Occupational Analyses Series

Refrigeration and Air Conditioning Mechanic

2009

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FOREWORD

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this National Occupational Analysis as the national standard for the occupation of Refrigeration and Air Conditioning Mechanic.

Background

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. To this end, Human Resources and Skills Development Canada sponsors a program, under the guidance of the CCDA, to develop a series of National Occupational Analyses (NOA).

The NOAs have the following objectives:

- to describe and group the tasks performed by skilled workers;
- to identify which tasks are performed in every province and territory;
- to develop instruments for use in the preparation of Interprovincial Red Seal Examinations and curricula for training leading to the certification of skilled workers;
- to facilitate the mobility of apprentices and skilled workers in Canada; and,
- to supply employers, employees, associations, industries, training institutions and governments with analyses of occupations.

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This analysis was prepared by the Workplace Partnerships Directorate of HRSDC. The coordinating, facilitating and processing of this analysis were undertaken by employees of the National Occupational Analysis (NOA) development team of the Trades and Apprenticeship Division. Ken Sketchley for the host jurisdiction of Nova Scotia also participated in the development of this NOA.

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* National Occupational Classification

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140 Promenade du Portage, Phase IV, 5th Floor
Gatineau, Quebec K1A 0J9

These publications can be ordered or downloaded online at: www.red-seal.ca. Links to Essential Skills Profiles for some of these trades are also available on this website.

STRUCTURE OF ANALYSIS

To facilitate understanding of the occupation, the work performed by tradespersons is divided into the following categories:

Blocks	the largest division within the analysis that is comprised of a distinct set of trade activities
Tasks	distinct actions that describe the activities within a block
Sub-Tasks	distinct actions that describe the activities within a task
Key Competencies	activities that a person should be able to do in order to be called 'competent' in the trade

The analysis also provides the following information:

Trends	changes identified that impact or will impact the trade including work practices, technological advances, and new materials and equipment
Related Components	a list of products, items, materials and other elements relevant to the block
Tools and Equipment	categories of tools and equipment used to perform all tasks in the block; these tools and equipment are listed in Appendix A
Context	information to clarify the intent and meaning of tasks
Required Knowledge	the elements of knowledge that an individual must acquire to adequately perform a task

The appendices located at the end of the analysis are described as follows:

Appendix A — Tools and Equipment	a non-exhaustive list of tools and equipment used in this trade
Appendix B — Glossary	definitions or explanations of selected technical terms used in the analysis
Appendix C — Acronyms	a list of acronyms used in the analysis with their full name
Appendix D — Block and Task Weighting	the block and task percentages submitted by each jurisdiction, and the national averages of these percentages; these national averages determine the number of questions for each block and task in the Interprovincial exam
Appendix E — Pie Chart	a graph which depicts the national percentages of exam questions assigned to blocks
Appendix F — Task Profile Chart	a chart which outlines graphically the blocks, tasks and sub-tasks of this analysis

DEVELOPMENT AND VALIDATION OF ANALYSIS

Development of Analysis

A draft analysis is developed by a committee of industry experts in the field led by a team of facilitators from Human Resources and Skills Development Canada. This draft analysis breaks down all the tasks performed in the occupation and describes the knowledge and abilities required for a tradesperson to demonstrate competence in the trade.

Draft Review

The National Occupational Analysis (NOA) development team then forwards a copy of the analysis and its translation to provincial and territorial authorities for a review of its content and structure. Their recommendations are assessed and incorporated into the analysis.

Validation and Weighting

The analysis is sent to all provinces and territories for validation and weighting. Participating jurisdictions consult with industry to validate and weight the document, examining the blocks, tasks and sub-tasks of the analysis as follows:

BLOCKS	Each jurisdiction assigns a percentage of questions to each block for an examination that would cover the entire trade.
TASKS	Each jurisdiction assigns a percentage of exam questions to each task within a block.
SUB-TASKS	Each jurisdiction indicates, with a YES or NO, whether or not each sub-task is performed by skilled workers within the occupation in its jurisdiction.

The results of this exercise are submitted to the NOA development team who then analyzes the data and incorporates it into the document. The NOA provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for block and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

This method for the validation of the NOA also identifies common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions perform a sub-task, it shall be considered common core. Interprovincial Red Seal Examinations are based on the common core sub-tasks identified through this validation process.

Definitions for Validation and Weighting

YES	sub-task performed by qualified workers in the occupation in a specific jurisdiction
NO	sub-task not performed by qualified workers in the occupation in a specific jurisdiction
NV	analysis Not Validated by a province/territory
ND	trade Not Designated in a province/territory
NOT COMMON CORE (NCC)	sub-task, task or block performed by less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade
NATIONAL AVERAGES %	average percentage of questions assigned to each block and task in Interprovincial Red Seal Examination for the trade

Provincial/Territorial Abbreviations

NL	Newfoundland and Labrador
NS	Nova Scotia
PE	Prince Edward Island
NB	New Brunswick
QC	Quebec
ON	Ontario
MB	Manitoba
SK	Saskatchewan
AB	Alberta
BC	British Columbia
NT	Northwest Territories
YT	Yukon Territory
NU	Nunavut

ANALYSIS

Safe working procedures and conditions, accident prevention, and the preservation of health are of primary importance to industry in Canada. These responsibilities are shared and require the joint efforts of government, employers and employees. It is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and work environments can be created by controlling the variables and behaviours that may contribute to accidents or injury.

It is generally recognized that safety-conscious attitudes and work practices contribute to a healthy, safe and accident-free work environment.

It is imperative to apply and be familiar with the Occupational Health and Safety (OH&S) Acts and Workplace Hazardous Materials Information System (WHMIS) Regulations. As well, it is essential to determine workplace hazards and take measures to protect oneself, co-workers, the public and the environment.

Safety education is an integral part of training in all jurisdictions. As safety is an imperative part of all trades, it is assumed and therefore it is not included as a qualifier of any activities. However, the technical safety tasks and sub-tasks specific to the trade are included in this analysis.

SCOPE OF THE REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE

"Refrigeration and Air Conditioning Mechanic" is this trade's official Red Seal occupational title approved by the CCDA. This analysis covers tasks performed by refrigeration and air conditioning mechanics whose occupational title has been identified by some provinces and territories of Canada under the following names:

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
Pipefitter — Refrigeration Mechanic Specialty (Non-Construction)					✓								
Refrigeration and Air Conditioning Mechanic	✓	✓	✓	✓					✓		✓	✓	✓
Refrigeration and Air Conditioning Mechanic (Commercial)							✓						
Refrigeration and Air Conditioning Systems Mechanic						✓							
Refrigeration Mechanic								✓		✓			
Refrigeration Mechanic (Construction)					✓								

Refrigeration and air conditioning mechanics install and service residential, commercial, industrial and institutional heating, ventilation, air conditioning and refrigeration units and systems. Their duties include laying out reference points for installation, assembling and installing components, installing wiring to connect components to an electric power supply and calibrating related controls. They also measure, cut, bend, thread and connect pipe to functional components and utilities.

Refrigeration and air conditioning mechanics maintain systems by testing components, brazing or soldering parts to repair defective joints, adjusting and replacing worn or defective components and reassembling repaired components and systems. They also test and recharge these systems.

People in this trade may be employed by refrigeration and air conditioning contractors, property owners and institutional and public sector employers or may be self-employed. They work on a variety of projects in the residential, commercial, industrial and institutional sectors, including office buildings, restaurants, food processing plants, ice arenas, computer facilities, supermarkets and hospitals.

Refrigeration and air conditioning mechanics may work on refrigerated trucks, automotive air conditioning systems, box cars, appliances and ships. In addition to their regular duties, some mechanics may also be required to prepare work estimates and plan systems for clients.

Refrigeration and air conditioning mechanics work in various locations such as rooftops, mechanical rooms and computer rooms. The work may be performed indoors or outdoors year round and may require extensive traveling. The work may also be performed independently. Inherent risks in this trade include working at heights, in confined spaces, and working with compressed gases, utilities and hazardous chemicals.

Key attributes for people entering this trade are good customer service, writing and communication skills, and an eye for detail. Good coordination and manual dexterity are also important, as are good mechanical and mathematical skills. Good physical condition and the strength to lift heavy components are also valuable. Much of the work is performed alone.

This analysis recognizes similarities and overlaps with the work of steamfitters/pipefitters, plumbers, gasfitters, sheet metal workers, industrial mechanics (millwrights) and electricians.

With experience, refrigeration and air conditioning mechanics may act as mentors and trainers of apprentices in the trade. They may also become specialized in one area of the trade, advance to supervisory positions or become instructors.

OCCUPATIONAL OBSERVATIONS

Refrigeration and air conditioning mechanics continue to be challenged by the growing variety of energy-efficient equipment and sophisticated electronic controls as well as by the proliferation of new refrigerants and oils. The systems are being engineered with greater detail and complexity due to increasing needs for efficiency and reliable operation. Increased documentation and record-keeping now plays a greater role in mechanics' daily tasks.

Due to health and safety concerns and regulations, indoor air quality is recognized as a priority when installing and servicing systems. As well, several other governing agencies have an increasing presence causing refrigeration and air conditioning mechanics to be much more aware of compliance issues such as for pressure vessels, environmental spills, etc.

There is an increase in the use of advanced electronic control systems such as microprocessors and modems. Mechanics are required to increase their knowledge of computers.

Occupational health and safety training such as Workplace Hazardous Materials Information System (WHMIS), first aid, fall arrest and confined space are necessary in today's working environment.

There is an increasing demand on mechanics to work with customers and clients to identify and interpret pertinent documents.

In this time of environmental awareness, mechanics need to take greater care in the planning, installing and servicing stages of heating, ventilation and air conditioning (HVAC), and refrigeration equipment. They must be very conscious of issues such as noise pollution, use of chemicals and energy conservation. Also, they should promote the use of environmentally-friendly chemicals, components and accessories.

Trends

Increasingly, computers are integrated into the refrigeration equipment.

