ONTARIO COLLEGE OF TRADES

ORDRE DES MÉTIERS DE L'ONTARIO

Apprenticeship Curriculum Standard

Refrigeration and Air Conditioning Systems Mechanic Branch 1 - 313A

Level 3 Advanced

Date: 2008

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

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

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

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Introduction

This curriculum revision for the Level 3 – Refrigeration and Air Conditioning Systems Mechanic – Residential, Industrial, Commercial, and Institutional is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into 6 reportable subjects. The Program Summary of Reportable Subjects chart summarizes the training hours for each reportable subject.

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

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.

Program Summary of Reportable Subjects – Level 3– Advanced Refrigeration & Air Conditioning Systems Mechanic

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
S0751.0	Applied Psychrometrics – Industrial, Commercial, and Institutional (ICI)	21	6	15
S0752.0	Prints and Heat Load Calculations - Industrial, Commercial, and Institutional (ICI)	18	3	15
S0753.0	Air Cooling Systems – Industrial, Commercial, and Institutional (ICI)	60	39	21
S0754.0	Air Distribution Systems and Accessories – Industrial, Commercial, and Institutional (ICI)	36	24	12
S0755.0	Advanced Electrical and Control Systems – Industrial, Commercial, and Institutional (ICI)	81	39	42
S0756.0	Electronic Devices and Controls – Industrial, Commercial, and Institutional (ICI)	24	12	12
	Total	**240**	**123**	**117**

Number: **S0751**

Title: **APPLIED PSYCHROMETRICS – Industrial, Commercial and Institutional (ICI)**

Duration: Total 21 hours Theory 6 hours Practical 15 hours

Prerequisites: L1CC – S0731, S0732, S0733, S0734, S0735, S0736, S0737
L2 – S0744, S0745, S0746, S0747, S0748, S0749

Content:

S0751.1 Describe psychrometric terms and conditions related to the performance of refrigeration and air conditioning systems. **(2 / 0 hrs)**

S0751.2 Describe processes involving alterations to the conditions of a mixture of dry air and water vapour in refrigeration and air conditioning systems. **(4 / 0 hrs)**

S0751.3 Describe procedures for constructing and analyzing psychrometric diagrams to determine operating parameters of refrigeration and air conditioning systems. **(0 / 15 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

Mark Distribution:

Theory Testing	Practical Application Testing	Final Assessment
30%	70%	100%

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

S0751.0 Applied Psychrometrics – Industrial, Commercial and Institutional (ICI)

Duration: Total 21 hours Theory 6 hours Practical 15 hours

Cross-Reference to Training Standards:
313A: 6239.0, 6240.0, 6241.0, 6242.0, 6243.0, 6244.0, 6245.0

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice will be able to interpret a psychrometric graphs, construct psychrometric diagrams; interpret psychrometric graphs; and, analyze data on psychrometric diagrams used for refrigeration and air conditioning systems in Industrial, Commercial, or Institutional (ICI) applications.

LEARNING OUTCOMES AND CONTENT

51.1 Describe psychrometric terms and conditions related to the performance of refrigeration and air conditioning systems. **(2 / 0 hrs)**

Describe the conditions required to maintain body comfort including:
- metabolic rate
- body heat loss
- body heat gain
- effective temperatures

Identify terms relevant to the condition of a mixture of dry air and water vapour including:
- composition of air
- enthalpy
- density
- barometric pressure
- wet bulb temperatures
- dry bulb temperatures
- dew point temperatures
- specific and relative humidity

51.2 Describe processes involving alterations to the conditions of a mixture of dry air and water vapour in refrigeration and air conditioning systems. **(4 / 0 hrs)**

Interpret processes on psychrometric charts and tables including:
- sensible heating and cooling
- humidification and dehumidification
- heating and humidification
- cooling and dehumidification
- air mixtures

51.3 Demonstrate procedures for constructing and analyzing psychrometric diagrams to determine operating parameters of refrigeration and air conditioning systems. **(0 / 15 hrs)**

Demonstrate the construction of psychrometric diagrams.

Interpret the operation of refrigeration and air conditioning systems using psychrometric charts, tables, and software including:

- entering and leaving air-conditions
- apparatus dew point
- coil temperature
- cooling coil bypass factor
- airflow quantities
- system capacity
- air mixtures
- air economizers

Describe procedures for documenting system operational information including:

- entering and leaving air-conditions
- apparatus dew point
- coil temperature
- cooling coil bypass factor
- airflow quantities
- cooling system capacity
- percentage of fresh air
- fresh air damper
- fresh air economizer

Number: **S0752**

Title: **PRINTS AND HEAT LOAD CALCULATIONS – Industrial, Commercial and Institutional (ICI)**

Duration: Total 18 hours Theory 3 hours Practical 15 hours

Prerequisites: L1CC – S0731, S0732, S0733, S0734, S0735, S0736, S0737
L2 – S0744, S0745, S0746, S0747, S0748, S0749

Content:

S0752.1 Interpret building drawings for the design of an structure that includes refrigeration and air conditioning systems. **(3 / 5 hrs)**

conditioning

S0752.2 Demonstrate freehand sketching for refrigeration and air conditioning systems installation. **(0 / 2 hrs)**

S0752.3 Describe the impact of heat sources on refrigeration and air conditioning applications. **(0 / 2 hrs)**

S0752.4 Calculate heat gain and heat loss for refrigeration and air conditioning applications. **(0 / 6 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

Mark Distribution:

Theory Testing	Practical Application Testing	Final Assessment
20%	80%	100%

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

S0752.0 Prints and Heat Load Calculations – Industrial, Commercial and Institutional (ICI)

Duration: Total 18 hours Theory 3 hours Practical 15 hours

Cross-Reference to Learning Outcomes/Training Standard:
313A: 6239.0, 6240.0, 6241.0, 6242.0, 6243.0, 6244.0, 6245.0

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice will be able to: interpret building drawings and job documentation; demonstrate sketching for installations; identify heat sources; and, perform heat gain and heat loss calculations for refrigeration and air conditioning systems in Industrial, Commercial, or Institutional (ICI) applications.

LEARNING OUTCOMES AND CONTENT

52.1 Interpret building drawings for the design of a structure that includes refrigeration and air conditioning systems. **(3 / 5 hrs)**

Interpret isometric, orthographic and multi-view drawings.

Interpret working drawings and manuals to identify the location and size of the mechanical equipment and components.

Describe function of lines used in the production of working drawings including:
- object
- dimension
- extension
- projection
- hidden

Identify the symbols, abbreviations, and nomenclature used in typical drawings and installation manuals.

Interpret symbols used on mechanical system drawings to identify:
- piping
- motors
- compressors
- fans
- blowers
- evaporators
- condensers
- metering devices
- pumps

52.1 Continued

Interpret job documentation to identify pertinent information including:
- title block
- drawing revision level
- building orientation
- drawing scales
- type of equipment
- unit capacities
- electrical equipment requirements
- types, quantity, and location of hangers and supports
- on-site piping identification
- materials
- manufacturers' checklists

Determine the precise location and size of mechanical components.

