

# Refrigeration and Air Conditioning Mechanic (Residential)

Provincial Occupational  
Standard **DRAFT**

**2023**

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## **ACKNOWLEDGEMENTS**

Apprenticeship Manitoba wishes to express sincere appreciation for the contribution of the many tradespersons, industrial establishments, professional associations, labour organizations, provincial government departments and agencies, and all others who contributed to this publication.

### **OTHER RELATED OCCUPATIONAL TITLES**

In developing this analysis, the Industry Working Group (IWG) consulted the Red Seal Occupational Standard prepared by Human Resources Skills Development Canada from the following:

Refrigeration and Air Conditioning Mechanic Red Seal Occupational Standard 2019

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## STRUCTURE OF THE OCCUPATIONAL STANDARD

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

<b>Major Work Activity</b>	the largest division within the occupational standard that is comprised of a distinct set of trade activities
<b>Tasks</b>	distinct actions that describe the activities within a major work activity
<b>Sub-Tasks</b>	distinct actions that describe the activities within a task
<b>Key Competencies</b>	activities that a person should be able to do in order to be called 'competent' in the trade

The occupational standard also provides the following information:

<b>Trends</b>	changes identified that impact or will impact the trade including work practices, technological advances, and new materials and equipment
<b>Context</b>	information to clarify the intent and meaning of tasks
<b>Required Knowledge</b>	the elements of knowledge that an individual must acquire to adequately perform a task

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

<b>Appendix A – Tools and Equipment</b>	a non-exhaustive list of tools and equipment used in this trade
<b>Appendix B – Glossary</b>	definitions or explanations of selected technical terms used in the occupational standard
<b>Appendix C – Acronyms</b>	a list of acronyms used in the trade with their full name
<b>Appendix D – Major Work Activity and Task Weighting</b>	the major work activity and task percentages which determine the number of questions for each major work activity and task in the Provincial exam
<b>Appendix E – Pie Chart</b>	a graph which depicts the percentages of exam questions assigned to major work activities
<b>Appendix F – Task Profile Chart</b>	a chart which outlines graphically the major work activities, tasks and sub-tasks of this occupational standard

# **OCCUPATIONAL STANDARD**

## **SAFETY**

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

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 workplace health and safety legislation and regulations including Workplace Hazardous Materials Information System (WHMIS) and transportation of dangerous goods (TDG) regulations. Mechanics are responsible for ensuring the safety of themselves and others in the work environment. They must follow company, client and jurisdictional regulations. It is critical that Mechanics be constantly aware of their surroundings and the hazards they may encounter.

Safety education is an integral part of training. 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 occupational standard.

Residential refrigeration and air conditioning mechanics may be faced with a number of hazards on a daily basis. Such hazards as open flames, electricity and pressurized vessels can result in serious injury as well as equipment damage. Mechanics who work in confined spaces may experience fumes and gases from refrigerants, oil substrates, adhesives, acetylene, CO<sup>2</sup> and other materials while servicing and installing. Other hazards include working alone, working with sharp metal pieces, at heights, with hot metals, cutting processes and moving/handling heavy tools and equipment.

Mechanics need to be aware of all risks associated with their trade. An awareness of immediate surroundings, and potential safety hazards is the best tool for maintaining safety standards on the job. Safety education and occupational safety and health best practices is a key factor in both injury prevention and injury response. Understanding Manitoba's safety and health requirements and trade safety awareness creates a safe working environment for everyone.



## **SCOPE OF THE RACM (Residential) TRADE**

This Provincial Occupational Standard (POS) outlines the major tasks performed by residential refrigeration and air conditioning mechanics in Manitoba as identified by mechanics themselves.

This POS identifies the residential refrigeration and air conditioning mechanic as a tradesperson who specializes in the planning, installation, commissioning and maintenance of residential HVAC systems. The analysis attempts to cover the full range of competencies required in the residential home heating and cooling industry, some of which are shared with other trades.

For the purpose of this POS, the term 'residential' refers to single-family dwellings that include private houses, condominium units, and duplexes with individual heating and cooling HVAC systems. The term 'HVAC system' refers to heating, cooling, as well as indoor air quality (IAQ). Specifically, the home heating dimension of the mechanic's work includes electric, gas, and oil furnaces, hydronic heating systems, geothermal, and solid fuel appliances. By contrast, the home cooling dimension includes vapour-compression air-conditioning systems.

Manitoba residential refrigeration and air conditioning mechanics may be self-employed in their own home heating and cooling businesses or employed by companies that service residential clients. Some of these employers provide both commercial and residential services to their various clients. However, the entitlement to undertake commercial work is subject to provincial regulations which outlines both the size and type of equipment as well as residential and commercial applications.

The RACM (Residential) specialty shares skill sets with a number of other trades. In a climate characterized by extremes in hot and cold temperatures, the work of maintaining the comfort and habitability of private dwellings is crucial and consistent with provincial regulations shared by other designated trades doing similar work.

The RACM (Residential) specialty has evolved in response to increased requirements for specialized skills and knowledge to address safety and environmental concerns. These include, for instance, ozone layer depletion, indoor air quality and higher efficiencies related to fuel costs. There has also been an increased knowledge/understanding of residential structures as integrated systems best served by tradespeople who are dedicated to the planning, installing, commissioning, and maintaining/servicing of these systems.