New types of refrigerants that are more environmentally-friendly are being introduced into the industry. Often, higher pressures and other characteristics associated with these refrigerants require an increased level of safety awareness. As well, new tools and equipment are required to work with these refrigerants.

Safety protocols are becoming more complex due to an increase in government regulations and enforcement. This makes the job site safer, but results in increased administrative duties for refrigeration and air conditioning mechanics.

There is a trend towards electronic dispatching, purchasing and invoicing.

Related Components (including, but not limited to)

All components apply.

Tools and Equipment

See Appendix A.

Task 1 Uses and maintains tools and equipment.

Context

Refrigeration and air conditioning mechanics use and maintain tools to allow them to perform the tasks of their trade safely and efficiently. Maintenance of tools and equipment includes activities such as inspecting, lubricating, storing and performing minor repairs.

Required Knowledge

K 1	knowledge of types of hand tools such as benders, flaring tools and pipe cutters
K 2	knowledge of types of portable tools such as reciprocating saws, chop saws and drills
K 3	knowledge of types of stationary tools such as threading machines, drill presses and grinders

K 4	knowledge of types of diagnostic and measuring equipment such as multimeters, infrared thermometers and air flow meters
K 5	knowledge of types of brazing tools such as air-fuel and oxy-fuel tools
K 6	knowledge of types of brazing and soldering tool tips
K 7	knowledge of types of rigging, hoisting and lifting equipment
K 8	knowledge of types of access equipment such as personnel lifts, ladders and scaffolding
K 9	knowledge of operating procedures for rigging, hoisting and lifting equipment
K 10	knowledge of capacities of rigging, hoisting and lifting equipment
K 11	knowledge of government legislation and regulations related to the use of access equipment, and rigging, hoisting and lifting equipment
K 12	knowledge of types of recovery and recycling equipment
K 13	knowledge of government legislation and regulations such as Transport of Dangerous Goods (TDG), WHMIS and Ozone Depleting Substance (ODS) related to the handling of refrigerants and oils
K 14	knowledge of types of PPE such as hard hats, safety glasses and respirators
K 15	knowledge of types of safety equipment such as first aid kits and fire extinguishers
K16	knowledge of certification and training requirements for access equipment, personal protective equipment (PPE) and safety equipment
K 17	knowledge of fall arrest equipment and requirements
K 18	knowledge of operation of basic service and cargo vehicles
K 19	knowledge of hazardous situations such as environment sump, asbestos and inadequate oxygen levels
K 20	knowledge of seismic restraint measures

Sub-task

A-1.01 Maintains hand tools.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	no	NV	NV	NV

Key Competencies

A-1.01.01	inspect hand tools for damage such as dull blades and wheels, and cracks
A-1.01.02	lubricate hand tools such as flaring tools and cutters to ensure proper operation
A-1.01.03	wipe tools after use to ensure they are clean and rust-free
A-1.01.04	store hand tools in a clean and dry location to ensure they are in operating condition
A-1.01.05	replace hand tool parts such as cutting blades and hacksaw blades

Sub-task

A-1.02 Maintains portable and stationary power tools.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.02.01	check batteries and chargers to ensure they are in good condition and batteries are fully charged
A-1.02.02	inspect power tools for unsafe conditions such as missing parts, defective or missing guards and frayed cords
A-1.02.03	inspect power tool parts such as cutting blades, bits and dies to identify defects, faults and worn parts
A-1.02.04	clean power tools to ensure they are ready for use
A-1.02.05	replace power tool components such as drill bits and cutting discs
A-1.02.06	store power tools in a clean and dry location to ensure they are in operating condition

Sub-task

A-1.03 Maintains brazing and soldering equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.03.01	inspect hoses for conditions such as cracks, loose connections and damage
A-1.03.02	inspect regulators for conditions such as damaged gauges and diaphragms, and leakage
A-1.03.03	clean or replace torch tips and o-rings
A-1.03.04	check cylinders to ensure adequate gas pressure
A-1.03.05	inspect cylinders for thread and valve damage to prevent leakage and fire
A-1.03.06	store cylinders in a secure, upright position, within rated temperatures and according to WHMIS procedures

Sub-task

A-1.04 Maintains recovery and recycling equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.04.01	inspect equipment for damage from transport and use
A-1.04.02	clean and test equipment such as recovery units and hoses
A-1.04.03	check and clean screens and filters to prevent blockage and ensure proper filtration of the refrigerant
A-1.04.04	store refrigerant cylinders in a secure, upright position, within rated temperatures and according to WHMIS procedures
A-1.04.05	check and verify certification of cylinders
A-1.04.06	mark and label recovered refrigerants and their state of condition

Sub-task

A-1.05 Maintains evacuation tools and equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.05.01	change oil on vacuum pumps to ensure proper operation of pump
A-1.05.02	clean vacuum pumps regularly
A-1.05.03	store equipment in a secure position to prevent oil spillage
A-1.05.04	maintain adequate oil level to enable evacuation
A-1.05.05	inspect and replace components such as gauges, o-rings and seals
A-1.05.06	test pumps using tools such as vacuum gauges and micron gauges to ensure proper calibration

Sub-task

A-1.06 Maintains charging tools and equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.06.01	calibrate scales and gauges by adjusting zero point to ensure accurate measurements
A-1.06.02	inspect tools and equipment for damage such as frayed cords, cracked hoses and seals, and broken glasses and dials
A-1.06.03	clean, seal and store equipment

Sub-task

A-1.07 Maintains diagnostic and measuring tools and equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.07.01	charge batteries to ensure equipment is ready for use
A-1.07.02	inspect leads, probes and sensors for damage and wear
A-1.07.03	verify calibration of equipment such as thermometers, scales and leak detectors
A-1.07.04	store tools and equipment in a dry location

Sub-task

A-1.08 Uses access equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.08.01	select ladders and work platforms for the job taking into consideration length, site conditions and task being performed
A-1.08.02	inspect ladders and scaffolding for damage and missing components
A-1.08.03	identify hazards such as power lines and excess loads when erecting ladders and scaffolding
A-1.08.04	secure access equipment such as ladders and scaffolding
A-1.08.05	erect, level and dismantle scaffolding according to jurisdictional regulations
A-1.08.06	use equipment within operating limitations as indicated on manufacturers' tags and in compliance with OH&S regulations

Sub-task

A-1.09 Uses rigging, hoisting and lifting equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.09.01	select equipment for task considering factors such as weight, loads and distance to be travelled
A-1.09.02	inspect equipment such as slings, come-alongs and shackles for wear, damage and defects on a regular basis
A-1.09.03	remove defective equipment from service and submit for testing and re-certification
A-1.09.04	identify hazards such as power lines, excavations and excessive loads
A-1.09.05	rig loads following rigging procedures and according to jurisdictional regulations to ensure safety and to prevent damage to rigging equipment and material
A-1.09.06	attach and use tag lines to guide and position loads
A-1.09.07	use basic international crane hand signals and two-way radios to communicate with equipment operators
A-1.09.08	store equipment in clean and dry locations away from sunlight

Sub-task

A-1.10 Uses personal protective equipment (PPE) and safety equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.10.01	select and wear PPE appropriate for task and as identified by site policies and jurisdictional regulations
A-1.10.02	identify PPE damage such as excessively worn boots and cracked safety glasses
A-1.10.03	locate and use safety equipment such as fire extinguishers, eye wash stations and first aid kits

A-1.10.04	store PPE and safety equipment according to manufacturers' recommendations
A-1.10.05	replace safety harnesses, hard hats and lanyards as required by regulations

Sub-task

A-1.11 Uses computers.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.11.01	connect computer to automated control systems by referring to manufacturers' operating procedures
A-1.11.02	program parameters on computers and user-interface panels to set up operation of systems
A-1.11.03	use on-board functions to monitor and diagnose problems
A-1.11.04	use communication function of computers
A-1.11.05	save files

Task 2 Organizes work.

Context Refrigeration and air conditioning mechanics organize their work in order to complete their tasks safely, efficiently and productively.

Required Knowledge

K 1	knowledge of types of codes such as refrigeration, plumbing, gas, building, electrical and oil burner
K 2	knowledge of jurisdictional codes and regulations such as national, provincial and municipal
K 3	knowledge of types and formats of drawings and schematics
K 4	knowledge of information contained on schematics and drawings such as symbols, dimensions and tolerances
K 5	knowledge of trade practices and standard training procedures
K 6	knowledge of common pipe sizes
K 7	knowledge of types and grades of piping

K 8	knowledge of work-related documents such as repair orders, preventative maintenance, service logs and start up sheets
K 9	knowledge of training and certification requirements such as OH&S, TDG, WHMIS, first aid and fall arrest
K 10	knowledge of equipment and system specifications
K 11	knowledge of materials lists, work orders and permits
K 12	knowledge of location of safety equipment and materials
K 13	knowledge of WHMIS information such as labels and Material Safety Data Sheets (MSDS)
K 14	knowledge of company safety policies and guidelines
K 15	knowledge of metric and imperial measurements
K 16	knowledge of trade terminology

Sub-task

A-2.01 Interprets codes, regulations and procedures.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.01.01	locate code sections that apply to the task being performed
A-2.01.02	use code information to perform required calculations
A-2.01.03	refer to tables and charts in codes
A.2.01.04	refer to jurisdictional regulations to determine permits required
A-2.01.05	refer to facility and equipment procedures for tasks such as lock-out and shutdown
A-2.01.06	refer to manufacturers' or owners' start-up procedures to ensure equipment is commissioned correctly
A-2.01.07	adhere to company and worksite procedures such as required training, service reports and safety and communication procedures

Sub-task

A-2.02 Interprets blueprints and specifications.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.02.01	refer to manufacturers' and shop drawings to obtain equipment specifications such as weight, size and service access locations
A-2.02.02	refer to engineering specifications to determine which equipment is required
A-2.02.03	refer to blueprints to identify electrical, mechanical and communication equipment
A-2.02.04	scale drawings for placement of equipment and accessories, coring of holes and location of utilities
A-2.02.05	interpret drawings such as isometric, elevation and plan views
A-2.02.06	interpret schematic drawings and pictorial diagrams to provide information on electrical equipment

