documentation and drawings

Describe metallurgical bonding in the welding process.

Interpret welding terminology.

Identify types of joints to be welded including:
- lap joint
- tee joint
- butt joint
- corner joint

Identify the required filler rod.

Demonstrate oxy-acetylene welding techniques including:
- joint cleaning
- joint preparation
- torch set-up procedure
- lighting procedures
- running a bead without filler material and with filler rod
- fuel gases
- gas regulators
- primary and secondary flame
- flame characteristics
- leaks
- check valves
- cleaning oxy-fuel gas tip
- adjusting regulators
- welding inspection techniques
- shut down procedures
- de-pressurizing gas system

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
33%	67%	100%

Number:	S0736		
Title:	**Installation of Mechanical Cooling Systems**		
Duration:	Total: 45 hours	Theory: 15 hours	Practical: 30 hours
Prerequisites:	Grade 12		

Content:

- S0736.1 Identify applicable safe work practices for the installation of mechanical air cooling systems. (1 / 0 hrs)
- S0736.2 Demonstrate use of measuring and checking instruments and devices used when installing mechanical cooling systems. (1 / 2 hrs)
- S0736.3 Demonstrate use of hand and powers tools to cut and join refrigerant tubing and install a mechanical cooling system. (2 / 4 hrs)
- S0736.4 Identify lifting equipment and material handling equipment used during installations. (1 / 2 hrs)
- S0736.5 Describe worksite preparation procedures.(1 / 0 hrs)
- S0736.6 Demonstrate installation procedures for mechanical cooling systems. (3 / 13 hrs)
- S0736.7 Demonstrate procedures for starting up and commissioning a mechanical cooling system. (6 / 9 hrs)

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

Instructional and Delivery Strategies:
Lecture
Video
Paper based material
Demonstration – Practical Lab Assignments
CBT
E-Learning

Reference Materials:

Occupational Health and Safety Manual for Refrigeration and Air Conditioning
Dangerous Goods Transportation Act
Workplace Hazardous Materials Information System
Occupational Health and Safety Act and Regulations for Construction Projects
Environmental Code of Practice for the Reduction of Chlorofluorocarbon (ODP program)
Emissions from Refrigeration and Air Conditioning Systems
Modern Refrigeration and Air Conditioning (Althouse, Turnquist & Bracciano)
Applicable Software Training Materials
Manufacturers' Literature
Applicable Acts, Regulations, Legislation, and Codes

- Ontario Fire Code
- Canadian Electrical Code
- Boiler Pressure Vessels Act -Mechanical Refrigeration Code CSA B52
- Provincial and Federal Halocarbon Regulations
- TSSA (Technical Standards and Safety Act)
- Building Code
- Municipal Codes

Number:	S0736.0		
Title:	**Installation of Mechanical Cooling Systems**		
Duration:	Total: 45 hours	Theory: 15 hours	Practical: 30 hours

Cross-Reference to Training Standard: U6231.0 > U6235.0; U6239.0 > U6241.0

General Learning Outcome

Upon successful completion, the apprentice will be able demonstrate procedures for the installation and commissioning of mechanical cooling systems.

Learning Outcomes

36.1 Identify applicable safe work practices for the installation of mechanical air cooling systems.
(1 / 0 hrs)

Identify applicable Codes, Acts, Regulations and Legislations for the installation of mechanical cooling systems including:
- OHSA (Ontario Health and Safety Act)
- WCA (Workers' Compensation Act)
- EPA (Environmental Protection Act)
- DGTA (Dangerous Goods Transportation Act)
- WHMIS (Workplace Hazardous Materials Information System)
- OFC (Ontario Fire Code)
- CEC (Canadian Electrical Code)
- BPVA (Boiler Pressure Vessels Act) (Pressure Piping)
- MOE (Ministry of the Environment)
- ODP (Ozone Depletion Prevention Program/Refrigerant Environmental Awareness Program)
- TSSA (Technical Standards and Safety Act)
- EA (Energy Act)
- Building Code
- Municipal Codes

Identify pertinent safe practices during the installation of a mechanical cooling system including:
- safety legislation
- protective clothing
- protective equipment and gear
- hand and power tools
- material handling equipment

36.2 Demonstrate use of measuring and checking instruments and devices when installing mechanical cooling systems.
(1 / 2 hrs)

Identify instruments used to measure both ambient and operational temperatures required to start-up a mechanical cooling system.

Describe the operating principles and function of temperature measuring instruments including:
- glass thermometers
- psychrometers
- digital pocket thermometers
- electronic thermometers
- infrared thermometers

Demonstrate the application of the temperature measuring instruments including:
- meters measuring range
- scale values
- calibration procedures
- maintenance of instruments
- storage

Identify devices used to measure refrigerant pressures in a system to start-up a mechanical cooling system.

Describe operating principles and functions of pressure measuring devices including:
- gauge manifold
- compound gauges
- pressure gauges
- vacuum gauges
- digital gauges
- manometers

Demonstrate the application of pressure measuring devices including:
- determine pressure range of the gauge
- describe saturation scales on gauges
- manifold connections:
  - charge a system
  - recover refrigerant
  - evacuate a system

Describe maintenance, storage and calibration procedures for pressure measuring devices.