An important dimension of the residential refrigeration and air conditioning mechanics' work involves new construction where state of the art components are used. However, the Manitoba residential housing stock varies widely in age and quality and the ability to maintain that stock frequently makes demands on the mechanic's ability to retrofit state of the art components, systems and appliances into older structures. Consequently mechanics need to be aware of current knowledge and be familiar with older ways of building and living in homes. Regardless of the age of dwellings, a significant dimension of the mechanic's work involves technical and other communications with homeowners and other occupants about matters of vital concern that have economic, health as well as safety-related implications. Homeowners have high expectations with indoor air quality and comfort.

At the technical level, mechanics are required to work with a variety of indoor air quality systems that include air exchangers, specialty filters, air cleaners/purifiers, humidifiers, UV sterilizers, heat pump equipment and line and low voltage.

The tasks of the RACM (Residential) entails specialty skill sets that include the ability to interpret and comply with a complex regulatory environment, ability to visualize and design air handling systems and to use a variety of sophisticated tools and equipment. The latter are identified in a detailed appendix to the POS and include a number of tools that are shared with other Manitoba tradespeople. With few exceptions, the vast majority of the residential mechanic's work is concentrated on residential project job sites, although, on occasion some mechanics are required to produce or customize sheet metal fittings to comply with individual projects.

Similarly, some mechanics will use skills sets from other trades to install tubing, piping and electrical components and techniques such as brazing and soldering during the installation or servicing of RACM (Residential) systems.

As noted earlier, some of the processes may require additional certification and/or licensing as per provincial regulations and many mechanics will seek these credentials. Important examples include the limited electrical license, the Gas B License, the Wood Energy Technology Transfer (WETT) Certificate, confined entry, MOPIA, and TODG Certificates.

Mechanics require highly-developed mechanical and mathematical aptitudes, hand-eye coordination, spatial perception and manual dexterity. They also require some technical and scientific knowledge with regard to safety, electricity, electronics, electric motors, microprocessors, troubleshooting strategies, blueprint reading and other document use, sketching, computer skills and customer relations.

An important aspect of the residential refrigeration and air conditioning mechanics' practice is the ability to provide workplace skills coaching/mentoring and other supports for apprentice level trade learning on the job. These mechanics must also apply customer service skills which include effective strategies for communication, problem solving and conflict resolution.

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## OCCUPATIONAL OBSERVATIONS

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Clean air regulations and consumer demands for improved efficiencies and air quality in living spaces requires high quality planning, installation, commissioning, maintenance and servicing skills.

Older systems (furnaces and air conditioners) are being replaced by improved models with more sophisticated electronics and new technologies. In addition, regional codes and regulations are increasingly important to the occupation in residential settings.

Consumers seek advancements in both heating and cooling for their homes. As a result, mechanics are facing the increased use of electronic diagnostic and monitoring equipment such as computerized test equipment to assess air quality and new approaches to heat/energy recovery ventilation systems. Consequently, heat pump technology and hydronic heating and cooling systems are becoming more common.

Home construction and renovation projects are becoming increasingly larger and more advanced requiring exceptional service and trade expertise. Mechanics must be expertly trained to safely install and service air conditioning and heating equipment to ensure the comfort and safety of those within homes. For this to occur, mechanics must also understand the basics of matter (solid, liquid, vapour) energy and heat transfer theory (thermodynamics).

Residential clients are increasingly sophisticated in their knowledge of mechanical systems and indoor air quality within homes. As a result, mechanics must be aware of advancements related to product knowledge, new construction techniques and materials, communication skills using social media, and approaches to troubleshooting and customer-service techniques.

### Safety Regulations for RACM (Residential)

- MOPIA
- WHMIS
- SDS
- Asbestos Abatement
- B.149A Gas Code
- TDG Certificate (Transportation of Dangerous Goods)
- Workplace Health & Safety Guideline
- Federal and provincial building codes
- Company workplace policies

## MAJOR WORK ACTIVITY A COMMON OCCUPATIONAL SKILLS

**Trends** The safety of workers is of primary importance to the province, employer and employee. Homeowners are requesting additional safety devices added to their HVAC equipment for their protection. The tools and equipment in this trade are ever evolving to meet new technologies and demands. Operating and maintenance documentation are primarily moving to accessible digital formats. Communication from clients, shop and technical support continue to evolve using many different digital platforms.

### Task A-1 Performs safety-related functions

**Context** Refrigeration and air conditioning mechanics must be able to recognize hazards and protect themselves and others. They must also protect property and the environment.