Sub-task

A-2.03 Uses documentation and reference material.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.03.01	refer to tables and charts to obtain pipe sizes, pressure/temperature relationships and pressure/enthalpy relationships
A-2.03.02	refer to technical bulletins and manuals to obtain detailed information about equipment
A-2.03.03	refer to warranties to assist in submitting required documentation
A-2.03.04	submit information such as start-up and claim sheets in order to activate and claim warranties
A-2.03.05	refer to wholesaler catalogues to assist in the selection and ordering of parts and equipment

A-2.03.06	maintain refrigerant log sheets to keep record of purchases, recovery and losses of refrigerant
A-2.03.07	complete written documents such as work reports, work orders, incident reports, permits and time sheets

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Sub-task

A-2.04 Communicates with others.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	no	NV	NV	NV

Key Competencies

A-2.04.01	operate communication equipment such as radios, cell phones and computers
A-2.04.02	communicate with non-tradespeople such as consultants, engineers, owners and end-users to relay technical information
A-2.04.03	communicate with other tradespeople such as crane operators, plumbers, electricians and utilities personnel
A-2.04.04	coordinate with other trades during layout and installation of heating, ventilation and air conditioning (HVAC), and refrigeration systems to avoid interference with other trades
A-2.04.05	communicate with apprentices
A-2.04.06	communicate with office staff such as dispatchers, sales staff and managers
A-2.04.07	communicate with customers to identify and interpret pertinent documentation

Sub-task

A-2.05 Plans job tasks and procedures.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.05.01	prepare a material list, confirm availability and order materials required for task
A-2.05.02	schedule delivery of equipment and materials
A-2.05.03	arrange for storage of materials in a safe and secure location until required for task
A-2.05.04	arrange time to access work site to avoid downtime and delays
A-2.05.05	schedule tasks with other trades such as gasfitters, sheet metal workers, plumbers and electricians
A-2.05.06	assign qualified personnel to specific locations and tasks to ensure task is completed efficiently and deadlines are met
A-2.05.07	arrange for use of major tools and equipment such as cranes, threaders and personnel lifts
A-2.05.08	organize tools and equipment usage to make sure the right tools and equipment are available when needed

Sub-task

A-2.06 Maintains safe work environment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.06.01	follow specified safety procedures such as fall arrest, hot work and confined space procedures
A-2.06.02	recognize hazards such as high voltage, rotating equipment, working at heights and noisy locations
A-2.06.03	maintain a clean and tidy work site to avoid injuries to self and others
A-2.06.04	apply lock-out and tag-out when working on equipment to avoid injury
A-2.06.05	coordinate tasks with other workers to avoid injury to self and others
A-2.06.06	use flagging, pylons and signage when working in high traffic areas

A-2.06.07	handle hazardous materials in accordance with WHMIS procedures such as disposal, labelling and using PPE
A-2.06.08	participate in safety meetings and discussions to ensure that information is recorded and distributed to all team members
A-2.06.09	recognize and report unsafe conditions so that they may be rectified

Task 3 Performs routine trade activities.

Context Refrigeration and air conditioning mechanics perform these routine trade activities to enable them to complete the tasks of their trade. The activities are performed in a number of blocks within this analysis.

Required Knowledge

K 1	knowledge of sign-in procedures when preparing the work site
K 2	knowledge of types and ratings of fasteners such as anchors, bolts and inserts
K 3	knowledge of types and applications of brackets and hangers such as unistrut, teardrop and horseshoe clamps
K 4	knowledge of limitations of fasteners, brackets and hangers
K 5	knowledge of specialty brackets and hangers such as seismic and vibration isolation
K 6	knowledge of compatibility of fasteners, brackets and hangers with other materials
K 7	knowledge of procedures and regulations for lock-out and tag-out
K 8	knowledge of lock-out devices such as padlocks, breaker locks and multiple lock holder
K 9	knowledge of regulations such as OH&S, WHMIS and ODS (Greenhouse gases)
K 10	knowledge of types of sealants and adhesives such as silicone, insulation glues, spray foam and thread seal
K 11	knowledge of application techniques for sealants and adhesives
K 12	knowledge of types of adhesives such as insulation glues, primers and pipe adhesives
K 13	knowledge of environmental protection requirements such as recovery, disposal, handling and storage for cleaners and lubricants
K 14	knowledge of characteristics, applications, qualities and capabilities of cleaners and lubricants
K 15	knowledge of electrical requirements of system components

K 16	knowledge of electrical code book
K 17	knowledge of types of wiring termination
K 18	knowledge of types and gauges of wire
K 19	knowledge of internal wiring such as wiring in packaged units and wiring in a split system
K 20	knowledge of types of refrigerants such as azeotropes and zeotropes
K 21	knowledge of charging and recovery techniques of refrigerants
K 22	knowledge of pressure/temperature relationships of refrigerants
K 23	knowledge of types of compressed gases such as acetylene, nitrogen and carbon dioxide
K 24	knowledge of types of chemicals such as cleaning agents and solvents
K 25	knowledge of types of oils such as vacuum pump oil and lubricating oil
K 26	knowledge of compatibility of refrigerants and refrigerant oils
K 27	knowledge of types and temperature ranges of refrigerant oils
K 28	knowledge of line voltage connections and sizing
K 29	knowledge of line voltage types and phasing
K 30	knowledge of proper location for disposal of decommissioned equipment

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Sub-task

A-3.01 Prepares work site.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.01.01	identify area for storage of tools, equipment and supplies
A-3.01.02	locate washrooms, safety equipment and emergency exits on site
A-3.01.03	identify on-site hazards such as overhead lines and other construction activity
A-3.01.04	locate service points such as water, gas and electricity
A-3.01.05	locate isolation points such as water, gas and electrical shut-offs
A-3.01.06	coordinate site access for equipment such as cranes, personnel lifts and delivery trucks
A-3.01.07	erect barricades and flagging to warn others
A-3.01.08	ensure work area hazards are eliminated or controlled

Sub-task

A-3.02 Handles materials and supplies.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.02.01	receive and verify delivered material using packing slips, serial numbers, model numbers and catalogue numbers
A-3.02.02	inspect delivered materials to detect shipping damage
A-3.02.03	label materials and supplies according to procedures such as WHMIS regulations and company policy
A-3.02.04	secure material and supplies by using equipment such as chains, straps and slings when being stored or shipped
A-3.02.05	manually lift materials and supplies according to OH&S regulations and industry standards to avoid personal injury and damage to materials and equipment
A-3.02.06	store materials and supplies appropriately to prevent damage, deterioration, discharge or theft
A-3.02.07	dispose of waste materials according to environmental standards

Sub-task

A-3.03 Installs fasteners, brackets and hangers.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.03.01	select fasteners, brackets and hangers according to job specifications and compatibility
A-3.03.02	lay out fasteners, brackets and hangers according to plans
A-3.03.03	construct hangers and brackets from raw material for custom applications
A-3.03.04	place brackets and hangers securely according to codes and job requirements
A-3.03.05	select and use tools and equipment such as hammer drills, power saws, measuring tapes and levelling devices

Sub-task

A-3.04 Performs lock-out, tag-out and isolation procedures.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.04.01	notify building authorities of maintenance and repairs prior to and after completion and acquire hot permit as required
A-3.04.02	isolate equipment by shutting off components such as disconnect switches and shut-off valves
A-3.04.03	apply locking device to secure isolation to prevent accidental start-up
A-3.04.04	record lock-out information on a tag attached to the locking device
A-3.04.05	verify the isolation of equipment to ensure that the equipment can be worked on safely
A-3.04.06	remove tags and locks from equipment after completion of repair

Sub-task

A-3.05 Applies sealants and adhesives.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.05.01	select sealants and adhesives according to manufacturers' recommendations, application and compatibility with other materials
A-3.05.02	ensure adequate ventilation during application of sealants and adhesives
A-3.05.03	select and use tools and equipment such as brushes and caulking gun to apply sealants and adhesives as per manufacturers' recommendations
A-3.05.04	inspect sealing surfaces for signs of wear and warpage before sealants or adhesives are applied

Sub-task

A-3.06 Performs internal electrical wiring of systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.06.01	select and use tools and equipment appropriate to the task being performed
A-3.06.02	select wire size and type according to amperage, insulation rating and compatibility with other components
A-3.06.03	cut, join, crimp and route wiring according to applicable code and manufacturers' specifications
A-3.06.04	label wire terminations for identification purposes
A-3.06.05	update schematics to record changes and modifications according to manufacturers' recommendations
A-3.06.06	check continuity with meters such as ammeter, voltmeter, and multimeter to ensure that circuit is complete

Sub-task

A-3.07 Performs field wiring of systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	no	yes	yes	NV	NV	NV

Key Competencies

A-3.07.01	lock out and disconnect/reconnect power to equipment
A-3.07.02	identify correctly sized wiring, fusing and overloads according to jurisdictional regulations and manufacturer's specifications
A-3.07.03	verify circuit is de-energized to avoid personal injury or damage to equipment
A-3.07.04	refer to and interpret electrical schematics and termination points
A-3.07.05	route and secure wiring according to trade standards
A-3.07.06	terminate wiring to related equipment using components such as crimped connectors, junction boxes and terminal lugs
A-3.07.07	label or tag wiring with wire markers for identification and service purposes

Sub-task

A-3.08 Uses refrigerants, gases and oils.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.08.01	select refrigerants according to system and specifications
A-3.08.02	select refrigerant oils according to refrigerant and temperature range of system
A-3.08.03	select and use tools and equipment such as gauges, scales and pumps
A-3.08.04	recover refrigerant when there are leaks and burnouts, when components need to be changed and when decommissioning the system
A-3.08.05	dispose of secondary refrigerants and refrigerant oils according to environmental protocols and jurisdictional regulations
A-3.08.06	use nitrogen to pressure test systems for leak detection
A-3.08.07	use nitrogen to purge refrigerant lines to prevent oxidation during soldering and brazing
A-3.08.08	use compressed gases such as oxy-fuel and air-fuel to solder and braze components

Trends

There is an increased use of electronic valves, which are replacing mechanically-operated valves.