Determine lengths of piping runs by scaling the drawings.

52.2 Demonstrate freehand sketching for refrigeration and air conditioning system installations. **(0 / 2 hrs)**

Demonstrate freehand sketching to locate and position equipment for refrigeration and air conditioning installations including:
- condensing units
- packaged units
- air handling units
- refrigerant piping layout

Demonstrate freehand sketching for the fabrication of items required for installations including:
- duct transitions
- plenums
- air purification
- air cleaning equipment
- brackets for piping
- brackets for condensing units

52.3 Describe the impact of heat sources on refrigeration and air conditioning applications. **(0 / 2 hrs)**

Identify heat sources including:
- heat leakage into the building
- air leakage into the building
- ventilation air
- solar load
- appliances
- lighting
- heat gain from occupants
- heat lag
- insulation and vapour barriers
- degree-day
- R, K, U and C factors

Describe how heat sources impact applications.

52.4 Calculate heat gain and heat loss calculations for refrigeration and air conditioning applications. **(0 / 6 hrs)**

Determine pertinent information for calculating heat gain or heat loss using:
- job surveys
- buildings plans
- design conditions as per Ontario Building Code
- geographical location
- building dimensions
- building orientation
- room sizes and use
- type of wall construction
- roof construction
- roofing colour
- type and thickness of insulation
- location, type and size of windows
- location, type and size of doors
- heat emitting equipment
- occupancy
- load estimate forms
- load estimate tables

Calculate heat gain and heat loss for refrigeration and air conditioning applications.

Number: **S0753**

Title: **AIR COOLING SYSTEMS –**
Industrial, Commercial and Institutional (ICI)

Duration: Total 60 hours Theory 39 hours Practical 21 hours

Prerequisites: L1CC – S0731, S0732, S0733, S0734, S0735, S0736, S0737
L2 – S0744, S0745, S0746, S0747, S0748, S0749

Content:

S0753.1 Describe operating principles and function of a heat pump. **(3 / 0 hrs)**

S0753.2 Identify applicable sections of the Ontario Building Code and Mechanical Refrigeration Standard B52 for refrigeration and air cooling systems . **(4 / 0 hrs)**

S0753.3 Describe operating principals and function of refrigerant piping in refrigeration and air cooling systems. **(4 / 6 hrs)**

S0753.4 Describe installation procedures for refrigeration and air cooling systems. **(6 / 2 hrs)**

S0753.5 Describe the operating principles and function of cooling towers. **(1 / 1 hrs)**

S0753.6 Describe the operating principles and function of water piping, pumps, and accessories for the cooling tower operation. **(6 / 2 hrs)**

S0753.7 Describe procedures for troubleshooting and servicing refrigeration and air cooling systems. **(4 / 4 hrs)**

S0753.8 Describe procedures for transferring power to open drive-type compressors and pumps in refrigeration and air cooling systems. **(2 / 0 hrs)**

S0753.9 Describe alignment procedures for compressors and pumps in refrigeration and air cooling systems. **(0 / 3 hrs)**

S0753.10 Describe verification procedures for control operations in refrigeration and air cooling systems. **(2 / 1 hrs)**

S0753.11 Describe procedures for troubleshooting and identifying problems in refrigeration and air cooling systems. **(4 / 2 hrs)**

S0753.12 Describe lithium bromide absorption cooling cycles in refrigeration and air cooling systems**.** **(3 / 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

Mark Distribution:

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

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
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- Mechanical Refrigeration Code CSA B52
- Provincial and Federal Halocarbon Regulations
- TSSA (Technical Standards and Safety Act)
- Building Code
- Municipal Codes

S0753.0 Air Cooling Systems – Industrial, Commercial and Institutional (ICI)

Duration: Total 60 hours Theory 39 hours Practical 21 hours

Cross-Reference to Learning Outcomes/Training Standard:
313A: 6239.0, 6240.0, 6241.0, 6242.0, 6243.0, 6244.0, 6245.0

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice will be able to describe maintenance procedures for refrigeration and air cooling systems in Industrial, Commercial, or Institutional (ICI) applications.

LEARNING OUTCOMES AND CONTENT

53.1 Describe the operating principles and function of a heat pump. **(3 / 0 hrs)**

Describe the operating principles and function of a heat pump including:
- cooling cycle
- heating cycle
- defrost cycle
- air to air
- liquid source
- ground source

Identify the operating temperatures and pressures for a heat pump including:
- cooling cycle
- heating cycle
- defrost cycle

Describe the operating principles and function for heat pump accessories including:
- liquid indicators
- moisture indicators
- accumulators
- crankcase heaters
- four way reversing valves
- solenoid valves
- check valves
- pressure relief valves

Describe troubleshooting procedures for identifying problems that can occur with heat pump accessories.

Describe procedures to maintain heat pump accessories including inspection, replacement, or repair.

53.1 Continued

Describe the operating principles and function for liquid source heat exchangers utilized in heat pump systems.

Describe the operating principles and function of water piping, pumps and accessories required for ground or water source heat pump systems.

Describe troubleshooting procedures for identifying problems that can occur with heat pumps.

53.2 Identify applicable sections of the Ontario Building Code and Mechanical Refrigeration Standard B52 for refrigeration and air cooling systems. **(4 / 0 hrs)**

Identify sections in the Ontario Building Code that pertain to refrigeration and air cooling system installations.

Identify pertinent sections in the Mechanical Refrigeration Standard B52 including:

- classification of occupancy
- classification of refrigerants and refrigerating systems
- declaration of tests
- posting of signs
- refrigerant substitutions
- system application requirements
- requirements for various occupancies
- materials
- design pressures
- refrigerant piping
- service provisions
- factory tests
- nameplate data
- installation practices
- field-testing
- charging, withdrawal and disposal of refrigerants
- expansion of liquid refrigerants
- container filling limits
- refrigerant storage
- posting of instructions
- pressure vessel protection
- system protection
- relief devices
- pressure relief discharge lines
- breathing apparatus and protective equipment
- enclosed spaces
- ASHRAE– Standard 15

53.3 Describe the operating principles and function of refrigerant piping in refrigeration and air cooling systems. **(4 / 6 hrs)**

Identify the layout for refrigerant piping to ensure the required oil return.

Interpret the refrigerant piping layout in cooling systems to identify:
- compressor safeguards
- shut down requirements
- piping function during operating cycles

Describe the refrigerant piping installation and support methods to ensure:
- minimum damage to piping and equipment
- release of refrigerants

Describe materials and fittings used to connect components of a cooling system including:
- grades of copper tubing and pipe
- hoses
- isolating valves
- pipe insulation

Describe specific requirements and precautions for suction line piping in cooling systems.

Identify pipe sizes and quantity for suction lines using:
- manufacturers' specifications
- charts
- tables
- technical literature
- codes and regulations

Describe troubleshooting procedures for identifying problems that can occur with excessive pressure drop in suction line piping.

Identify specific requirements and precautions for liquid line piping in air cooling systems.