#### Required Knowledge

- A-1.01.K1 hazards such as line voltage, corrosive chemicals, toxicity, combustive reactions, fire, rotating equipment, working at heights, confined spaces, noisy locations, pressure hazards, refrigerants, ozone depleting substances, greenhouse gases, weather, overhead obstacles
- A-1.K2 WHMIS, SDS, TDG, and MOPIA procedures such as disposal, labelling, handling and using personal protective equipment (PPE)
- A-1.K3 regulations such as Occupational Health and Safety (OH&S), jurisdictional, TDG and WHMIS
- A-1.K4 lock-out, tag-out and isolation hazards such as pressure, voltage, thermal, fluids, toxicity, corrosiveness, oxygen displacement/deprivation, asphyxiation, environmental, rotating devices, pinch hazards, trip hazards
- A-1.K5 lock-out, tag-out and isolation equipment such as capacitors, rotating fans, rotating wheels, motors, pneumatics, pressurized tanks, heat exchangers, thermal equipment
- A-1.K6 lock-out, tag-out and isolation components such as disconnect switches, isolation valves, locking clasps, motors, rotating devices, blocking and restraint devices
- A-1.K7 locking devices such as locks, blocks, chains, hasps, plugs, caps and blank-off plates
- A-1.K8 PPE such as hard hats, safety glasses, respirators, boots, gloves, safety vests, harnesses, lanyards
- A-1.K9 defective and damaged PPE such as excessively worn boots, cracked safety glasses, and expired safety equipment

A-1.K10 safety equipment such as fire extinguishers, portable eye wash stations, first aid kits, spill kits

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**Sub-task**

**A-1.01 Maintains safe work environment**

**Key Competencies**

- A-1.01.01 follow safe operating procedures (SOP) according to tasks to be performed
  - A-1.01.02 recognize hazards according to safety risk assessment
  - A-1.01.03 maintain a clean and tidy work site to avoid injuries to self and others
  - A-1.01.04 coordinate tasks with other workers to avoid injury to self and others
  - A-1.01.05 use flagging, pylons and signage when working in all areas
  - A-1.01.06 handle hazardous materials according to Workplace Hazardous Materials Information System (WHMIS) and transportation of dangerous goods (TDG) procedures
  - A-1.01.07 participate in safety meetings and discussions to ensure that information is recorded and distributed to all team members
  - A-1.01.08 recognize and report unsafe conditions in accordance with jurisdictional regulations so that they may be rectified
- 

**Sub-task**

**A-1.02 Performs lock-out, tag-out and isolation procedures**

**Key Competencies**

- A-1.02.01 notify property owner of maintenance and repairs and obtain required permits
  - A-1.02.02 identify hazards associated with equipment and components
  - A-1.02.03 isolate equipment and components and establish a zero energy state
  - A-1.02.04 apply locking device to secure isolation
  - A-1.02.05 record lock-out information on tag attached to locking devices
  - A-1.02.06 verify isolation of equipment to ensure that the equipment can be worked on safely according to company and regulatory policies
  - A-1.02.07 remove tags and locks from equipment after completion of repair
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**Sub-task****A-1.03 Uses personal protective equipment (PPE) and safety equipment****Key Competencies**

- A-1.03.01 select, wear and ensure proper fit of PPE according to task, site and company policies, manufacturers' specifications and jurisdictional regulations
- A-1.03.02 inspect and identify expired, defective and damaged PPE and remove from service, repaired or replaced and recertified according to company policies and jurisdictional regulations
- A-1.03.03 locate and use safety equipment according to job requirements, risk assessments, manufacturers' specifications and jurisdictional regulations
- A-1.03.04 clean and store PPE and safety equipment according to manufacturers' recommendations
- A-1.03.05 inspect and recommend recertification of safety equipment according to jurisdictional regulations

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**Task A-2****Uses tools and equipment.**

**Context** Mechanics select, use and maintain tools and equipment in a safe and effective manner relevant to the task being performed.

**Required Knowledge**

- A-2.K1 hand tools such as flaring tools, pipe cutters, benders, wrenches, screwdrivers and applications and procedures for use
- A-2.K2 maintenance of hand tools such as lubricating, sharpening and calibrating
- A-2.K3 portable and power tool applications and procedures for use
- A-2.K4 maintenance of portable and power tools such as lubricating, sharpening, tightening and draining
- A-2.K5 brazing and soldering equipment applications, maintenance and procedures for use
- A-2.K6 brazing and soldering equipment defects such as cracks, loose connections, damage
- A-2.K7 brazing and soldering equipment problems such as damaged gauges and diaphragms, leakage

- A-2.K8 recovery and recycling equipment such as recovery units, hoses, cylinders, gauges, scales, filter driers
- A-2.K9 recovery and recycling equipment applications, maintenance and procedures for use
- A-2.K10 refrigerant recovery according to manufacturers' instructions, tank specifications and jurisdictional regulations
- A-2.K11 refrigerant cylinder storage according to WHMIS procedures, OH&S, TDG and as a ozone depletion substance
- A-2.K12 evacuation tools and equipment such as vacuum gauges, micron gauges, vacuum pumps
- A-2.K13 evacuation components such as gauges, O-rings, seals, gas ballast valve and hoses
- A-2.K14 evacuation tools and equipment applications, maintenance and procedures for use
- A-2.K15 charging tools and equipment include such as scales, cylinders, manifold gauges, hoses, core removal tools, meters and valve core depressors
- A-2.K16 charging tools and equipment applications, maintenance and procedures for use
- A-2.K17 diagnostic and measuring tools and equipment such as thermometers, scales, leak detectors, meters, calipers, micrometers, gauge manifolds, manometers, hygrometers, hydrometers, refractometers and decibel meters
- A-2.K18 diagnostic and measuring tools and equipment applications, maintenance and procedures for use
- A-2.K19 access equipment such as ladders and scaffolding
- A-2.K20 access equipment safety factors, load characteristics, environment and application
- A-2.09.K21 rigging, hoisting and lifting equipment such as slings, come-alongs/chain falls, shackles, jacks, hoists, belts, ropes, cables, spreader bars and pry bars
- A-2.K22 consideration factors for rigging, hoisting and lifting and their jurisdictional regulations such as safety, load characteristics, environment and application
- A-2.K23 rigging, hoisting and lifting communication methods such as hoist hand signals, two-way radios, video, radio, mobile phones
- A-2.K23 digital technology such as laptops, smart phones, user interface modules, tablets for residential HVAC applications
- A-2.K23 digital technology applications, maintenance and procedures for use