Energy conservation is being driven by government, customers and industry. This must be taken into consideration when planning a system and its components. For example, during the installation planning, mechanics must consider the phase-out of chlorofluorocarbons (CFC) and hydro chlorofluorocarbons (HCFC) refrigerants such as R-22 & R-11.

Related Components (including, but not limited to)

HVAC: heat pumps, air handling units, controls and sensors, dampers, fans, ducting, humidifiers and dehumidifiers, air cleaners, air scrubbers, cooling towers, unit heaters, compressors, speed drives, filters, furnaces, electric heaters, motors, heating modules, valves, metering devices, fluid pumping systems, indoor air quality (IAQ) accessories.

Refrigeration systems: oil separators, receivers, accumulators, evaporators, heat exchangers, condensers, motors, flow controls, fluid coolers, piping and tubing, compressors, heat pumps.

Control systems: microprocessors, VAV boxes, computers, switches, refrigerant monitors, sensors, cables, thermostats, safety devices, on-board electronics, interface panels, actuators, valves, wiring.

Tools and Equipment

See Appendix A.

Task 4 Plans installation of heating, ventilation and air conditioning, and refrigeration systems.

Context

Refrigeration and air conditioning mechanics plan the installation of HVAC and refrigeration systems to facilitate the smooth installation of the equipment and to ensure the desired end result. Proper planning ensures system longevity and reliability, and reduces operating costs. HVAC and refrigeration systems include commercial, residential, industrial and institutional applications.

Required Knowledge

K 1	knowledge of types of HVAC systems such as split systems, package units, heat reclaim units and heat exchangers
K 2	knowledge of types of refrigeration systems such as coolers, freezers, chillers and process refrigeration systems
K 3	knowledge of types of HVAC accessories such as IAQ add-ons and outdoor temperature sensors
K 4	knowledge of types of refrigeration accessories such as temperature sensors and transducers
K 5	knowledge of types of HVAC components such as compressors, condensers, evaporators and metering devices
K 6	knowledge of types of refrigeration components such as valves, oil separators and accumulators
K 7	knowledge of types of insulation such as fibreglass, closed cell foam insulation and duct insulation
K 8	knowledge of piping materials, fittings and accessories
K 9	knowledge of warranties and guarantees
K 10	knowledge of available utilities and energy sources
K 11	knowledge of jurisdictional regulations
K 12	knowledge of industry related calculations
K 13	knowledge of psychrometrics
K 14	knowledge of piping practices for flow velocity and oil return
K 15	knowledge of thermodynamics
K 16	knowledge of electrical requirements and codes for installation of equipment
K 17	knowledge of building automation systems
K 18	knowledge of adhesives to join insulation
K 19	knowledge of building practices vapour barrier for server rooms
K 20	knowledge of new electronic metering and capacity valves and controls
K 21	knowledge of proper installation of condensate drain

Sub-task

B-4.01 Verifies heating, ventilation and air conditioning, and refrigeration system parameters and requirements.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.01.01	calculate HVAC heat loads by taking into account characteristics such as ambient temperature, insulation, windows, doors and square footage
B-4.01.02	calculate refrigeration heat loads by taking into account characteristics such as ambient temperature, processes and applications
B-4.01.03	identify correct system size according to heat load calculations
B-4.01.04	identify utilities available or needed to ensure proper installation and operation of equipment
B-4.01.05	identify regional parameters such as humidity and environmental conditions
B-4.01.06	select and use tools and equipment to obtain information required to determine system parameters for heat load
B-4.01.07	identify provisions for condensate drainage

Sub-task

B-4.02 Selects heating, ventilation and air conditioning, and refrigeration components, equipment and accessories.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.02.01	identify equipment, components and accessories based on manufacturers' specifications, engineering specifications, system requirements, best refrigerant for application and blueprints or shop drawings
B-4.02.02	identify HVAC component limitations such as blower capacity and pressure drop
B-4.02.03	identify refrigeration component limitations such as pressure drops and oil return
B-4.02.04	identify appropriate IAQ accessories according to requirements
B-4.02.05	identify components required according to system design and requirements

B-4.02.06	source equipment based on availability, servicing requirements and customer requirements
B-4.02.07	identify alternative systems, such as building automation systems, heat reclaim units and heat exchangers, based on energy savings and environmental issues
B-4.02.08	identify accessories such as gas monitors and leak detectors according to code and customer requirements

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Sub-task

B-4.03 Determines location of components, equipment and accessories.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.03.01	identify placement of equipment based on sizing, future serviceability, utilities, structure and jurisdictional regulations
B-4.03.02	identify location limitations of components, equipment and accessories based on manufacturers' specifications and system requirements
B-4.03.03	identify location of system taking into consideration aesthetics and surrounding environmental issues such as noise, exhaust and intake vent locations and expected snow conditions
B-4.03.04	take measurements to ensure that equipment will fit in location
B-4.03.05	verify energy sources and utility connections

Sub-task

B-4.04 Selects insulation.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.04.01	identify appropriate insulation based on manufacturers' specifications, engineering specifications and system requirements
B-4.04.02	identify insulation based on limitations such as location, traffic, environmental conditions and aesthetics
B-4.04.03	identify alternative options for insulation

Sub-task

B-4.05 Performs piping, flow controls and accessories take-off.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.05.01	determine piping route based on blueprints, working drawings and site visits
B-4.05.02	measure selected piping route to determine material requirements
B-4.05.03	establish material order list for components such as piping, flow controls and accessories
B-4.05.04	establish pipe size according to pipe run, refrigerant type and equipment capacity

Task 5 Plans installation of control systems.

Context Proper planning of control systems ensures appropriate operation of the equipment installed. Control systems are used to operate the system effectively and efficiently.

Required Knowledge

K 1	knowledge of types of control systems such as electric and electronic
K 2	knowledge of types of control system components such as thermostats, timers and pressure controls
K 3	knowledge of end user requirements
K 4	knowledge of operation of control system
K 5	knowledge of sequence of operation
K 6	knowledge of electrical theory
K 7	knowledge of system application such as temperature and relative humidity
K 8	knowledge of system requirements such as safety controls

Sub-task

B-5.01 Verifies control system parameters and requirements.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.01.01	identify control system requirements according to clients' needs and equipment specifications
B-5.01.02	identify regional parameters
B-5.01.03	identify location of control system
B-5.01.04	identify safety controls required for system operation

Sub-task

B-5.02 Performs control system take-off.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.02.01	determine material required according to established parameters
B-5.02.02	select compatible controls
B-5.02.03	measure selected wiring and tubing route to determine material requirements

Sub-task

B-5.03 Performs control system initial layout.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	no	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.03.01	determine proper location of mechanical and electrical controls according to function
B-5.03.02	determine sequence of operations
B-5.03.03	develop working drawing for reference
B-5.03.04	determine wiring and tubing route to connect controls to system based on blueprints, working drawings and site visit

Trends

Due to health and safety issues, indoor air quality is becoming more important when installing a system. Modern systems are larger and more complex (e.g. air filtration, fresh air requirements) and require rigorous monitoring for efficient system operation.

There is increasing environmental awareness, and more care has to be taken when selecting and placing the system. Mechanics have to pay attention to noise pollution and use environmentally-friendly components and accessories (e.g. refrigerants, automated systems) whenever possible.

More refrigeration systems are being installed that include considerations for energy efficiency, refrigerant quantity and new piping design.

New installation procedures and products are being introduced to deal with environment events such as severe weather and seismic activity.

Related Components (including, but not limited to)

HVAC: heat pumps, air handling units, controls and sensors, dampers, fans, ducting, humidifiers and dehumidifiers, air cleaners, air scrubbers, cooling towers, unit heaters, compressors, speed drives, filters, furnaces, electric heaters, motors, heating modules, fluid pumping systems, valves, metering devices, IAQ accessories.

Refrigeration systems: oil separators, receivers, accumulators, evaporators, heat exchangers, condensers, motors, flow controls, fluid coolers, piping and tubing, compressors, heat pumps.

Control systems: microprocessors, VAV boxes, computers, switches, refrigerant monitors, sensors, cables, thermostats, safety devices, on-board electronics, interface panels, actuators, valves, wiring.

Tools and Equipment

See Appendix A.

Task 6 — Installs heating, ventilation and air conditioning, and refrigeration systems.

Context Refrigeration and air conditioning mechanics assemble, place, secure and connect components of HVAC and refrigeration systems for all types of applications such as residential, commercial, industrial and institutional.