Identify pipe sizes and quantity for liquid lines using:
- manufacturers' specifications
- charts
- tables
- technical literature
- codes and regulations

Describe liquid-line piping pressure drop/gain in air cooling systems.

53.3 Continued

Identify required sub-cooling for liquid line piping.

Describe the operating principles and function of suction risers in air cooling systems including:
- function of downsized suction riser
- sizing reduced suction riser
- function of a double suction riser
- sizing double suction risers
- sizing suction lines for multiple compressor installations
- sizing suction lines for multiple evaporate installations

Identify specific requirements and precautions for discharge line piping in air cooling systems.

Identify pipe sizes and quantity for discharge lines using:
- manufacturers' specifications
- charts
- tables
- technical literature
- codes and regulations

Describe troubleshooting procedures for identifying problems that can occur with excessive pressure drop in discharge line piping.

Describe the operating principles and function of a discharge riser including:
- function of a downsized discharge riser
- sizing a reduced discharge riser
- function of a double discharge riser
- sizing of double discharge risers
- sizing of discharge lines for multiple compressor installations
- sizing of discharge lines for multiple evaporator installations

Describe considerations for alternate refrigerant retrofit in refrigeration and air cooling systems.

53.4 Describe installation procedures for refrigeration and air cooling systems. **(6 / 2 hrs)**

Identify installation requirements of Acts, Regulations, Legislation, and Codes including:
- unit location
- noise
- SEER
- approvals
- required permits
- inspections
- sub-trades
- licenses
- certifications

Identify required planning documentation for air cooling installations including:
- work orders
- sign-off sheets
- manufacturers' checklists

Describe the operating principles and function of condensing units in air cooling systems including:
- construction
- operating functions
- nameplate data

Interpret manufacturers' equipment specification and installation manuals to determine unit capacities and physical characteristics.

Describe the operating principles and function of evaporator coil configurations in cooling systems including:
- A coil
- inclined coil
- slab coil

Describe direct expansion evaporators adaptations for capacity control including:
- hot gas bypass
- liquid injection
- multiple evaporators

53.4 Continued

Describe refrigerant feed arrangements for direct expansion evaporators in cooling systems including:
- orifice type distributors
- venturi type distributors
- row split coil-circuiting arrangement
- face split coil-circuiting arrangement
- serpentine coil circuiting arrangement
- multi-evaporator coil positioning and control strategies

Describe operating principles and function of evaporators in cooling systems including:
- cooling coil performance
- cooling coil capacity tables
- sensible heat ratio
- required airflow
- bypass factors

Describe the operating principles and function of air handling units and fans in cooling systems.

Describe the operating principles and function of heat recovery ventilators in cooling systems.

Describe installation requirements of heat recovery ventilators.

Describe the operating principles and function of energy recovery ventilators in cooling systems.

Describe installation requirements for energy recovery ventilators.

Describe the operating principles and function of mechanical cooling cycle accessories in cooling systems including:
- liquid indicators
- moisture indicators
- accumulators
- crankcase heaters
- four way reversing valves
- solenoid valves
- check valves
- pressure relief valves

Describe the operating principles and function of humidifiers in air cooling systems.

53.5 Describe the operating principles and function of cooling towers. **(1 / 1 hrs)**

Describe the operating principles and function of natural draft cooling tower assemblies and spray ponds.

Describe the operating principles and function of ejector type cooling tower assemblies including:
- water pumps, piping and valves
- spray nozzles
- wet deck fill material
- controls

Describe the operating principles and function of induced draft and forced draft cooling tower assemblies including:
- water pumps
- water piping
- water valves
- wet sump
- dry sump
- sump heater
- fans
- drive motors
- spray nozzles
- wet deck fill material
- eliminators
- controls

Describe the operating principle and function of closed loop cooling towers.

Describe cooling tower total water consumption including:
- bleed-off
- evaporation
- drift

Describe methods to regulate water temperature including:
- by-pass regulating valve
- water temperature control
- damper controls
- variable speed fans
- pumps

53.5 Continued

Describe maintenance and service of cooling towers including:

- start-up procedures
- shutdown procedures
- water treatment
- role of specialists in water treatment
- tower
  - cleaning
  - draining
  - flushing
- Legionnaires disease
- Legionella bacteria
- bleed-off and make-up water (manufacturers' data)
- back-flow prevention
- strainers
- water pump

53.6 Describe the operating principles and function of water piping, pumps, and accessories for the cooling tower operation. **(6 / 2 hrs)**

Describe piping applications for water distribution circuits including:

- circulating and make-up water
- drain
- bypass
- bleed off

Describe operating principles and function of cooling tower open and closed loop water circulating pumps including:

- manufacturers' published data
- performance curves
- pump construction
- location of the pump in the system
- effect of incorrect pump rotation
- cause of cavitations
- pressure losses "net positive suction head"
- field-testing a centrifugal pump assembly
- checking impeller size
- measure pump head
- calculating water flow rate
- measuring flow rates and pressure
- dismantling and reassembling the pump
- replacing pump packing
- winter shutdown procedures

Describe repair or replacement procedures for cooling system:

- pumps
- drain pan
- motors
- coils
- fans
- dampers
- floats
- drive mechanisms

53.7 Describe procedures for troubleshooting and servicing refrigeration and air cooling systems. **(4 / 4 hrs)**

Interpret manufacturers' specifications to verify an air cooling system:
- operating pressures
- temperatures
- flow rates
- voltage
- amperage
- phase unbalance
- power consumption
- power factor

Describe checking procedures to verify an air cooling system:
- operating pressure
- temperature
- flow rate
- voltage
- amperage
- phase unbalance
- power consumption
- level
- speed

Identify components and layout of a secondary refrigerant distribution system in an air cooling system including:
- cooling coils
- chemical pot feeders
- pumps
- strainers
- valves
- gauges
- insulation
- supports
- piping

Identify repair procedures of a secondary refrigerant distribution system in an air cooling system.

Describe the operating principles and function of a hydrometer including:
- testing glycol or brine concentration
- testing antifreeze solution concentration
- restoring glycol or brine concentration
- restoring antifreeze solution concentration

53.7 Continued

Describe procedures for verifying a secondary refrigerant charge in an air cooling system including:
- checking
- adjustments
- replacing
- flow meters
- gauges
- refractometers
- devices used for measuring concentration levels

Describe maintenance procedures for mechanical cooling cycle accessories including:
- inspection
- replacing
- repair
- piping components
  - vibration eliminators
  - supports
- liquid indicators
- moisture indicators
- accumulators
- crankcase heaters
- four way valves
- solenoid valves
- check valves
- pressure relief valves

Describe procedures for checking and determining the pressure drop across refrigerant filters in air cooling systems.

Describe procedures for replacing a refrigerant filter drier.

Describe the operating principles and function of air cooling system:
- heat transfer devices
- evaporators
- condensers.

Describe maintenance procedures for primary and secondary heat exchangers in air cooling systems including:
- testing
- cleaning
- repairing
- pressure measuring devices
- temperature measuring devices

53.7 Continued

Identify required heat transfer medium in an air cooling system including:
- pressures
- flow rates
- velocities

Describe procedures for performing temperature or pressure differential tests in an air cooling system including:
- temperature measuring devices
- pressure measuring devices

Describe the operating principles and function of air handling units and fans in an air cooling systems.