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**Sub-task****A-2.01 Uses hand tools****Key Competencies**

- A-2.01.01 select hand tools according to job requirements
  - A-2.01.02 inspect hand tools for damage
  - A-2.01.03 maintain hand tools to ensure proper operation, clean and rust-free
  - A-2.01.04 replace hand tool parts if required
  - A-2.01.05 tag and remove defective hand tools from service according to job requirements
  - A-2.01.06 store hand tools in a clean and dry location to ensure they are in operating condition
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**Sub-task****A-2.02 Uses portable and stationary power tools****Key Competencies**

- A-2.02.01 check batteries, chargers and fuel levels to ensure they are in good condition, and batteries are fully charged
  - A-2.02.02 inspect power tools for unsafe conditions
  - A-2.02.03 inspect power tool parts to identify defects, faults and wear
  - A-2.02.04 use power tools following the correct procedures
  - A-2.02.05 maintain power tools to ensure they are ready for use
  - A-2.02.06 replace power tool components if required
  - A-2.02.07 store power tools in a clean and dry location to ensure they are in operating condition
  - A-2.02.08 tag and remove defective power tools from service according to manufacturers' recommendations and company policies
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**Sub-task****A-2.03 Uses brazing and soldering equipment**



**Key Competencies**

A-2.03.01	inspect hoses for defects
A-2.03.02	inspect regulators and check valves for problems
A-2.03.03	inspect torch tips and O-rings and clean or replace if required
A-2.03.04	check cylinder capacity to ensure adequate gas pressure according to job requirements
A-2.03.05	inspect cylinders for thread and valve damage to prevent leakage and fire
A-2.03.06	verify certification of cylinders according to Transport Canada
A-2.03.07	store cylinders in a secure, upright position, within rated temperatures according to WHMIS procedures, OH&S and TDG
A-2.03.08	tag and remove defective brazing and soldering equipment from service

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**Sub-task****A-2.04 Uses recovery and recycling tools and equipment****Key Competencies**

A-2.04.01	inspect tools and equipment for damage from transport and use
A-2.04.02	clean and test tools and equipment
A-2.04.03	check, clean or replace screens and filters to prevent blockage and ensure filtration of the refrigerant
A-2.04.04	store refrigerant cylinders in a secure and upright position within rated temperatures according to WHMIS procedures, OH&S, TDG and ozone depletion substance
A-2.04.05	verify certification of cylinders according to jurisdictional regulations
A-2.04.06	connect recovery tools and equipment to system according to manufacturers' instructions
A-2.04.07	recover refrigerant from system according to manufacturers' instructions, tank specifications and jurisdictional regulations
A-2.04.08	label recovered refrigerants and their state of condition according to jurisdictional regulations
A-2.04.09	tag and remove defective recovery and recycling tools and equipment from service according to company policies

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**Sub-task****A-2.05 Uses evacuation tools and equipment****Key Competencies**

- A-2.05.01 change oil on vacuum pumps to ensure operation of pump according to manufacturers' instructions
  - A-2.05.02 clean and flush vacuum pumps according to manufacturers' recommendations
  - A-2.05.03 store equipment in a secure position to prevent oil spillage
  - A-2.05.04 maintain adequate oil level to enable evacuation
  - A-2.05.05 inspect and replace components if required
  - A-2.05.06 test vacuum pumps using tools according to manufacturers' instructions
  - A-2.05.07 tag and remove defective evacuation tools and equipment from service
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**Sub-task****A-2.06 Uses charging tools and equipment****Key Competencies**

- A-2.06.01 inspect charging tools and equipment for damage
  - A-2.06.02 calibrate scales and gauges by adjusting zero point to ensure accurate measurements
  - A-2.06.03 clean, isolate and store tools and equipment according to company policies
  - A-2.06.04 tag and remove defective charging tools and equipment from service according to company policies
  - A-2.06.05 connect equipment to system according to job requirements, manufacturers' instructions and industry trade practices
- 

**Sub-task****A-2.07 Uses diagnostic and measuring tools and equipment****Key Competencies**

- A-2.07.01 charge or change batteries ensure tools and equipment are ready for use