Identify measuring devices used to measure air flow in a system.

Describe the operating principles and functions for airflow measuring devices and instruments including:

- U-tube manometers
- inclined manometer
- electronic manometer
- pitot tube
- differential pressure gauge (magnehelic)
- rotating vane anemometer
- deflecting vane anemometer
- thermal anemometer
- flow hood
- tachometer

Demonstrate the use of airflow measuring devices and instruments.

36.3 Demonstrate the use of hand and power tools to cut and join refrigerant tubing and to install mechanical cooling system.
(2 / 4 hrs)

Identify hand tools required to cut and join refrigerant tubing. Describe features of tubing cutters including:

- size
- operating characteristics
- dimensional restrictions
- necessary force
- maintenance

Demonstrate the use of tubing cutters. Describe features of flaring tools including:

- size
- operation characteristics
- maintenance

Demonstrate the use of flaring tools.

Describe features of swaging tools including:

- size
- operating characteristics
- dimensional restrictions
- necessary force
- maintenance

Demonstrate the use of swaging tools. Describe features of crimping tools including:

- size
- maintenance

Demonstrate the use of crimping tools.
Identify features of power tools used to install a mechanical cooling system including:

- threading machines
- electric drills
- drill presses
- electric skill saws
- chop saws
- reciprocating saws
- jig or scroll saws
- grinders
- impact wrenches
- pipe cutters

Describe assembling, adjusting, and maintenance of power tools.

36.4 Identify lifting equipment and material handling equipment used during installations. (1 / 2 hrs)

Describe preparation procedures for material handling equipment including:

- safety legislation
- government regulations
- job documentation
- calculations
  - size of system
  - weight of load
  - height of lift
  - distance of move

Identify the operating principles and functions of lifting and material handling equipment including:

- hoists
- crane
- slings
- cables
- chains
- rollers
- dollies
- ladders
- boom truck
- lifts
- inspection procedures
- equipment assessment process

- repair recommendations
- lifting and moving procedures
- tagging procedures
- documentation of work

36.5 Describe worksite preparation procedures.
(1 / 0 hrs)

Describe procedures for preparing the worksite including:
- safety legislation
- job documentation
- site inspection procedures
- worksite clearing procedures
- worksite hazards or obstacles
- checking that all power sources are available
- contacting other trades and inspectors
- documentation of work

36.6 Demonstrate installation procedures for mechanical cooling systems.
(3 / 13 hrs)

Describe procedures for locating and mounting mechanical system components.

Interpret planning documentation and manufacturers' design specifications.

Identify worksite system conditions including:
- power supply
- condensing medium temperature
- load medium temperature
- packing material has been removed
- panels are installed

Describe the operating principles and applications for mechanical cooling system components and accessories including:
- air handler
- air filtration equipment
- condensing unit
- evaporator coil
- system accessories
- piping
- pipe insulation
- system controls
- condensate pumps
- humidifiers

- heat recovery ventilators (HRV)
- energy recovery ventilators (ERV)
- mechanical ventilation equipment

Describe procedures for assembling and installing mechanical system components and accessories.

Demonstrate the assembly and installation of mechanical cooling system components and accessories.

36.7 Demonstrate procedures for starting up and commissioning a mechanical cooling system.
(6 / 9 hrs)

Identify applicable safety procedures when leak-testing a system.

Describe tools and materials used for leak-testing including:
- inert gases
- regulators
- gauges
- soap solutions
- dyes
- ultraviolet leak detectors
- electronic leak detectors
- ultrasonic leak detectors

Demonstrate procedures for conducting a positive pressure test to locate refrigerant leaks including:
- devices to detect HCFC and HFC refrigerant leaks
- visual inspection
- positive pressure leak test
- bubble solutions
- negative pressure leak test
- electronic leak detectors
- ultrasonic leak detectors

Demonstrate a pressure test to locate leaks using inert gases and leak detection soap.

Describe inches of mercury and micron vacuum readings.

Identify pertinent codes, acts, legislation, and regulations that apply when evacuating a residential air conditioning system.

Identify the equipment required to evacuate a residential air conditioning unit

Identify methods used to speed up evacuation.

Demonstrate the application of evacuation equipment to perform system evacuation to specified micron readings including:
- vacuum pumps
- vacuum gauges
- high vacuum gauge tube (thermistors)
- depth of vacuum

Interpret design specifications to determine required operating conditions.

Identify the tools and materials used to charge a system with refrigerant including:
- manifold gauges
- hoses
- weigh scales
- charging cylinders
- temperature measuring instruments
- psychrometers
- refrigerant recovery equipment

Demonstrate use of tools and materials to add the correct refrigerant charge to a new air conditioning system.

Demonstrate the procedures for accurately measuring a refrigerant charge.

Demonstrate procedures for charging the system with refrigerant.

Demonstrate procedures for the start-up of the system.