Describe troubleshooting procedures for identifying problems that can occur with air handling units and fans.

Describe maintenance procedures for air handling units and fans including:
- cleaning
- repairing
- replacing

Describe the operating principles and function:
- drain piping
- drain pans
- condensate pumps.

Describe the operating principles and function of hermetic compressors including:
- reciprocating
- scroll
- rotary
- helical rotary
- screw compressors

53.7 Continued

Identify the operating principles and function of centrifugal compressor components in air cooling systems including:

- compressor components
  - impeller
  - volute casing
  - discharge and suction volute
  - inlet guide vane
  - seals
  - bearings
- refrigerant travel through the compressor
- unique operating characteristics
  - impeller staging
  - impeller speed
- lubrication
- application
- capacity control methods

Identify procedures for analyzing the operation of compressors in air cooling systems.

Describe troubleshooting procedures for identifying failures that can occur with hermetic compressors.

Identify procedures for analyzing compressor oil.

Describe troubleshooting procedures for identifying failures that can occur with the mechanical or electrical components of the cooling systems.

Describe maintenance procedures for mechanical or electrical failures including:

- hermetic compressor replacement
- mechanical failure clean up
- electrical failure clean up

Describe the operating principles and function of suction filters in air cooling systems.

53.7 Continued

Describe the operating principles and function of metering devices in air cooling systems including:
- fixed orifice
- capillary tubes
- thermostatic expansion valves
- verification procedures
- metering device failure

Demonstrate adjustment procedures for adjusting thermostatic expansion valves in air cooling systems.

Determine required system settings including:
- pressures
- temperatures
- superheat
- sub-cooling

Demonstrate procedures to check that the system contains refrigerant charge.

Describe procedures to diagnose parameters in air cooling systems including:
- voltage
- amperage
- power consumption
- phase unbalance
- power factor
- voltage
- equipment rotation
- system oil charge

Demonstrate the application of tools, instruments, devices, and equipment including:
- hand tools
- electrical measuring instruments
- pressure measuring devices
- flow meters
- temperature sensing instruments
- specialty tools and instruments

Describe procedures to restore the air cooling system to design specifications.

53.8 Describe procedures for transferring power to open drive-type compressors and pumps in refrigeration and air cooling systems. **(2 / 0 hrs)**

Identify methods used to transfer power to an open type compressor in air cooling systems including:

- direct drive coupling
- belt drive

Describe operating principles and function of pulleys, sheaves, and bushings in air cooling systems:

- cast iron
- steel
- securing to the motor and compressor shaft
- multi-groove
- variable pitch
- defects
  - wear
  - frayed
  - pulley unbalance
  - pulley distortion

Describe the operating principles and function of drive belts in air cooling systems including:

- construction of belt
- high horsepower
- fractional horsepower (light duty)
- maintenance procedures
  - pulley diameters
  - driven-driver speed
  - V-belt tension adjustment
  - installation of drive belts

53.9 Describe alignment procedures for compressors and pumps in refrigeration and air cooling systems. **(0 / 3 hrs)**

Describe parallel and angular misalignment in compressors in air cooling systems.

Identify types of direct-drive compressor couplings.

Identify equipment used to perform a direct-drive compressor alignment.

Identify precision measuring instruments and tools used to perform a compressor alignment including:

- vernier calipers
- laser alignment devices
- depth gauges
- dial indicators
- feeler and pitch gauges
- torque wrenches
- tachometers

Describe the operating principles and function of precision measuring instruments including:

- type
- assembling
- adjusting
- capacity
- identifying defects
- maintenance
- storage

Describe procedures to perform a direct-drive compressor alignment in air cooling systems.

53.10 Describe verification procedures for control operations in refrigeration and air cooling systems. **(2 / 1 hrs)**

Interpret system design specifications in control systems using:
- manufacturers' specifications
- charts
- tables
- technical literature
- job documentation
- codes and regulations

Determine required operational control settings.

Describe procedures for rectifying control components including:
- instruments
- simulators
- analyzers
- computers
- test
- adjust
- repair
- replace

53.11 Describe procedures for troubleshooting and identifying problems in refrigeration and air cooling systems. **(4 / 2 hrs)**

Determine the air cooling system design parameters and settings using:
- charts
- tables
- technical literature
- job documentation
- codes and regulations

Describe procedures for checking, inspecting, and testing the air cooling system to verify operating conditions.

Describe procedures for identifying faulty conditions, damaged or defective components.

Describe procedures for isolating the major section of the system that is causing the problem.

Describe maintenance procedures or corrective actions that are used for restoring the air cooling system to design specifications.

53.12 Describe lithium bromide absorption cooling cycles in refrigeration and air cooling systems. **(3 / 0 hrs)**

Describe a lithium bromide absorption cycle in air cooling systems.

Identify the components of a lithium bromide absorption cooling cycle.

Describe crystallization.

Describe operating conditions that cause crystallization.

Describe lithium bromide absorption cycle applications in refrigeration and cooling systems.

Number: **S0754**

Title: **AIR DISTRIBUTION SYSTEMS AND ACCESSORIES – Industrial, Commercial and Institutional (ICI)**

Duration: Total 36 hours Theory 24 hours Practical 12 hours

Prerequisites: L1CC – S0731, S0732, S0733, S0734, S0735, S0736, S0737
L2 – S0744, S0745, S0746, S0747, S0748, S0749

Content:

S0754.1 Describe the operating principles and function of fans in air distribution systems in refrigeration and air conditioning systems. **(3 / 1 hrs)**

S0754.2 Identify the components and layout plans for designed air distribution systems in refrigeration and air conditioning systems. **(2 / 3 hrs)**

S0754.3 Describe the operating principles and function of air distribution components in refrigeration and air conditioning systems. **(12 / 2 hrs)**

S0754.4 Describe the operating principles and function of an air filtration apparatus in refrigeration and air conditioning systems. **(3 / 0 hrs)**

S0754.5 Describe ventilation and indoor air quality requirements in refrigeration and air conditioning systems. **(2 / 2 hrs)**

S0754.6 Describe verification procedures to check that the air distribution system on refrigeration and air conditioning systems is operating to design parameters. **(2 / 4 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

Mark Distribution:

Theory Testing	Practical Application Testing	Final Assessment
66%	33%	100%

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

S0754.0 Air Distribution Systems and Accessories – Industrial, Commercial and Institutional (ICI)

Duration: Total 36 hours Theory 24 hours Practical 12 hours

Cross-Reference to Learning Outcomes/Training Standard:
U6238; U6239; U6240; U6241; U6242

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice will be able to describe the operating principles and functions of air distribution systems on refrigeration and air conditioning systems in Industrial, Commercial, or Institutional (ICI) applications.

LEARNING OUTCOMES AND CONTENT

54.1 Describe the operating principles and function of fans for air distribution systems on refrigeration and air conditioning systems. **(3 / 1 hrs)**

Identify fan components for air distribution including:
- bearings
- bushings
- blades
- blowers
- housings
- shafts
- motors

Identify the nomenclature that describes drive arrangements for fans in air distribution systems.