Required Knowledge

K 1	knowledge of trade standards regarding installation
K 2	knowledge of blueprints and specifications
K 3	knowledge of specific service requirements
K 4	knowledge of utility requirements
K 5	knowledge of manufacturers' recommended assembly techniques and procedures
K 6	knowledge of system restraints for conditions such as seismic activity, permafrost and weather conditions
K 7	knowledge of jurisdictional regulations
K 8	knowledge of pipe sizing
K 9	knowledge of vibration and noise elimination
K 10	knowledge of refrigerants
K 11	knowledge of piping layout
K 12	knowledge of techniques and procedures for routing and connecting refrigerant piping
K 13	knowledge of system evacuation process
K 14	knowledge of electrical requirements and codes for installation of equipment
K 15	knowledge of safe routing of refrigerant lines

Sub-task

C-6.01 Confirms layout.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.01.01	verify site measurements for equipment and component location
C-6.01.02	verify that equipment location meets the manufacturers' specifications
C-6.01.03	verify utilities according to designed initial layout to ensure proper operation of equipment
C-6.01.04	verify equipment and components orientation for future service requirements
C-6.01.05	modify HVAC and refrigeration system components or location to accommodate actual site conditions

Sub-task

C-6.02 Assembles heating, ventilation and air conditioning, and refrigeration components, equipment and accessories.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.02.01	unpack and perform pre-assembly check to ensure all necessary equipment and components are available and in good condition
C-6.02.02	select and use tools and equipment such as hand tools and power equipment to assemble equipment and components
C-6.02.03	confirm final assembly of components

Sub-task

C-6.03 Places heating, ventilation and air conditioning, and refrigeration components, equipment and accessories.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.03.01	select and use tools and equipment such as wrenches, chain falls, lifts and ladders to place equipment and components
C-6.03.02	install anchors and supports according to manufacturers' recommendations and seismic requirements
C-6.03.03	install isolation components such as spring isolators and cork pads to eliminate vibration transmission
C-6.03.04	secure the equipment and components according to regional conditions, codes, and manufacturers' and owners' specifications
C-6.03.05	verify utility connections done by qualified personnel to ensure proper installation

Sub-task

C-6.04 Installs piping and tubing.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.04.01	select piping and tubing materials according to specific applications
C-6.04.02	select brazing materials for joining similar and dissimilar metals
C-6.04.03	braze and solder piping and tubing using oxy-fuel and air-fuel equipment
C-6.04.04	cut and fit piping and tubing using procedures such as flaring and swaging
C-6.04.05	cut and thread pipe using taps and dies, and mechanical equipment
C-6.04.06	bend piping and tubing according to calculations and installation requirements
C-6.04.07	connect piping and tubing according to manufacturers' specifications and codes
C-6.04.08	hang piping and tubing using hangers, supports and cradles

C-6.04.09 install accessories such as vibration eliminators, flow controls and oil separators

C-6.04.10 insulate piping and tubing according to environmental conditions, location and applications

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Sub-task

C-6.05 Performs leak test on system.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.05.01 prepare system for leak test as required by manufacturers' recommendations, industry standards, and jurisdictional regulations

C-6.05.02 remove or isolate devices that could be damaged from pressure test in compliance with pressure limits

C-6.05.03 pressurize system with fluids or gases to perform standing test to ensure system integrity

C-6.05.04 select and use tools and equipment such as electronic, and ultrasonic leak detectors and certified gauges

C-6.05.05 interpret and record leak test results to verify system integrity within a given time period

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Sub-task

C-6.06 Evacuates system.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.06.01 select and use tools and equipment such as compound gauge, micron gauge and vacuum pump

C-6.06.02 check capacity of vacuum pump to meet evacuation requirements

C-6.06.03 connect pump to system according to manufacturers' specifications

C-6.06.04 perform a standing vacuum test as required

C-6.06.05 perform evacuation using evacuation measuring tools and equipment

C-6.06.06 interpret and record evacuation test results to verify system integrity

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Sub-task

C-6.07 Applies holding charge.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.07.01 select and use tools and equipment such as hand tools and compound gauge

C-6.07.02 select refrigerant according to system requirements

C-6.07.03 pressurize system with refrigerant to desired pressure

C-6.07.04 label system with type and amount of holding charge

Task 7 Installs control systems.

Context

Refrigeration and air conditioning mechanics assemble, place, secure and connect controls for HVAC and refrigeration systems for all types of applications such as residential, commercial, industrial and institutional.

The controls enable the systems to start, stop, monitor and modulate to obtain desired condition.

Required Knowledge

K 1 knowledge of trade standards regarding installation

K 2 knowledge of blueprints and specifications

K 3 knowledge of specific service requirements

K 4 knowledge of manufacturers' recommended assembly techniques and procedures

K 5 knowledge of sequence of operations

K 6 knowledge of wiring practices

K 7 knowledge of pneumatic fundamentals

K 8 knowledge of digital and analog controls

K 9 knowledge of electrical theory

K 10	knowledge of electronics
K 11	knowledge of integrating different types of controls

Sub-task

C-7.01 Places control system components.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-7.01.01	select and use tools such as hand tools and power equipment
C-7.01.02	unpack and perform pre-assembly check to ensure all necessary controls and components are available and in good condition
C-7.01.03	determine controls location and position
C-7.01.04	mount and secure controls according to manufacturers' specifications

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Sub-task

C-7.02 Connects system wiring and control tubing.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-7.02.01	select and use tools such as wire strippers, crimpers and meters
C-7.02.02	install control wiring according to manufacturers' specifications codes and jurisdictional regulations
C-7.02.03	install pneumatic controls using tubing according to manufacturers' specifications

Trends	There is an increase in the use of electronically-submitted warranties and commissioning reports. There is an increase in the use of computers such as laptops and interface panels to assist in the commissioning of equipment such as rooftop units, chillers and multi-plex systems. Electronic valves such as evaporator pressure regulators (EPR) and electronic expansion valves (EXV) are now being used to provide more accurate control and increase efficiency.
Related Components (including, but not limited to)	**HVAC:** heat pumps, air handling units, controls and sensors, dampers, fans, ducting, humidifiers and dehumidifiers, air cleaners, air scrubbers, cooling towers, unit heaters, compressors, speed drives, filters, furnaces, electric heaters, motors, heating modules, valves, fluid pumping systems, metering devices, IAQ accessories. **Refrigeration systems:** oil separators, receivers, accumulators, evaporators, heat exchangers, condensers, motors, flow controls, fluid coolers, piping and tubing, compressors, heat pumps. **Control systems:** microprocessors, VAV boxes, computers, switches, refrigerant monitors, sensors, cables, thermostats, safety devices, on-board electronics, interface panels, actuators, valves, wiring.
Tools and Equipment	See Appendix A.

Task 8 Commissions heating, ventilation and air conditioning, and refrigeration systems.

Context Commissioning of HVAC and refrigeration systems is an important step in the process and ensures that the system is complete, fully charged and that all necessary adjustments have been made. This enables the system to run efficiently and problem-free, and according to specifications.

Required Knowledge

K 1	knowledge of manufacturers' engineering design for pre-start-up, start-up, completing system charge and setting up components
K 2	knowledge of equipment applications
K 3	knowledge of sequence of operation of systems
K 4	knowledge of types of electrical connections such as terminal strips, crimped and wire nuts
K 5	knowledge of charging procedures
K 6	knowledge of pre-charge refrigerant weight and type
K 7	knowledge of temperature/pressure relationships
K 8	knowledge of types of refrigerant and medium
K 9	knowledge of regulating valves and metering devices
K 10	knowledge of control system operations

Sub-task

D-8.01 Performs pre-start-up checks for heating, ventilation and air conditioning, and refrigeration systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.01.01	ensure that energy source and equipment are compatible
D-8.01.02	verify completion of installation by checking items such as missing parts, and shipping mounts and straps that are not removed
D-8.01.03	check positioning of controls to enable the system to run efficiently
D-8.01.04	verify that equipment is securely fastened and mounted
D-8.01.05	check electrical connections to detect loose or damaged wiring

D-8.01.06	ensure free movement of movable components such as drives, dampers and actuators
D-8.01.07	verify holding charge applied during installation by measuring circuit pressure and referring to holding charge reports
D-8.01.08	verify sequence of operation of controls and components
D-8.01.09	select and use tools and equipment such as multimeters, gauges and screwdrivers

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Sub-task

D-8.02 Starts up heating, ventilation and air conditioning, and refrigeration systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.02.01	turn on and verify utilities such as electrical, gas and water to enable equipment
D-8.02.02	verify proper rotation of blowers, fans, pumps and motors to allow other equipment to operate
D-8.02.03	select and use tools and equipment such as multimeters, gauges and screwdrivers
D-8.02.04	check rotation of all components according to manufacturers' specifications
D-8.02.05	test and adjust operation of HVAC and refrigeration system components such as dampers, thermostats, safeties and cut-outs
D-8.02.06	verify system operation by measuring parameters such as amp draw, pressures and temperatures
D-8.02.07	set up and adjust components such as dampers and connected controls
D-8.02.08	use a phase monitor in a critical phase direction application

Sub-task

D-8.03 Completes system charge.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.03.01	select and use tools and equipment such as manifold gauges and thermometers
D-8.03.02	verify type of refrigerant required for system
D-8.03.03	operate charging equipment such as scales, oil pump, charging cylinders and gauges
D-8.03.04	measure and interpret operating pressures, temperatures and load conditions
D-8.03.05	weigh and measure refrigerant to be added by referring to manufacturers' specifications or according to operating pressures, temperatures and superheat
D-8.03.06	add oil as required to compressor to provide lubrication and ensure safe compressor operation
D-8.03.07	verify refrigerant charge to ensure system operates at all load conditions
D-8.03.08	label system with type and amount of operating charge

Sub-task

D-8.04 Sets up primary and secondary heating, ventilation and air conditioning, and refrigeration system components.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.04.01	select and use tools and equipment such as screwdrivers, service wrench and multimeters
D-8.04.02	adjust switches, valves and regulators to allow system to operate at design conditions
D-8.04.03	measure and interpret readings from primary and secondary HVAC and refrigerant systems

D-8.04.04 adjust components such as metering devices, flow controls and pressure regulating valves to allow system to operate at design conditions

D-8.04.05 adjust secondary components such as cooling towers, pumps and fans

Task 9 Commissions control systems.

Context Mechanics perform start-up checks and set operating parameters of control systems to ensure that controls and safeties are set up correctly and to ensure proper operation of HVAC and refrigeration systems.