A-2.07.02	inspect leads, probes and sensors for damage and wear and verify ratings according to job requirements and manufacturer's specifications
A-2.07.03	verify calibration of tools and equipment according to manufacturers' specifications
A-2.07.04	interpret the data, readings and results obtained according to established parameters
A-2.07.05	store tools and equipment in a dry, secure location according to manufacturers' recommendations
A-2.07.06	tag and remove defective diagnostic and measuring tools and equipment from service according to company policies

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### **Sub-task**

#### **A-2.08 Uses access equipment**

#### **Key Competencies**

A-2.08.01	select ladders and work platforms according to site conditions and task being performed
A-2.08.02	inspect ladders and scaffolding according to jurisdictional regulations
A-2.08.03	identify hazards when erecting ladders and scaffolding according to jurisdictional regulations
A-2.08.04	erect, secure, level and dismantle access equipment according to jurisdictional regulations and company policies
A-2.08.05	store tools and equipment in a dry, secure location according to jurisdictional regulations and company policies
A-2.08.06	use equipment within operating limitations according to jurisdictional regulations, manufacturers' instructions and certification requirements
A-2.08.07	tag and remove defective access equipment from service

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### **Sub-task**

#### **A-2.09 Uses rigging, hoisting and lifting equipment**

#### **Key Competencies**

A-2.09.01	select and use equipment according to task and factors
A-2.09.02	inspect equipment for wear, damage, defects and certification date and replaced if required

A-2.09.03	identify hazards according to hazard risk assessment
A-2.09.04	verify load size and parameters according to job and manufacturers' specifications
A-2.09.05	guide and position loads using tag lines
A-2.09.06	rig loads according to rigging procedures, manufacturers' specifications and jurisdictional regulations to ensure safety
A-2.09.07	communicate with equipment operators using approved communication methods
A-2.09.08	store equipment in clean and dry locations according to manufacturers' recommendations
A-2.09.09	tag and remove defective equipment from service according to company policies and jurisdictional regulations

### Sub-task

**A-2.10**      **Uses digital technology**

### Key Competencies

A-2.10.01	identify and apply hardware and software requirements to connect to the control system according to manufacturers' specifications
A-2.10.02	connect electronic devices to control systems according to manufacturers' specifications
A-2.10.03	use electronic devices to configure parameters to set up operation of system
A-2.10.04	monitor and diagnose problems and retrieve data using on-board and remote functions
A-2.10.05	back up program files for easy retrieval

## Task A-3

### Organizes work

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

### Required Knowledge

A-3.K1	drawings such as isometric, elevation, plan views, shop drawings and sketches
A-3.K2	views used on drawings such as elevation, plan, section, detail and 3-D

A-3.K3	information found on drawings such as lines, legend, symbols and abbreviations, title block, notes and specifications, schedules and units of measurement (metric/imperial)
A-3.K4	specification documents such as manufacturers', engineers', contractors' and clients'
A-3.K5	drawings and specification application and information extraction
A-3.K6	technical information such as start-up, claim and maintenance sheets
A-3.K7	technical documentation such as manufacturers' specifications, manufacturers' and wholesaler catalogues, drawings, employer-specific forms and reports and material take-offs
A-3.K8	log sheets such as refrigerant, repair, maintenance, equipment and operating logs
A-3.K9	written documents such as work orders, incident reports, permits, time sheets and estimates
A-3.K10	documentation and reference material purpose, application and interpretation
A-3.K11	collaboration with other trades such as gasfitters, sheet metal workers, plumbers and electricians
A-3.K12	types of major equipment such as threaders, personal lifts and scaffolding

### **Sub-task**

#### **A-3.1 Interprets drawings and specifications**

#### **Key Competencies**

A-3.1.01	determine equipment specifications according to manufacturers' specifications and drawings
A-3.1.02	determine equipment required according to design specifications
A-3.1.03	identify electrical, mechanical and communication equipment according to specifications and drawings
A-3.1.04	scale drawings for placement of equipment and accessories, coring of holes and location of utilities
A-3.1.05	interpret drawings, schematic and pictorial diagrams to provide information on electrical equipment, piping components and air distribution systems

### **Sub-task**

### **A-3.2 Uses documentation and reference material**

#### **Key Competencies**

- A-3.2.01 determine installation procedures and requirements according to manufacturers' specifications
- A-3.2.02 determine pipe and duct sizes, pressure/temperature (P/T) relationships and pressure/enthalpy relationships according to tables and charts
- A-3.2.03 verify detailed equipment information by referring to technical bulletins and manuals
- A-3.2.04 verify warranties to assist in submitting required documentation
- A-3.2.05 submit information in order to activate and claim warranties
- A-3.2.06 select and order parts and equipment by referring to documentation
- A-3.2.07 maintain log sheets according to jurisdictional regulations, and client and company policies
- A-3.2.08 complete written documents according to jurisdictional regulations, and client and company policies

#### **Sub-task**

### **A-3.3 Plans job tasks and procedures**

#### **Key Competencies**

- A-3.3.01 prepare material list, confirm availability and order materials according to task
- A-3.3.02 apply for and obtain permits according to jurisdictional regulations
- A-3.3.03 schedule delivery of equipment and materials
- A-3.3.04 arrange for storage of materials in a safe and secure location according to site conditions, manufacturers' specifications and company policies
- A-3.3.05 arrange time to access work site according to client requirements and to avoid downtime and delays
- A-3.3.06 schedule tasks with other trades, sectors and professionals
- A-3.3.07 select and assign personnel according to specific tasks, equipment and certifications
- A-3.3.08 arrange for use of major tools and equipment
- A-3.3.09 organize tools and equipment for availability where and when needed

**Task A-4****Uses communication and mentoring techniques**

**Context** Learning in the trades is done primarily in the workplace with tradespeople passing on their skills and knowledge to apprentices, as well as sharing knowledge among themselves. Apprenticeship is, and always has been about mentoring – learning workplace skills and passing them on. Because of the importance of this to the trade, this task covers activities related to communication in the workplace and mentoring skills.