Interpret information on a fan performance curve or a fan performance table.

Describe the effects of fan performance on the air distribution system.

Describe features of fan performance including:
- CFM
- RPM
- system static
- motor horsepower

54.1 Continued

Describe the operating characteristics and functions of fans in air distribution systems including:
- forward curved centrifugal fan
- backward inclined centrifugal fans
- radial type centrifugal fan
- propeller (axial) type fan
- tube axial or vane axial type centrifugal fan
- tubular centrifugal type fan

Describe procedures to check:
- drive mechanism alignment
- bearings
- air flow
- noise level
- vibration
- balance

Describe the operating principles and function of axial and centrifugal fan capacity controls on air distribution systems including:
- static controls
- electronic speed control devices
- inlet vanes

Describe drive systems for fans used on air distribution systems including:
- pulleys
- belts

Solve problems regarding pulley diameters and speed.

Describe procedures to check for vibrations and running amperages.

Describe maintenance of fans on air distribution systems including:
- replace damaged pulleys
- replace damaged fan bearings
- repair components
- lubricating fan components
- tension adjustment procedures for V-belts

54.2 Identify the components and layout plans for a designed air distribution in refrigeration and air conditioning systems. **(2 / 3 hrs)**

Describe the characteristics of air including:
- air distribution
- air properties
- air measurements

Describe an Occupied Zone.

Describe elements of a designed air distribution system including:
- primary air
- secondary air
- stratification.

Describe the comfort characteristics for air being delivered into an occupied Zone.

54.3 Describe the operating principles and function of components for air distribution of refrigeration and air conditioning systems. **(12 / 2 hrs)**

Describe the characteristics of air including:
- air distribution
- air properties
- air measurements

Identify the layout plans for the air distribution of refrigeration and air conditioning systems.

Identify air distribution components and equipment including:
- extended plenum duct system
- reducing trunk duct system

Describe the construction and function of air distribution components including:
- plenums
- fittings
- directional adjusting devices
- volume dampers
- parallel blade
- opposed blade dampers
- butterfly dampers

Describe the characteristics of air distribution systems including:
- single zone
- multi-zone single duct
- double duct
- terminal reheat

54.3 Continued

Describe the operating principles and function of zoning components including:
- dampers
- actuators
- bearings
- linkages
- wiring

Describe troubleshooting procedures for identifying failures that can occur with zoning components in refrigeration and air conditioning systems.

Describe maintenance procedures for zoning components including:
- tools and equipment
- adjustments
- repairing

Describe the operating principles and function of variable volume and variable temperature on air distribution systems including:
- variable air volume (VAV) boxes
- power sources
- associated controls
- components of VAV boxes
- controls
- accessories

Interpret drawings, manufacturers' specifications and manuals to identify the design, settings and parameters of the zoning control on refrigeration and air conditioning systems.

Determine zoning control parameters including:
- air pressures
- flow rates
- velocities.

Describe procedures to verify that the air distribution system is operating according to design specifications including:
- tools
- equipment
- devices
- specialty equipment
- testing procedures
- temperature tests
- pressure differential tests

Demonstrate airflow adjustment procedures.

54.4 Describe the operating principles and function of an air filtration apparatus in refrigeration and air conditioning systems. **(3 / 0 hrs)**

Describe the advantages of an efficient air filtration system on refrigeration and air conditioning systems including:

- reduction in cleaning and maintenance costs
- reduced sick time
- increased cooling system efficiency
- increased life expectancy of equipment

Describe the criteria used in selecting the filtration equipment including:

- particles in conditioned air
  - size
  - concentration
  - types
- removal of contaminants
- rate of efficiency of filters
- cost effective filtration
  - labour
  - maintenance
  - energy requirements
- pollutant disposal after removal
- resistance to airflow

Identify methods for the removal of air pollutants including:

- straining
- impingement
- interception
- diffusion (HEPA)
- electrostatic filters
- absorbents

Describe types of filters used to remove air pollutants including:

- panel filters
- dry-type extended filters
- renewable media filters
- electronic air filters

Identify filtration components including:

- controls
- filter racks
- frames
- drive mechanisms
- air-flow sensors

54.4 Continued

Describe the operation and configuration of electronic air cleaners on refrigeration and air conditioning systems.

Describe inspection procedures for air filters including:
- visually checking
- checking operation of air filters
- measuring static pressure drop across air filter

54.5 Describe ventilation and indoor air quality requirements in refrigeration and air conditioning systems. **(2 / 2 hrs)**

Identify procedures for checking indoor air quality including:
- air comfort levels
- air system parameters
- types of pollutants
- pollutant removal

Identify mechanical ventilation components and parameters on refrigeration and air conditioning systems including:
- exhaust fans
- building pressurization
- fresh air supply systems
- building ventilation requirements
  - Ontario Building Code (sections 6 and 9)
  - American Society of Heating Refrigeration and Air Conditioning Engineers' Standards
  - Manufacturers' specifications
- smoke management system
  - American Society of Heating Refrigeration and Air Conditioning Engineers' Standards

Describe the operating principles and function of heat recovery ventilators on refrigeration and air conditioning systems.

Describe troubleshooting procedures for identifying failures that can occur with heat recovery ventilators including:
- discoloration
- odours
- moisture
- corrosion

54.5 Continued

Describe procedures for maintaining heat recovery ventilators including:
- visual inspection
- resistance measurements
- checking
- repairing
- replacing

Describe the operating principles and function of energy recovery ventilators on refrigeration and air conditioning systems.

Describe troubleshooting procedures for identifying failures that can occur with the energy recovery ventilators on refrigeration and air conditioning systems including:
- discoloration
- odours
- moisture
- corrosion

Describe procedures for maintaining energy recovery ventilators including:
- visual inspection
- resistance measurements
- checking
- repairing
- replacing

Describe the operating principles and function of different humidification on refrigeration and air conditioning systems.

Describe the operating principles and function of dehumidification equipment on refrigeration and air conditioning systems including:
- steam
- ultra-sonic
- atomizing

Describe repair or replacement procedures for defective humidification and dehumidification equipment.

54.6 Describe verification procedures to check that the air distribution of refrigeration and air conditioning systems is operating to design parameters. **(2 / 4 hrs)**

Interpret manufacturers' specifications to verify:
- operating pressures
- temperatures
- air flow
- flow rates
- voltage
- amperage
- power consumption

Interpret test and balance reports for refrigeration and air conditioning systems.

Describe procedures used to balance an air distribution system.

Describe the operating principles and function for airflow measuring devices and instruments including:
- U-tube manometers
- inclined manometer
- electronic manometer
- pitot tube
- bourdon type (magnehelic™)
- rotating vane anemometer
- deflecting vane anemometer
- thermal anemometer
- flow hood
- tachometer

Demonstrate the application of the airflow measuring instruments in refrigeration and air conditioning systems.