Required Knowledge

K 1 knowledge of manufacturers' specifications, owners' expectations and start-up procedures

K 2 knowledge of sequence of operation of control systems

K 3 knowledge of operation of HVAC and refrigeration systems and components

K 4 knowledge of operating parameters such as end user set points, temperature, pressure, voltage current and OHM values

K 5 knowledge of control system terminology and symbols

K 6 knowledge of control system components that require calibration

K 7 knowledge of manufacturers' standard set points for control systems

K 8 knowledge of setup procedures for control systems

K 9 knowledge of electric, electronic and pneumatic test instruments

Sub-task

D-9.01 Performs start-up checks for control systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.01.01 select and use hand tools and equipment such as thermometers, multimeters and laptop computers

D-9.01.02 verify that electrical, pneumatic and electronic connections are completed in accordance with manufacturers' specifications and jurisdictional regulations

D-9.01.03 verify parameters such as supply voltage, air pressure and signal

D-9.01.04	verify that primary and secondary voltage match operating requirements
D-9.01.05	apply power to energize system
D-9.01.06	check transformer output to ensure correct secondary voltage and polarity where required

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Sub-task

D-9.02 Verifies/sets operating parameters.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.02.01	program controllers such as timers, microprocessors and analog control systems in order to set parameters such as alarm, humidity and temperature
D-9.02.02	adjust thermostats, economizer controls and pressure switches
D-9.02.03	select tools and equipment such as meters, gauges and small screwdrivers
D-9.02.04	adjust parameter set points according to load requirements and ambient conditions
D-9.02.05	record operating parameters in start-up information sheets for reference and warranty issues
D-9.02.06	calibrate components such as thermostats, receiver controllers, enthalpy controllers, and PE and EP switches to ensure accurate readings from components to controllers

Trends	There is an increase in the use of IAQ accessories to improve the quality of the living and working environment. Digital equipment and automation are replacing old technology. This combined with energy efficiency is driving continuous change and the need for ongoing training.
Related Components (including, but not limited to)	**HVAC:** heat pumps, air handling units, controls and sensors, dampers, fans, ducting, humidifiers and dehumidifiers, air cleaners, air scrubbers, cooling towers, unit heaters, compressors, speed drives, filters, furnaces, electric heaters, motors, heating modules, fluid pumping systems, valves, metering devices, IAQ accessories. **Refrigeration systems:** oil separators, receivers, accumulators, evaporators, heat exchangers, condensers, motors, flow controls, fluid coolers, piping and tubing, compressors, heat pumps. **Control systems:** microprocessors, VAV boxes, computers, switches, refrigerant monitors, sensors, cables, thermostats, safety devices, on-board electronics, interface panels, actuators, valves, wiring.
Tools and Equipment	See Appendix A.

Task 10 Maintains heating, ventilation and air conditioning, and refrigeration systems.

Context Refrigeration and air conditioning mechanics maintain systems to increase longevity, reliability and efficiency. Maintenance includes inspection, testing, and energy predictive and preventative maintenance activities.

Required Knowledge

K 1	knowledge of types of HVAC systems such as split systems, package units, heat reclaim units, and heat exchangers
K 2	knowledge of types of refrigeration systems such as chillers, freezers and process refrigeration systems
K 3	knowledge of types of HVAC accessories such as IAQ add-ons and outdoor temperature sensors
K 4	knowledge of types of refrigeration accessories such as temperature sensors and transducers
K 5	knowledge of types of HVAC components such as compressors, condensers, evaporators, and metering devices
K 6	knowledge of types of refrigeration components such as valves, oil separators and accumulators
K 7	knowledge of types of insulation such as fibreglass, foam insulation and duct insulation
K 8	knowledge of piping materials, fittings and accessories
K 9	knowledge of warranties and guarantees
K 10	knowledge of jurisdictional regulations
K 11	knowledge of OH&S and WHMIS
K 12	knowledge of defects such as wear and tear
K 13	knowledge of manufacturers' and owners' specifications and recommendations
K 14	knowledge of system operation and history
K 15	knowledge of industry related calculations
K 16	knowledge of psychrometrics
K 17	knowledge of piping practices for flow velocity and oil return
K 18	knowledge of thermodynamics
K 19	knowledge of cleaning products such as coil cleaners, solvents and abrasives
K 20	knowledge of lock-out and tag-out procedures
K 21	knowledge of maintenance schedule requirements

K 22	knowledge of building automation systems
K 23	knowledge of ductwork materials, ductwork sizing and practices to ensure proper airflow from equipment

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Sub-task

E-10.01 Inspects heating, ventilation and air conditioning, and refrigeration systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.01.01	perform visual inspection of system components such as belts, pulleys, sight glasses and oil or grease levels to determine abnormalities
E-10.01.02	perform run check to determine proper sequence of operation
E-10.01.03	determine additional service required such as power washing of coils, filter change and chemical treatment
E-10.01.04	identify components that need to be replaced or repaired
E-10.01.05	determine scheduling for maintenance intervals
E-10.01.06	identify excessive noise or vibration and its source
E-10.01.07	identify non-system items that may affect the overall efficiency of operation such as door gaskets, anti-sweat heaters and plugged condensate drains
E-10.01.08	perform inspection according to manufacturers' recommendations and jurisdictional regulations
E-10.01.09	select and use hand tools such as screwdrivers and nut drivers to access system panels

Sub-task

E-10.02 Tests heating, ventilation and air conditioning, and refrigeration system components and accessories.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.02.01	select and use tools and equipment such as magnahelic gauge and manometer
E-10.02.02	check refrigerant pressure to evaluate conditions such as proper valves settings, system capacity, dirty or plugged filter dryers and leaking compressor valves
E-10.02.03	perform leak test using electronic, chemical and mechanical methods
E-10.02.04	test electrical components such as relays, motors and coils using electrical meters
E-10.02.05	test mechanical components such as mechanical valves, linkages and bearings
E-10.02.06	retrieve oil sample for analysis
E-10.02.07	perform acid test on oil sample to determine system contamination
E-10.02.08	test and document operation of safety controls
E-10.02.09	identify components that need to be replaced or repaired
E-10.02.10	verify system requirements such as voltages, amperages, temperature and pressures are within specifications
E-10.02.11	perform air audits using electronic analysis equipment to determine IAQ
E-10.02.12	perform test procedures according to manufacturers' specifications and jurisdictional regulations
E-10.02.13	test operation of condensate pump

Sub-task

E-10.03 Performs predictive and preventative maintenance on heating, ventilation and air conditioning, and refrigeration systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.03.01	select and use tools and equipment appropriate to the task being performed
E-10.03.02	replace filters and belts at required intervals
E-10.03.03	locate lubrication points such as grease nipples and oil ports
E-10.03.04	lubricate components such as bearings, motor shafts and linkages as required
E-10.03.05	replace oil in gear boxes and compressors
E-10.03.06	select cleaners that are compatible with the parts and components
E-10.03.07	clean equipment components such as coils, heat exchangers, blower sections and condensate drain to improve system performance
E-10.03.08	recognize hazards of using cleaning materials such as acids, coil cleaners and solvents
E-10.03.09	replace components according to manufacturers' recommendations
E-10.03.10	perform vibration analysis to identify internal wear of components such as bearings and bushings
E-10.03.11	perform electrical tests such as megger and dielectric test to identify breakdown of winding and wire insulation
E-10.03.12	replace components according to maintenance schedule and normal wear and tear
E-10.03.13	verify the operation and calibration of safety devices
E-10.03.14	tighten electrical connections of system components

Task 11 Services heating, ventilation and air conditioning, and refrigeration systems.

Context Refrigeration and air conditioning mechanics will utilize the most current procedures to troubleshoot and repair the system, and return it to optimal operation in a timely manner.

Required Knowledge

K 1	knowledge of types of HVAC systems such as split systems, package units, and heat reclaim units and heat exchangers
K 2	knowledge of types of refrigeration systems such as coolers, freezers, chillers and process refrigeration systems
K 3	knowledge of types of HVAC accessories such as IAQ add-ons and outdoor temperature sensors
K 4	knowledge of types of refrigeration accessories such as temperature sensors and transducers
K 5	knowledge of types of HVAC components such as compressors, condensers, evaporators, and metering devices
K 6	knowledge of types of refrigeration components such as valves, oil separators and accumulators
K 7	knowledge of types of insulation such as fibreglass, foam insulation and duct insulation
K 8	knowledge of piping materials, fittings and accessories
K 9	knowledge of warranties and guarantees
K 10	knowledge of jurisdictional regulations
K 11	knowledge of internal wiring
K 12	knowledge of electrical theory
K 13	knowledge of pressure/temperature relationship
K 14	knowledge of refrigerants, oils and lubricants
K 15	knowledge of refrigerant recovery
K 16	knowledge of field wiring
K 17	knowledge of OH&S and WHMIS
K 18	knowledge of lock-out and tag-out procedures
K 19	knowledge of good ducting, supply return and fresh air flow
K 20	knowledge of filter types, charcoal and media
K 21	knowledge of belt types and their applications

Sub-task

E-11.01 Troubleshoots heating, ventilation and air conditioning, and refrigeration systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.01.01	retrieve information from customers about issue
E-11.01.02	select and use tools and equipment to diagnose breakdown based on information obtained
E-11.01.03	interpret temperature and pressure readings
E-11.01.04	use electrical schematics and diagrams to diagnose problems such as component failures, ground faults and open circuits
E-11.01.05	identify abnormalities by sensory inspection
E-11.01.06	interpret data to identify cause of problem such as defective components, utility issues and open circuits
E-11.01.07	identify parts that need to be replaced or repaired
E-11.01.08	identify available options for replacement or repair according to criteria set by the customers such as cost and obsolescence

Sub-task

E-11.02 Repairs heating, ventilation and air conditioning, and refrigeration systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.02.01	select and use tools and equipment appropriate to the task being performed
E-11.02.02	isolate failed component for repair
E-11.02.03	add/remove refrigerant/medium as required to facilitate repair or replacement of components using proper recovery procedures
E-11.02.04	shut down system to perform repair or replace of malfunctioning component
E-11.02.05	protect system from contamination using methods such as sealing, capping and isolating system components

E-11.02.06	make electrical or mechanical system repairs such as compressor replacement, contactor replacement and leak repairs
E-11.02.07	test and document operation of repaired component in system

Task 12 Maintains control systems.