**Required Knowledge**

- A-4.K1 people in the workplace such as other tradespeople, colleagues, apprentices, supervisors, clients, authorities having jurisdiction (AHJ), manufacturers
- A-4.K2 active listening skills such as hearing, interpreting, reflecting, responding, paraphrasing
- A-4.K3 learning styles such as seeing it, hearing it, trying it
- A-4.K4 recognition of harassment such as objectionable conduct, comment or display made either on a one-time or continuous basis that threatens, demeans, belittles, or causes personal humiliation or embarrassment to the recipient
- A-4.K5 recognition of discrimination is prohibited based on: race, national or ethnic origin, colour, religion, age, sex, sexual orientation, marital status, family status, disability or conviction for which a pardon has been granted
- A-4.K6 workplace and technical training essential skills such as reading, writing, document use, oral communication, numeracy, thinking, working with others, digital technology, continuous learning
- A-4.K7 workplace and technical training learning needs such as learning disabilities, learning preferences, language proficiency
- A-4.K8 workplace and technical training strategies to assist in learning a skill such as understanding the principles of instruction, developing coaching skills, being mature and patient, providing feedback
- A-4.K9 workplace and technical training teaching skills such as identifying the point of the lesson, linking the lesson, demonstrating the skill, providing practice, giving feedback, assessing skills and progress

**Sub-task**

**A-4.01** Uses communication techniques

**Key Competencies**

A-4.01.01	demonstrate communication practices with people in the workplace to ensure instructions and messages are understood by all parties involved in communication
A-4.01.02	listen using active listening practices
A-4.01.03	receive and respond to feedback on work to ensure understanding and corrective measures are taken
A-4.01.04	explain and provide feedback to ensure the task is carried out as directed
A-4.01.05	use questioning to improve communication to enhance understanding, on-the-job training and goal setting
A-4.01.06	participate in safety and information meetings to ensure information is relayed to the workforce, and is understood and applied
A-4.01.07	coordinate communication with other trades during layout and installation of residential HVAC systems to avoid interference with other trades

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#### **Sub-task**

#### **A-4.02 Uses mentoring techniques**

#### **Key Competencies**

A-4.02.01	identify and communicate learning objective and point of lesson
A-4.02.02	link lesson to other lessons and the job
A-4.02.03	demonstrate performance of a skill to an apprentice or learner
A-4.02.04	set up conditions required for an apprentice or learner to practice a skill safely by the apprentice or learner
A-4.02.05	assess apprentice or learner's ability to perform tasks with increasing independence to a point where skill can be done with little supervision
A-4.02.06	give supportive and corrective feedback to ensure the apprentice or learner adopts best practice
A-4.02.07	support apprentices in pursuing technical training opportunities within timeframe prescribed by Apprenticeship Manitoba
A-4.02.08	support equity group apprentices or learners to ensure the workplace and technical training environment is harassment and discrimination-free



**MAJOR WORK ACTIVITY B****PERFORMS ROUTINE TRADE ACTIVITIES**

**Trends** Industry is experiencing evolving technologies of refrigerant, sealants and adhesives to meet updated and changing construction standards. The average technician will have more ability to diagnose equipment with less tools using digital technology platforms. New products and procedures are being developed as environmental and legislative changes are updated for energy efficiency and environmental emissions.

**Task B-5****Performs work site preparation**

**Context** Residential refrigeration and air conditioning mechanics prepare the work site to accomplish their tasks. They ensure the availability and storage of material and supplies on site to be used for the job at hand.

**Required Knowledge**

- B-5.K1 workplace hazards such as utility distribution, other construction activities and other trade activities
- B-5.K2 isolation points such as water, gas, electrical shut-offs, fuels, compressed gases, steam and utility services
- B-5.K3 material handling equipment such as personnel lifts, delivery trucks, dollies, carts, hoists and lifts
- B-5.K4 job hazard assessment such as job tasks, identifying hazards, controls and PPE
- B-5.K5 PPE such as safety glasses, head protection, high-visibility apparel, foot and hand protection
- B-5.K6 equipment such as chains, straps, slings.