Number: **S0755**

Title: **ADVANCED ELECTRICAL AND CONTROL SYSTEMS – Industrial, Commercial and Institutional (ICI)**

Duration: Total 81 hours Theory 39 hours Practical 42 hours

Prerequisites: L1CC – S0731, S0732, S0733, S0734, S0735, S0736, S0737
L2 – S0744, S0745, S0746, S0747, S0748, S0749

Content:

S0755.1 Identify applicable Acts, Regulations, Legislation, and Codes, when working on electrical system accessories and components in refrigeration and air conditioning systems. **(2 / 0 hrs)**

S0755.2 Describe the operating principles and function of single and three phase alternating current inductive devices and circuits in refrigeration and air conditioning systems. **(22 / 2 hrs)**

S0755.3 Describe the operating principles and function of compressor and fan motors in refrigeration and air conditioning systems. **(5 / 2 hrs)**

S0755.4 Interpret control system terminology for refrigeration and air conditioning systems. **(2 / 0 hrs)**

S0755.5 Describe the operating principles and function of pneumatic control systems and components in refrigeration and air conditioning systems. **(2 / 4 hrs)**

S0755.6 Describe the operating principles and function of safety and operating controls in refrigeration and air conditioning systems. **(2 / 4 hrs)**

S0755.7 Determine the sequence of electrical operations in refrigeration and air conditioning systems. **(2 / 28 hrs)**

S0755.8 Describe troubleshooting procedures for the maintenance of control circuits and electrical components in refrigeration and air conditioning systems. **(2 / 2 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

Mark Distribution:

Theory Testing	Practical Application Testing	Final Assessment
48%	52%	100%

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

S0755.0 Advanced Electrical and Control Systems – Industrial, Commercial and Institutional (ICI)

Duration: Total 81 hours Theory 39 hours Practical 42 hours

Cross-Reference to Learning Outcomes/Training Standard:
U6238; U6239; U6240; U6241; U6242; U6243; U6244, U6245

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice will be able to describe the operating principles and function of electrical and control systems on refrigeration and air conditioning systems in Industrial, Commercial, or Institutional (ICI) applications.

LEARNING OUTCOMES AND CONTENT

55.1 Identify applicable Acts, Regulations, Legislation, and Codes, when working on the electrical system accessories and components in refrigeration and air conditioning systems. **(2 / 0 hrs)**

Identify pertinent requirements of Canadian Electrical Code (CEC) including:
- CEC regulations regarding grounding (section 10)
- CEC regulations regarding wiring methods for refrigeration and air conditioning systems (section 12)

Identify safety legislation for working with high voltage (over 750V) in refrigeration and air conditioning systems.

Describe procedures for lockout and tagging electrical devices.

Identify procedures for connection and disconnection of electrical equipment on refrigeration and air conditioning systems including:
- legal requirements
- mandatory permits
- inspections.

Identify legislative limitations and scope of electrical work of the Refrigeration and Air Conditioning Systems Mechanics including:
- ESA (Electrical Safety Authority)
- TQAA (Trade Qualification and Apprenticeship Act)
- Ministry of Labour
- Ontario Health and Safety Act

55.2 Describe the operating principles and function of single and three phase alternating current inductive devices and circuits in refrigeration and air conditioning systems. **(22 / 2 hrs)**

Perform calculations to determine:
- electrical quantities for series circuits
- electrical quantities for parallel circuits
- electrical quantities for combination circuits.

Describe inductance in refrigeration and air conditioning systems including:
- factors which effect inductance
- AC induction and the effect on current.
- purpose of the iron core
- induced electro-motive force
- unit of measurement
- symbol for inductance
- inductive reactance
- equation for inductive reactance.

Describe the phase relationship between voltage and current in an inductive circuit in refrigeration and air conditioning systems.

Describe the operating principles and function of solenoids in refrigeration and air conditioning systems including:
- relays
- contactors
- valves

Demonstrate procedures for constructing:
- circuits in which contactors control various loads
- circuits in which solenoid valves control the flow of a fluid.

Describe the operating principles and function of single phase and three phase transformers in refrigeration and air conditioning systems including:
- turns ratio
- step up versus step down
- VA rating
- primary and secondary voltage
- primary and secondary current
- no load voltage

Describe standard terminal and winding identification.

55.2 Continued

Describe single-phase and three-phase transformers in refrigeration and air conditioning systems including:
- connected in series
- connected in parallel
- transformer polarity
- load sharing for two transformers connected in parallel

Describe troubleshooting procedures for identifying failures that can occur with transformers including:
- visually inspecting
- testing procedures
- oil leakage
- defects
- discoloration

Describe 120/240 volt single-phase electrical services and panels.

Describe three-phase AC power supply.

Describe 208/230/440/575 volt three-phase electrical services and panels in refrigeration and air conditioning systems.

Describe single-phase and three-phase over-current protection devices on refrigeration and air conditioning systems including:
- circuit breakers
- fuses

Describe sizing procedures on over-current devices including:
- hermetic
- non-hermetic loads.

Describe single-phase and three-phase over-load protection devices.

Describe operating principles and function of conductors on refrigeration and air conditioning systems including:
- insulation
- voltage rating
- conductor sizing
- voltage drop

Describe characteristics of single-phase and three-phase power including:
- unit of measurement
- symbol for power
- apparent power
- identify the apparent power symbol
- power factor

55.2 Continued

Describe operating principles and function of capacitors on refrigeration and air conditioning systems including:

- capacitor construction
- capacitor characteristics
- capacitance and the effecting factors
- start capacitor
- run capacitor
- unit of measurement
- symbol for a capacitor
- dielectric strength
- capacitive reactance
- symbol for capacitive reactance
- capacitive reactance unit of measurement
- equation for capacitive reactance

Describe the phase relationship between voltage and current in a capacitive circuit.

Calculate the total capacitance for capacitors in series or parallel.

Describe characteristics of impedance including:

- unit of measure for impedance
- capacitive reactance unit of measurement
- equation for impedance.

.

Describe the operating principles and function of low voltage thermostats in refrigeration and air conditioning systems including:

- installation considerations
- thermostat troubleshooting techniques.

Describe the operating principles and function of control transformers on refrigeration and air conditioning systems.

Describe the operating principles and function of relays and contactors used in condensing units or compressors on refrigeration and air conditioning systems.

Describe the operating principles and function of relays used in fans.

Describe procedures for the electrical installation for electric heaters, electric motors, and electronic filtrating equipment on refrigeration and air conditioning systems.

55.3 Describe the operating principles and function of a compressor and fan motors in refrigeration and air conditioning systems. **(5 / 2 hrs)**

Describe the operating principles and function of single-phase compressor motors in refrigeration and air conditioning systems including:
- split phase
- permanent-split-capacitor
- capacitor start
- capacitor start, capacitor run

Identify the wiring for single-phase compressors including:
- current relays
- potential relays
- solid state relays

Interpret the electrical code to identify:
- hermetic compressor motors
- solid state relays
- open-drive motors
- wiring for hermetic compressor
- sizing over-current protection for hermetic compressors
- sizing overload protection for hermetic compressor motors

Describe the operating principles and functions of oil failure controls.