Context Control systems need to be maintained in order to ensure accuracy, reliability and efficiency of system. Maintenance includes inspection, testing, preventative maintenance, and calibration activities.

Required Knowledge

K 1	knowledge of types of control systems such as electric, electronic and pneumatic
K 2	knowledge of types of control system components such as thermostats, timers and pressure controls
K 3	knowledge of end user requirements
K 4	knowledge of operation of control system
K 5	knowledge of sequence of operation
K 6	knowledge of electrical and electronic theory
K 7	knowledge of system application such as temperature and relative humidity
K 8	knowledge of system requirements such as safety controls
K 9	knowledge of emergency procedures
K 10	knowledge of lock-out and tag-out procedures
K 11	knowledge of jurisdictional regulations

Sub-task

E-12.01 Inspects control systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-12.01.01	select and use tools such as screwdrivers and nut drivers to access system panels
E-12.01.02	perform visual inspection of control systems

E-12.01.03	check system voltage and amperage
E-12.01.04	perform run check to determine proper sequence of operation
E-12.01.05	determine additional service required such as battery replacement, re-securing components and resetting clocks and timers
E-12.01.06	identify components that need to be replaced or repaired
E-12.01.07	perform inspection according to manufacturers' specifications, customer requirements, and jurisdictional regulations

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Sub-task

E-12.02 Tests control systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-12.02.01	select and use hand tools and equipment such as multimeter, thermometer and computers
E-12.02.02	test electrical components such as relays and switches
E-12.02.03	test mechanical components such as actuators
E-12.02.04	identify components that need to be replaced or repaired
E-12.02.05	verify system requirements such as voltages, amperages, temperatures and pressures are within specifications
E-12.02.06	perform air testing using electronic analysis equipment to confirm that IAQ is within system parameters
E-12.02.07	perform test procedures according to manufacturers' specifications, customer requirements, and jurisdictional regulations

Sub-task

E-12.03 Performs preventative maintenance on control systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-12.03.01	select and use tools and equipment appropriate to the task being performed
E-12.03.02	replace components such as batteries, sensors and transducers at required intervals
E-12.03.03	clean equipment components such as circuit boards, contactors and thermostats
E-12.03.04	replace components according to manufacturers' recommendations
E-12.03.05	perform electrical tests to identify voltage drops
E-12.03.06	replace components according to maintenance schedule and normal wear
E-12.03.07	tighten electrical connections to control system components
E-12.03.08	secure loose control system components
E-12.03.09	make recommendations such as relocating sensors to improve system reliability and efficiency

Sub-task

E-12.04 Calibrates operating and safety controls.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-12.04.01	select and use tools and equipment appropriate to the task being performed
E-12.04.02	test conditions such as temperature, pressure and humidity to compare to system set point
E-12.04.03	verify safety controls shutdown system
E-12.04.04	verify that safety controls operate at established system set point
E-12.04.05	adjust controls that are operating outside established parameters

Task 13 Services control systems.

Context When controls systems are malfunctioning, refrigeration and air conditioning mechanics need to troubleshoot and repair the system components.

Required Knowledge

K 1	knowledge of types of control systems such as electric, electronic and pneumatic
K 2	knowledge of types of control system components such as thermostats, timers and pressure controls
K 3	knowledge of end user requirements
K 4	knowledge of operation of control system
K 5	knowledge of sequence of operation
K 6	knowledge of repair procedures
K 7	knowledge of alternative components available for replacement
K 8	knowledge of lock-out and tag-out procedures
K 9	knowledge of electrical and electronic theory
K 10	knowledge of system application such as temperature and relative humidity
K 11	knowledge of maintenance schedule requirements
K 12	knowledge of system requirements such as safety controls

Sub-task

E-13.01 Troubleshoots control systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-13.01.01	select and use tools and equipment appropriate to the task being performed
E-13.01.02	retrieve information from customers about issue
E-13.01.03	select and use tools and equipment to diagnose breakdown based on information obtained
E-13.01.04	interpret system readings such as temperature, humidity and pressure
E-13.01.05	utilize electrical schematics and diagrams for diagnostic

E-13.01.06	interpret data to identify cause of problem such as defective components, utility issues and open circuits
E-13.01.07	identify parts that need to be replaced or repaired
E-13.01.08	identify available options for replacement or repair according to criteria set by the customers such as cost and obsolescence

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Sub-task

E-13.02 Repairs control systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-13.02.01	select and use tools and equipment appropriate to the task being performed
E-13.02.02	de-energize system to perform repair
E-13.02.03	make system repairs such as component replacement, and wire and circuit repairs
E-13.02.04	test and document operation of repaired component in system
E-13.02.05	adjust controls that are operating outside established parameters
E-13.02.06	upgrade control systems to accommodate customers' needs

APPENDICES

APPENDIX A TOOLS AND EQUIPMENT

Hand Tools

bending tools and springs
bolt cutter
brushes (wire, paint, acid, tube)
caulking gun
chalk line
chisels
crowbar
cutters (side, wire)
drywall saw
files
fin combs
fish tape
flare nut wrenches
flaring tools
flashlight
folding pliers
funnel
fuse puller
grease gun
hack saw
hammer
hand cart
hand sprayer
hex keys
knock-out kit
labelling machine
levels (laser, bubble, precision, line, transit)
mirror
nut drivers
orifice drill set
O-ring removal tool
paint equipment
pipe cutters
pipe dies
pipe threaders
pliers
pry bar
pullers
punches
reamer
regulator (CO_2, nitrogen, oxygen, acetylene)
Schrader remover
scrapers
screw extractors
screwdrivers
snap ring pliers
socket sets
squares
stapler
straight edge
swaging tools
tap and die set
tin snips
tube cutter
utility knife
wire strippers
wrenches (pipe, open end, adjustable, valve, torque)

Portable and stationary Power Tools

air compressor and regulator
circulating pump
drill index
drills (electric, cordless, hammer)
glue gun
grinder
hole saw kit
impact gun
powder-actuated tools
power washer
router
saws (jig, reciprocating, band)
transfer pump
trouble light
two-way radios
vacuum cleaner

Brazing and soldering tools

air fuel equipment
brazing rod
cloth: sand, emery, sandpaper
oxy-fuel equipment
silver solder
soft solder
soldering iron/gun
torch kit

Recovery and Recycling Equipment

filter/drier
hazardous waste container
liquid pump
pressure/temperature chart
recovery and recycle unit
recovery and storage cylinder

Charging Tools and Equipment

charging cylinder
charging manifold
charging scales
refrigerant hoses
refrigerant oil pump
vacuum pump

Diagnostic and Measuring Equipment

air flow hood
air flow/volume test equipment
air quality tester
air volume test equipment
alignment tools
belt tension indicator
black light
calculator
calipers
capacitor tester
carbon monoxide analyzer/detector
combustion analyzer
compound gauge
computer
data loggers
decibel meter
dial indicator
dye penetrant kit
eddy current tester
electronic pressure/temperature chart
electronic scale
feeler gauges
flame safeguard tester
flowmeter
hydrometer
hygrometer
infrared thermography camera and display unit
leak detectors (electronic, ultrasonic, halide, soap tests, litmus test, sulphur test, ultraviolet)
litmus paper
magnahelic gauge
manifold gauge set
manometers (U-tube, incline, electronic)
measuring tape
megger
micrometers
micron gauge (mechanical, electronic)
multimeter (volt, amp, ohm, capacitance)
oil test kit
pH testing kit
phase meter (mechanical, electronic)
Pitot tube
pneumatic calibration kit
potentiometer
refractometers
refrigerant scale (mechanical, electronic)
ruler sling psychrometer
smoke tester

Diagnostic and Measuring Equipment (continued)

stethoscope
tachometer
thermocouple tester
thermometers (infrared, electronic, mechanical)
transducers (humidity, pressure, amps, current, voltage)
vacuum gauge
vibration analysis equipment
water analysis kit

Access equipment

ladders (step, extension)
personnel lift
scaffolding/staging

Rigging, Hoisting and Lifting Equipment

block and tackle
chain fall
chains and cables
come-along
crane
dollies
eye bolts
fork lift
jacks (hydraulic, mechanical)
johnson bar
material lift
rope
shackles
slings
spreader bars
winch

Personal protective equipment (PPE) and safety equipment

barricades /pylons
electrical live test safety equipment
fall arrest equipment
fire blanket
fire extinguisher
first aid kit/station
flagging
gloves (rubber, insulated, leather)
hard hat
hearing protection (ear plugs, muffs)
lock-out kit
mask (dust, particle, filter)
rain suit
respirator
rubber aprons and coveralls
rubber boots
safety boots
safety face shield
safety glasses
safety goggles
warning signs
welding gloves
welding goggles

APPENDIX B GLOSSARY

accumulator	a vessel in the suction line that collects liquid refrigerant to be boiled off
access equipment	equipment used to allow mechanics to reach work location (e.g. ladder, scaffolds, personnel lift)
accessories	optional parts added to equipment or system
analog controls	a mechanical control which is a variable type
commission	final activities before a system is fully functional
component	parts required as part of a system
condenser	heat rejection component that provides a state change of refrigerant (from gas to a liquid)
control system	electrical, electronic and pneumatic components and wiring used to operate the system
digital controls	an on or off control
evaporator	heat absorption component that provides a state change of refrigerant (from liquid to a gas)
field wiring	wiring required to be done on site
flow control	device for metering the flow of primary and secondary refrigerants (e.g. CPR, EPR, Solenoid valve)
heat exchanger	device used to transfer heat energy from one medium to another
holding charge	temporary or partial charge used for the protection of the system until commissioning
humidifier	device introducing water vapour to conditioned space in order to raise relative humidity
humidity	total amount of moisture in air
internal wiring	factory wiring

maintain	performing functions to prevent premature deterioration and breakdown of system
metering device	device designed to regulate flow of liquid refrigerant entering the evaporator
oil separator	device used to remove oil from refrigerant
pressure control	pressure-activated safety or operational control
predictive maintenance	monitoring trends to components for future replacement or repair using methods such as vibration analysis, eddy current
preventative maintenance	scheduled system maintenance
receiver	storage vessel for liquid refrigerant
refrigerant	heat transfer fluid used in a primary or secondary refrigeration system
refrigeration	removing and transferring of heat
regulators	device that control the flow of liquid and gases
replace	change a component on a system
repair system	fix system by repairing or replacing components and accessories
service	troubleshoot and repair system
solenoid valve	device that permits or stops refrigerant flow
trade standards	procedures based on codes, regulations, manufacturers' recommendations and best practices
troubleshoot	diagnosing system failures and malfunctions
utilities	services such as electricity, drainage, water or gas provided by the city or utility companies