Demonstrate use of tools and equipment to verify that the mechanical cooling system is operating to design specifications including:
- pressure gauges
- temperature measuring instruments
- electrical measuring instruments
- tachometers
- psychrometers
- simulators
- anemometers

Demonstrate verification procedures of the system operation including:
- load medium temperature
- control system set points
- supply voltage
- operating current
- condensing medium conditions
- medium conditions
- refrigerant system operating temperatures
- operating pressures

- compare operating conditions to design requirements
- determine whether system operation meets the job requirements
- determine whether contract requirements have been completed

Identify documentation requirements including:

- completion of warranty documents
- regulatory requirements
- manufacturers' literature and instruction
- routine maintenance schedule
- location of all equipment and controls
- control system operations

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
33%	67%	100%

Number:	S0737		
Title:	**Basic Maintenance Procedures**		
Duration:	Total: 15 hours	Theory: 9 hours	Practical: 6 hours
Prerequisites:	Grade 12		

Content:	S0737.1	Identify procedures for checking and inspecting mechanical cooling system components. (1 / 1 hrs)
	S0737.2	Identify inspection and basic maintenance procedures for a heat pump and accessories. (1 / 1 hrs)
	S0737.3	Identify inspection and basic maintenance procedures for a mechanical cooling system evaporators and condensers. (1 / 1 hrs)
	S0737.4	Identify inspection and basic maintenance procedures for a mechanical cooling system air handling unit. (1 / 1 hrs)
	S0737.5	Identify inspection and basic maintenance procedures for fans in a mechanical cooling system. (1 / 0.5 hrs)
	S0737.6	Identify various cooling system mechanical or electrical failures. (2 / 0.5 hrs)
	S0737.7	Identify inspection and basic maintenance procedures for a mechanical cooling system heat recovery ventilator.(1 / 0.5 hrs)
	S0737.8	Identify procedures for inspecting mechanical cooling system electronic air cleaners. (1 / 0.5 hrs)

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

Instructional and Delivery Strategies: Lecture
Video
Paper based material
Demonstration – Practical Lab Assignments
CBT
E-Learning

Reference Materials:

Occupational Health and Safety Manual for Refrigeration and Air Conditioning
Dangerous Goods Transportation Act
Workplace Hazardous Materials Information System
Occupational Health and Safety Act and Regulations for Construction Projects
Environmental Code of Practice for the Reduction of Chlorofluorocarbon (ODP program)
Emissions from Refrigeration and Air Conditioning Systems
Modern Refrigeration and Air Conditioning (Althouse, Turnquist & Bracciano)
Applicable Software Training Materials
Manufacturers' Literature
Applicable Acts, Regulations, Legislation, and Codes

- Ontario Fire Code
- Canadian Electrical Code
- Boiler Pressure Vessels Act -Mechanical Refrigeration Code CSA B52
- Provincial and Federal Halocarbon Regulations
- TSSA (Technical Standards and Safety Act)
- Building Code
- Municipal Codes

Number:	S0737.0		
Title:	**Basic Maintenance Procedures**		
Duration:	Total: 15 hours	Theory: 6 hours	Practical: 9 hours

Cross-Reference to Training Standard: 313D – U6235: U6236 313A - U6214

General Learning Outcome

Upon successful completion, the apprentice will be able identify procedures for the inspection and basic maintenance of mechanical cooling systems and components.

Learning Outcomes

37.1 Identify procedures for checking and inspecting mechanical cooling system components.
(1 / 1 hrs)

Identify procedures to inspect or check:

- drive mechanism alignment
- bearings
- belts
- pulleys
- coils
- linkages
- dampers
- wiring
- obstructions
- drain pans
- piping
- filters
- liquid levels
- air flow
- noise level
- discoloration
- moisture
- corrosion
- odors
- vibration
- static balance
- leakage
- dirt

37.2 Identify inspection and basic maintenance procedures for a system heat pump and accessories.
(1 / 1 hrs)

Identify procedures for inspecting and cleaning heat pumps and accessories.

37.3 Identify inspection and basic maintenance procedures for a mechanical cooling system evaporators and condenser.
(1 / 1 hrs)

Identify procedures for inspecting and cleaning evaporators and condensers.

37.4 Identify inspection and basic maintenance procedures for a mechanical cooling system air handling unit.
(1 / 1 hrs)

Identify procedures for inspecting and cleaning air handling units.

37.5 Identify inspection and basic maintenance procedures for fans in a mechanical cooling system.
(1 / 0.5 hrs)

Identify procedures for inspecting and lubricating of fans in a mechanical cooling system.

37.6 Identify various cooling system mechanical or electrical failures.
(1.5 / 1 hrs)

Identify various system mechanical or electrical failures.

37.7 Identify inspection and basic maintenance procedures for heat recovery ventilators.
(1 / 0.5 hrs)

Identify procedures for inspecting and cleaning heat recovery ventilators.

37.8 Identify procedures for inspecting mechanical cooling system electronic air cleaners.
(1 / 0.5 hrs)

Identify inspection procedures for air filters.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	60%	100%

Skilled Trades Ontario | Métiers spécialisés Ontario

skilledtradesontario.ca

Refrigeration and Air Conditioning Mechanic