Describe the operating principles and function for single-phase compressor motor protective devices including:
- built in thermal overloads
- external overload devices

Describe the operating principles and function for single-phase open motors used to power fans for condensers and air handlers including:
- split phase
- single-speed permanent-split capacitor motors
- multi-speed permanent-split capacitor motors

Describe procedures for reversing the direction of rotation for single-phase open motors.

Describe troubleshooting procedures for identifying failures that can occur with single-phase motors including:
- high voltage
- low voltage
- over loading
- blocked ventilation
- over lubricating

55.3 Continued

Describe operating principles and function of squirrel cage and components on refrigeration and air conditioning systems including:

- induction motor
- three-phase motors
- stator
- rotor
- rotor slip
- end bells
- bearings
- number of poles
- rpm relationship

Describe the operating principles and function of motors on refrigeration and air conditioning systems including:

- poly-phase compressor motors
- motor starters
- three-phase starters
  - across the line
  - part winding
  - star delta
  - electronic starter

Describe procedures for constructing circuits in which motor starters control compressors and fan motors

Describe procedures for changing the rotation of three-phase motors.

Describe variable frequency motor speed control devices.

Describe troubleshooting procedures for identifying failures that can occur with three-phase motors including:

- high voltage
- low voltage
- single phasing
- over loading
- blocked ventilation
- over lubricating
- phase unbalance

55.4 Interpret control system terminology for refrigeration and air conditioning systems. **(2 / 0 hrs)**

Interpret control system terminology for refrigeration and air conditioning systems including:

- anticipation
- averaging
- closed loop
- open loop
- control medium
- control point
- set point
- controlled device
- controller
- differential
- direct acting
- reverse acting
- feedback
- normally closed
- normally open
- range
- throttling range

55.5 Describe the operating principles and function of pneumatic control systems and components in refrigeration and air conditioning systems. **(2 / 4 hrs)**

Interpret manufacturers' data to determine the type of pneumatic control devices used on refrigeration and air conditioning systems.

Interpret schematic pneumatic diagrams for refrigeration and air conditioning systems including:

- symbols
- legend
- control devices
- safety devices
- air supply pressures
- sequence of operation
- pneumatic controls and components

55.5 Continued

Describe the operating principles and function of refrigeration and air conditioning systems air supply equipment including:

- compressors
- filters
- auto drains
- compressor motors
- compressor belts
- compressor pulleys
- compressor oil level
- driers
- pressure controls
- safeties
- solenoids

Describe the operating principles and function of pneumatic components including:

- air driers
- pressure regulators
- controllers
- electric pneumatic switches
- pressure electric switches
- actuators
- thermostats
- relays

Describe troubleshooting procedures for identifying problems that can occur with pneumatic components in refrigeration and air conditioning systems including:

- calibration procedures
- checking flow
- leak testing
- noise levels
- measuring instruments
- testing instruments
- specialty tools
- repair procedures
- replacement procedures
- pressure measuring devices

55.6 Describe the operating principles and function of safety and operating controls in refrigeration and air conditioning systems. **(2 / 4 hrs)**

Identify the operating principles and function of safety and operating controls in refrigeration and air conditioning systems including:

- temperature controls
- humidity
- line voltage
- low voltage
- programmable
- two position
- proportional
- pressure controls
- amperage
- oil safety controls
- fluid flow controls
- liquid level controls
- timer controls

Describe troubleshooting procedures for identifying failures that can occur with safety and operating controls including:

- defective
- damaged
- equipment for checking functions
  - thermometer
  - pressure gauge
  - hygrometer
  - psychrometer
  - multimeter
  - ammeter
  - voltmeter
  - ohmmeter
  - manometer

55.7 Determine the sequence of electrical operations in refrigeration and air conditioning systems. **(2 / 28 hrs)**

Identify types and purpose of electrical diagrams including:
- pictorial diagrams
- electrical installation diagrams
- schematic diagrams

Interpret manufacturers' data to determine the type of control devices in refrigeration and air conditioning systems.

Interpret schematic electrical diagrams including:
- symbols
- legend
- motor starting devices
- overload devices
- control devices
- safety devices
- transformers
- applicable voltages

Identify the sequence of electrical operation for refrigeration and air conditioning systems by reading:
- charts
- tables
- technical literature
- manufacturers' specifications
- schematic wiring diagrams
- codes and regulations

Identify schematic electrical diagrams to identify:
- sequence of electrical operation
- sequence of operation
  - heat pump cooling
  - heating
  - defrost cycle
  - three-phase reduce voltage starter
  - Y-Delta starter

Demonstrate sketching procedures to develop electrical schematic control diagrams for refrigeration and air conditioning systems.

55.8 Describe troubleshooting procedures for the maintenance of control circuits and electrical components in refrigeration and air conditioning systems. **(2 / 2 hrs)**

Demonstrate the use of electrical measuring devices to measure the performance of electrical control circuits and electrical components in refrigeration and air conditioning systems including:

- ammeters
- voltmeters
- ohmmeters
- meg ohm meter/insulation tester (meggers™)
- Wattmeters
- multimeters
- capacitor analyzers

Determine the limitations of electrical measuring instruments including:

- measuring range
- scale values
- handling methods
- instrument condition
- calibration procedures

Demonstrate procedures for measuring and testing electric power including:

- current flow
- continuity
- three-phase circuits/rotation
- voltage (AC-DC)
- amperage (AC-DC)
- resistance and power
- capacitors

Interpret meter readings by value and unit of measurement.

Describe calibration and adjustment procedures for electrical measuring instruments including:

- adjusting
- range
- scale
- connecting instruments

Demonstrate verification procedures for the parameters of control systems using:

- simulators
- analyzers
- computers

55.8 Continued

Describe the operating principles and function of electrical and automated controls in refrigeration and air conditioning systems including:

- fan cycling
- fan speed
- hi/low pressure
- defrost controls for heat pumps
- humidity
- crankcase heaters
- off cycle timers
- electronic or manual thermostats
- zone control devices

Identify tools and specialty devices to check control systems including:

- hand tools
- pressure measuring devices
- temperature measuring instruments
- flow measuring instruments
- electrical measuring instruments
- level indicators
- simulators
- tachometers

Demonstrate verification procedures for the control system operational parameters including:

- pressures
- temperatures
- flow rate
- voltages
- amperage
- fluid levels
- speeds

Demonstrate procedures to check and verify primary and secondary controls on refrigeration and air conditioning systems including:

- voltage
- motor rotation
- fan cycling or fan speed controls
- hi/low pressure controls
- defrost controls for heat pumps
- humidity controls
- crankcase heaters
- off cycle timers
- electronic or manual thermostats
- zone control devices

55.8 Continued

Describe troubleshooting procedures to locate electrical faults within the control system of refrigeration and air conditioning systems including the hopscotch method.

Demonstrate procedures for removing or replacing defective control components on refrigeration and air conditioning systems.