**Sub-task**

- B-5.01** Prepares work site

**Key Competencies**

- B-5.01.01 read/understand electrical schematics and manufacturer's specifications
- B-5.01.02 comply with procedure for installation of all zoning components
- B-5.01.03 identify area for storage of tools, equipment and supplies according to site condition and job location

B-5.01.04	locate safety equipment, muster sites and emergency exits
B-5.01.05	identify on-site hazards
B-5.01.06	locate isolation points according to site conditions
B-5.01.07	coordinate site access for equipment
B-5.01.08	erect barricades and signage according to site safety requirements and jurisdictional regulations to warn others
B-5.01.09	perform job hazard assessment according to job specification, site conditions, company policies and jurisdictional regulations
B-5.01.10	eliminate or mitigate hazards in work area
B-5.01.11	identify PPE required for task
B-5.01.12	determine location and layout of equipment and systems according to site conditions and design specifications

### **Sub-task**

#### **B-5.02            Handles materials and supplies**

#### **Key Competencies**

B-5.02.01	receive and verify delivered materials using packing slips, serial numbers, model numbers and catalogue numbers according to specifications
B-5.02.02	inspect delivered materials to detect shipping damage and compliance with specifications
B-5.02.03	label materials and supplies according to WHMIS regulations and company policies
B-5.02.04	secure materials and supplies when being stored or shipped according to jurisdictional regulations, manufacturers' specifications and site conditions
B-5.02.05	manually lift materials and supplies according to OH&S regulations and industry standards to avoid personal injury and damage to materials, supplies and equipment
B-5.02.06	store materials and supplies to prevent damage, deterioration, discharge or theft according to jurisdictional regulations, manufacturers' specifications and site conditions
B-5.02.07	dispose of waste materials according to jurisdictional regulations and site conditions

**Task B-6****Performs trade activities**

**Context** Residential refrigeration and air conditioning mechanics perform routine trade activities to enable them to complete the tasks of their trade. The activities are performed at various stages of the work.

**Required Knowledge**

- B-6.K1 brazing and soldering methods such as cutting, cleaning, sanding and reaming
- B-6.K2 brazing and soldering torches such as air fuel, oxy fuel
- B-6.K3 job requirements for brazing and soldering such as metal compatibility, pressure requirements
- B-6.K4 brazing and soldering heat protection materials such as heat blankets and heat sinks
- B-6.K5 brazing and soldering components such as fittings, accessories, compressors, evaporators, metering devices and condensers
- B-6.K6 pipe and fittings such as copper, steel, copper-iron alloy, and brass
- B-6.K7 leak and pressure testing tools and equipment such as electronic leak detectors, certified gauges, regulators and leak detection solution
- B-6.K8 leak and pressure testing liquids such as water and glycol
- B-6.K9 leak and pressure testing gases such as nitrogen and other inert gases
- B-6.K10 evacuation tools and equipment such as compound gauges, micron gauges, vacuum pumps
- B-6.K11 evacuation and removal of non-condensables to accepted levels
- B-6.K12 refrigerants such as primary (chlorofluorocarbon [CFC], hydrofluorocarbon [HFC], hydrofluoroolefin [HFO], hydro chlorofluorocarbon [HCFC] , secondary (water, glycol solutions, brine solutions)
- B-6.K13 refrigerant oils such as vacuum pump oil, cutting oil, compressor oil
- B-6.K14 gases such as nitrogen, acetylene, propane and oxygen
- B-6.K15 safety classifications of refrigerants such as toxicity and flammability
- B-6.K16 effects of refrigerants, gases and refrigerant oils on the environment such as ozone depletion potential, global warming potential, pollution and contamination
- B-6.K17 field wiring tools and equipment such as crimpers, cutters, pliers, strippers, screwdrivers and hex keys
- B-6.K18 field wiring components such as connectors, junction boxes and terminal strips

B-6.K19	field wiring codes and regulations such as the Canadian Electrical Code and jurisdictional regulations
B-6.K20	sealants and adhesive tools and equipment such as brushes, caulking guns, paint scrapers and rollers
B-6.K21	sealants such as silicone, spray foam, thread seal, fire stop, duct seal and mastic
B-6.K22	adhesives such as insulation glues, primers and pipe adhesives

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### **Sub-task**

#### **B-6.01 Performs brazing and soldering**

##### **Key Competencies**

B-6.01.01	purge pipes with inert gases to prevent oxidation during soldering and brazing
B-6.01.02	prepare pipe using methods according to industry standards
B-6.01.03	select tip size and torch type according to pipe size, job location and industry standards
B-6.01.04	select safety procedures according to task at hand
B-6.01.05	select brazing and soldering material according to job requirements and jurisdictional regulations
B-6.01.06	select and place heat protection materials to protect surrounding area or components according to manufacturers' recommendations and safety procedures
B-6.01.07	solder and braze components using compressed gases and according to jurisdictional regulations and safety procedures

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### **Sub-task**

#### **B-6.02 Performs leak and pressure tests on system**

##### **Key Competencies**

B-6.02.01	select and use tools and equipment
B-6.02.02	prepare system for leak and/or pressure test
B-6.02.03	remove or isolate devices or sections of the system that could be damaged during pressure test

- B-6.02.04      pressurize system with system compatible liquids and/or gases to perform pressure test to ensure system integrity according to jurisdictional regulations and job requirements
- B-6.02.05      interpret and record leak and pressure test results to verify system integrity within a given period
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### **Sub-task**