APPENDIX C ACRONYMS

CPR	Crankcase pressure regulator
CFC	Chlorofluorocarbons
EP	Electric and Pneumatic
EPR	Evaporator Pressure Regulator
EXV	Electronic Expansion Valve
HCFC	Hydrochlorofluorocarbons
HGBP	Hot gas bypass
HVAC	Heating, ventilation and air conditioning
IAQ	Indoor air quality
MSDS	Material Safety Data Sheets
ODS	Ozone depleting substance
OH&S	Occupational Health and Safety
PE	Pneumatic and electric
PPE	Personal protective equipment
TDG	Transport of Dangerous Goods
TXV	Thermostatic Expansion Valve
WHMIS	Workplace Hazardous Material Information System

APPENDIX D BLOCK AND TASK WEIGHTING

BLOCK A OCCUPATIONAL SKILLS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	10	10	5	18	20	10	15	14	25	10	NV	NV	NV	14%

Task 1 Uses and maintains tools and equipment.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	10	25	25	30	15	40	40	27	30	40	NV	NV	NV	28%

Task 2 Organizes work.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	25	30	34	30	20	25	33	20	20	NV	NV	NV	25%

Task 3 Performs routine trade activities.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	75	50	45	36	55	40	35	40	50	40	NV	NV	NV	47%

BLOCK B INSTALLATION PLANNING

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	10	10	10	18	35	15	10	22	20	15	NV	NV	NV	16%

Task 4 Plans installation of heating, ventilation and air conditioning, and refrigeration systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	70	60	70	55	70	60	50	80	60	60	NV	NV	NV	63%

Task 5 Plans installation of control systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	40	30	45	30	40	50	20	40	40	NV	NV	NV	37%

BLOCK C INSTALLATION

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	20	20	23	25	30	25	22	20	25	NV	NV	NV	23%

Task 6 Installs heating, ventilation and air conditioning, and refrigeration systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	70	60	70	58	70	75	60	85	80	60	NV	NV	NV	69%

Task 7 Installs control systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	40	30	42	30	25	40	15	20	40	NV	NV	NV	31%

BLOCK D COMMISSIONING

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	25	15	18	10	15	15	23	10	25	NV	NV	NV	18%

Task 8 Commissions heating, ventilation and air conditioning, and refrigeration systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	70	60	70	57	70	75	30	80	70	60	NV	NV	NV	64%

Task 9 Commissions control systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	40	30	43	30	25	70	20	30	40	NV	NV	NV	36%

BLOCK E MAINTENANCE AND SERVICE

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	40	35	50	23	10	30	35	19	25	25	NV	NV	NV	29%

Task 10 Maintains heating, ventilation and air conditioning, and refrigeration systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	30	45	24	40	25	20	35	50	30	NV	NV	NV	34%

Task 11 Services heating, ventilation and air conditioning, and refrigeration systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	40	45	33	40	30	30	40	40	30	NV	NV	NV	36%

Task 12 Maintains control systems.

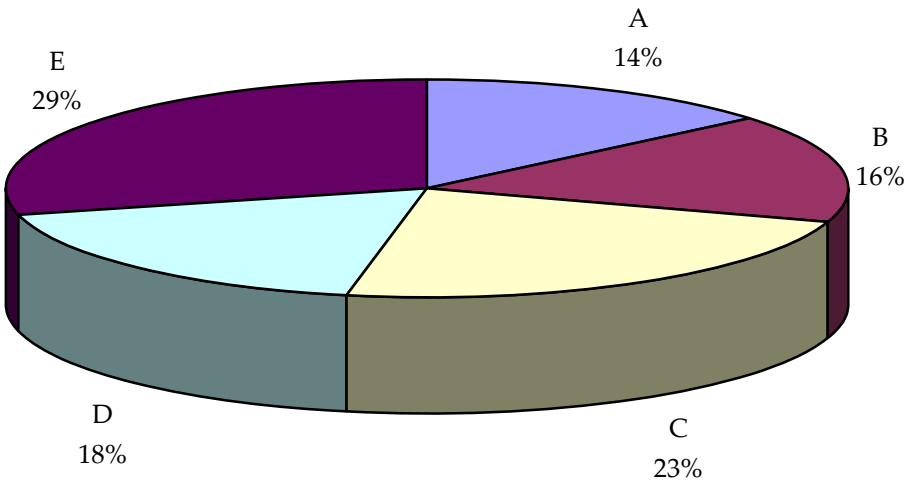
	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	10	15	5	18	10	25	15	10	5	20	NV	NV	NV	13%

Task 13 Services control systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	15	5	25	10	20	35	15	5	20	NV	NV	NV	17%

APPENDIX E

PIE CHART*



TITLES OF BLOCKS

BLOCK A	Occupational Skills	BLOCK D	Commissioning
BLOCK B	Installation Planning	BLOCK E	Maintenance and Service
BLOCK C	Installation		

*Average percentage of the total number of questions on an interprovincial examination, assigned to assess each block of the analysis, as derived from the collective input from workers within the occupation from all areas of Canada. Interprovincial examinations typically have from 100 to 150 multiple-choice questions.

APPENDIX F

TASK PROFILE CHART – Refrigeration and Air Conditioning Mechanic

BLOCKS	TASKS	SUB-TASKS				
A - OCCUPATIONAL SKILLS	1. Uses and maintains tools and equipment.	1.01 Maintains hand tools.	1.02 Maintains portable and stationary power tools.	1.03 Maintains brazing and soldering equipment.	1.04 Maintains recovery and recycling equipment.	1.05 Maintains evacuation tools and equipment.
		1.06 Maintains charging tools and equipment.	1.07 Maintains diagnostic and measuring tools and equipment.	1.08 Uses access equipment.	1.09 Uses rigging, hoisting and lifting equipment.	1.10 Uses personal protective equipment (PPE) and safety equipment.
		1.11 Uses computers.				
	2. Organizes work.	2.01 Interprets codes, regulations and procedures.	2.02 Interprets blueprints and specifications.	2.03 Uses documentation and reference material.	2.04 Communicates with others.	2.05 Plans job tasks and procedures.
		2.06 Maintains safe work environment.				
	3. Performs routine trade activities.	3.01 Prepares work site.	3.02 Handles materials and supplies.	3.03 Installs fasteners, brackets and hangers.	3.04 Performs lock-out, tag-out and isolation procedures.	3.05 Applies sealants and adhesives.

BLOCKS	TASKS	SUB-TASKS				
		3.06 Performs internal electrical wiring of systems.	3.07 Performs field wiring of systems.	3.08 Uses refrigerants, gases and oils.		
B - INSTALLATION PLANNING	4. Plans installation of heating, ventilation and air conditioning, and refrigeration systems.	4.01 Verifies heating, ventilation and air conditioning, and refrigeration system parameters and requirements.	4.02 Selects heating, ventilation and air conditioning, and refrigeration components, equipment and accessories.	4.03 Determines location of components, equipment and accessories.	4.04 Selects insulation.	4.05 Performs piping, flow controls and accessories take-off.
	5. Plans installation of control systems.	5.01 Verifies control system parameters and requirements.	5.02 Performs control system take-off.	5.03 Performs control system initial layout.		
C - INSTALLATION	6. Installs heating, ventilation and air conditioning, and refrigeration systems.	6.01 Confirms layout.	6.02 Assembles heating, ventilation and air conditioning, and refrigeration components, equipment and accessories.	6.03 Places heating, ventilation and air conditioning, and refrigeration components, equipment and accessories.	6.04 Installs piping and tubing.	6.05 Performs leak test on system.
		6.06 Evacuates system.	6.07 Applies holding charge.			
	7. Installs control systems.	7.01 Places control system components.	7.02 Connects system wiring and control tubing.			

BLOCKS	TASKS	SUB-TASKS			
D - COMMISSIONING	8. Commissions heating, ventilation and air conditioning, and refrigeration systems.	8.01 Performs pre-start-up checks for heating, ventilation and air conditioning, and refrigeration systems.	8.02 Starts up heating, ventilation and air conditioning, and refrigeration systems.	8.03 Completes system charge.	8.04 Sets up primary and secondary heating, ventilation and air conditioning, and refrigeration system components.
	9. Commissions control systems.	9.01 Performs start-up checks for control systems.	9.02 Verifies/sets operating parameters.		
E - MAINTENANCE AND SERVICE	10. Maintains heating, ventilation and air conditioning, and refrigeration systems.	10.01 Inspects heating, ventilation and air conditioning, and refrigeration systems.	10.02 Tests heating, ventilation and air conditioning, and refrigeration system components and accessories.	10.03 Performs predictive and preventative maintenance on heating, ventilation and air conditioning, and refrigeration systems.	
	11. Services heating, ventilation and air conditioning, and refrigeration systems.	11.01 Trouble-shoots heating, ventilation and air conditioning, and refrigeration systems.	11.02 Repairs heating, ventilation and air conditioning, and refrigeration systems.		
	12. Maintains control systems.	12.01 Inspects control systems.	12.02 Tests control systems.	12.03 Performs preventative maintenance on control systems.	12.04 Calibrates operating and safety controls.
	13. Services control systems.	13.01 Trouble-shoots control systems.	13.02 Repairs control systems.		