Number: **S0756**

Title: **ELECTRONIC DEVICES AND CONTROLS – Industrial, Commercial and Institutional (ICI)**

Duration: Total 24 hours Theory 12 hours Practical 12 hours

Prerequisites: L1CC – S0731, S0732, S0733, S0734, S0735, S0736, S0737
L2 – S0744, S0745, S0746, S0747, S0748, S0749

Content:

S0756.1 Describe the operating principles and function of electronic devices and controls in refrigeration and air conditioning systems. **(1 / 0 hrs)**

S0756.2 Describe the operating principles and function of input/output sensors and devices in refrigeration and air conditioning systems. **(1 / .05 hrs)**

S0756.3 Describe the operating principles and function of electronic controllers in refrigeration and air conditioning systems. **(1 / .05 hrs)**

S0756.4 Describe procedures for installing electronic controllers in refrigeration and air conditioning systems. **(1 / 0 hrs)**

S0756.5 Describe methods for the wiring of electronic controllers in refrigeration and air conditioning systems. **(1 / 1 hrs)**

S0756.6 Describe methods for communicating with electronic controllers in refrigeration and cooling systems. **(1 / 1 hrs)**

S0756.7 Demonstrate programming procedures for changing the control parameters in refrigeration and control systems. **(2 / 4 hrs)**

S0756.8 Describe troubleshooting procedures for identifying failures that can occur with electronic controls in refrigeration and control systems. **(2 / 4 hrs)**

S0756.9 Describe energy conservation methods and strategies used with electronic controls in refrigeration and air conditioning systems. **(2 / 1 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

Mark Distribution:

Theory Testing	Practical Application Testing	Final Assessment
50%	50%	100%

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

S0756.0 Electronic Devices and Controls – Industrial, Commercial and Institutional (ICI)

Duration: Total 24 hours Theory 12 hours Practical 12 hours

Cross-Reference to Learning Outcomes/Training Standard:
U6238; U6239; U6240; U6241; U6242; U6243; U6244, U6245

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice will be able to describe procedures for installing and maintaining electronic devices and controls on refrigeration and air conditioning systems in Industrial, Commercial, or Institutional (ICI) applications.

LEARNING OUTCOMES AND CONTENT

56.1 Describe the operating principles and function of electronic controls in refrigeration and air conditioning systems. **(1 / 0 hrs)**

Identify control actions including:
- two position
- floating
- proportional
- integral
- derivative

Identify control loop systems including:
- open
- closed loop

Describe analog and digital control signals.

Identify the fundamentals and elements of:
- electronic logic
- binary circuits
- digital circuits
- direct digital control
- electronic controllers

56.1 Continued

Describe the operating principles and function of electronic controls and components in refrigeration and air conditioning systems including:

- semiconductors (PN junction)
- diodes
- triads
- rectifiers
- silicon-controlled rectifiers
- sensors and thermistors
- transducers
- thermocouples
- thermoelectric devices

56.2 Describe the operating principles and function of input/output sensors and devices in refrigeration and air conditioning systems. **(1 / .05 hrs)**

Identify analog and digital inputs/outputs in refrigeration and air conditioning systems.

Identify analog and digital peripheral control devices.

Describe the operating principles and function of:

- temperature sensors
- pressure sensors
- transducers
- transmitters

Describe procedures for:

- interfacing of electronic devices with electro-mechanical devices
- calibrating input/output loops
- troubleshooting input/output loops

56.3 Describe the operating principles and function of electronic controllers in refrigeration and air conditioning systems. **(1 / 0 hrs)**

Identify electronic control system architectures in refrigeration and air conditioning systems.

Identify types of electronic controls in refrigeration and air conditioning system including:

- thermostats
- humidistats
- gas detectors
- equipment interfaces
- unit controllers
- motor speed controllers

Describe interfacing electronic controllers with conventional controlled devices in refrigeration and air conditioning systems including:

- actuators
- dampers
- relays
- valves

Describe the application of electronic controls in refrigeration and air conditioning systems.

Describe stand-alone and distributed control systems in refrigeration and air conditioning systems.

Describe the sequence of operation of typical control strategies in refrigeration and air conditioning systems.

56.3 Continued

Describe direct digital control application strategies for refrigeration and air conditioning systems including:

- air handling
- chilled water reset
- cooling tower control
- enthalpy control
- hot water reset
- local control
- mixed-air control
- multiple chiller control
- multi-stage control
- multizone control
- outdoor air control
- return air temp
- static pressure control
- supply air temp
- VAV (variable air volume)
- VVT (variable volume, variable temperature)
- VFD (variable frequency drive)

56.4 Describe procedures for installing electronic controllers in refrigeration and air conditioning systems. **(1 / 0 hrs)**

Describe planning procedures for the installation of electronic controls in refrigeration and air conditioning systems.

Interpret installation drawings and job specifications to identify control systems.

Identify power supply required for electronic control systems.

Identify equipment and devices required to install electronic control systems.

Identify electronic controls required for the installation.

Describe the procedures for installing electronic control systems.

Describe the process of commissioning electronic controls in refrigeration and air conditioning systems.

56.5 Describe methods for the wiring of electronic controllers in refrigeration and air conditioning systems. **(1 / 1 hrs)**

Interpret schematics, drawings, and job documentation to identify:
- wiring methods for stand-alone and distributed control networks
- interconnecting wiring media
- connection points on components and controls
- techniques used minimize noise and interference
- wiring media for control networks

56.6 Describe methods for communicating with electronic controllers in refrigeration and air conditioning systems. **(1 / 1 hrs)**

Identify communication port standards including:
- RS232
- RS422
- RS485

Identify operator machine interfaces including:
- local (panel)
- hand held
- lap top, palm top
- server
- web server (IP)
- remote (modem)

Describe methods of communicating with various control systems including:
- various access methods
- RS232 to 485 converters
- web based

56.7 Demonstrate programming procedures for changing the control parameters in refrigeration and air conditioning systems. **(2 / 4 hrs)**

Identify program types including:
- system programs
- application programs

Describe procedures for using interface devices with control programs including:
- computers
- local interfaces
- hand held

Demonstrate procedures for modifying the control system parameters.

56.8 Describe troubleshooting procedures for identifying failures that can occur with the electronic controls in refrigeration and air conditioning systems. **(2 / 4 hrs)**

Identify procedures for servicing and maintaining electronic controls in refrigeration and air conditioning systems including:

- interpreting control system data
- servicing procedures
- electrical measuring devices
- electronic diagnostic devices
- measuring devices
- maintenance tools and equipment
- interfacing devices to communicate with the system
- testing reports and charts
- analyzing procedures
- inspection procedures
- removal procedures
- replacement procedures
- recommendations for corrective actions

Describe verification procedures to check:

- correct function of electronic controls
- control system operation meets the design criteria

56.9 Describe energy conservation methods and strategies used with electronic controls in refrigeration and air conditioning systems. **(2 / 1 hrs)**

Identify methods for optimizing the operation of electronic controls in refrigeration and air conditioning systems for energy conservation including:

- outdoor reset
- time scheduled control
- temperature setback
- VFD speed reduction

Describe the benefits of energy conservation strategies.

Describe energy conservation strategies for typical refrigeration and air conditioning applications.