#### **B-6.03      Evacuates systems**

##### **Key Competencies**

- B-6.03.01      select and use tools and equipment according to manufacturers' specifications and job requirements
- B-6.03.02      check integrity of vacuum pump to meet evacuation requirements
- B-6.03.03      ensure system is at atmospheric pressure according to manufacturers' specifications
- B-6.03.04      connect vacuum pump to system according to manufacturers' recommendations, industry standards and jurisdictional regulations
- B-6.03.05      perform evacuation according to manufacturers' specifications and jurisdictional regulations
- B-6.03.06      perform standing micron vacuum test according to manufacturers' specifications and jurisdictional regulations
- B-6.03.07      interpret and record evacuation test results to verify system integrity
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### **Sub-task**

#### **B-6.04      Uses refrigerants, gases and oils**

##### **Key Competencies**

- B-6.04.01      select and use tools and equipment according to task
- B-6.04.02      select refrigerants according to system, manufacturers' specifications and jurisdictional regulations
- B-6.04.03      select refrigerant oils according to refrigerant, temperature range of system and manufacturers' specifications

B-6.04.04	recover refrigerant and refrigerant oil when repairing, relocating, troubleshooting and decommissioning systems according to manufacturers' specifications, codes and jurisdictional regulations
B-6.04.05	select gases according to task
B-6.04.06	dispose of refrigerants and refrigerant oils according to environmental protocols and jurisdictional regulations
B-6.04.07	transport and store refrigerants, gases and refrigerant oils according to jurisdictional regulations and manufacturers' specifications
B-6.04.08	charge system with refrigerant oil and refrigerants according to manufacturers' specifications and job-specific requirements

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### **Sub-task**

#### **B-6.05          Performs field wiring of systems**

#### **Key Competencies**

B-6.05.01	select and use tools and equipment according to manufacturers' specifications
B-6.05.02	verify circuit is de-energized to avoid personal injury or damage to equipment by following lock-out and tag-out procedures
B-6.05.03	verify voltage, polarity, and equipment wiring configuration to ensure correct component selection according to manufacturers' requirements
B-6.05.04	identify correctly sized fusing and overloads according to jurisdictional regulations and manufacturers' specifications
B-6.05.05	interpret electrical schematics and termination points according to manufacturers' and design specifications, and jurisdictional regulations
B-6.05.06	select wire size and type according to amperage, insulation rating, compatibility with other components, and codes and jurisdictional regulations
B-6.05.07	select components according to locations where they will be used and jurisdictional regulations
B-6.05.08	route and secure wiring according to codes, jurisdictional regulations and site requirements
B-6.05.09	terminate wiring to related equipment using components
B-6.05.10	label or tag wiring with wire markers for identification and service purposes according to jurisdictional regulations and design specifications
B-6.05.11	update wiring diagrams to record changes and modifications

**Sub-task****B-6.06 Applies sealants and adhesives****Key Competencies**

- B-6.06.01 select sealants and adhesives according to manufacturers' recommendations, engineers' specifications and compatibility with other materials
- B-6.06.02 select and use tools and equipment according to manufacturers' specifications
- B-6.06.03 ensure adequate ventilation during application of sealants and adhesives according to manufacturers' specifications and jurisdictional regulations
- B-6.06.04 inspect and prepare sealing surfaces before sealants or adhesives are applied according to manufacturers' specifications
- B-6.06.05 use sealant and adhesive according to codes, regulations, manufacturers' specifications and job requirements

**MAJOR WORK ACTIVITY C****PLANS RESIDENTIAL HVAC  
INSTALLATION****Trends**

Customers are frequently requesting energy efficiency, cost effectiveness and peak performance of equipment that contains the most up to date technologies. Industry will continue to experience supply chain issues and must recommend alternative equipment and components to meet customer demands. Customers are requesting systems that monitor their HVAC equipment can be controlled remotely. Both urban and rural jurisdictions are requiring more permit processing times to initiate and complete jobs to code which lengthens the overall planning time. Coordinating installation during regular hours is becoming more challenging due to the increase of client requests and customer availability.

**Task C-7****Plans Installation of residential HVAC systems****Context**

Residential refrigeration and air conditioning mechanics plan the installation of residential HVAC 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.

**Required Knowledge**

- C-7.K1 residential HVAC concepts such as temperature, heat, mass and weight, density, specific gravity, specific volume and pressure

C-7.K2	residential HVAC compressors such as reciprocating, scroll, rotary
C-7.K3	residential HVAC basic single-phase motors
C-7.K4	residential HVAC psychrometric processes such as cooling, humidification, heating and humidification, heating, heating and dehumidification, dehumidification, cooling and dehumidification
C-7.K5	residential HVAC air movement components such as fans (axial, radial) and mechanical drives (belt, direct)
C-7.K6	residential HVAC electrical circuits such as series, parallel, series-parallel
C-7.K7	residential HVAC components such as compressors, condensers, evaporators, liquid pumps, metering devices, valves, heat exchangers, pressure vessels, temperature sensors, transducers, valves and regulators
C-7.K8	residential HVAC equipment selection factors such as code requirements, manufacturers' and engineering specifications, system and client requirements, best refrigerant for application, drawings, site conditions and environmental conditions
C-7.K9	residential HVAC component limitations such as blower capacity, pressure drops, size, fluid flow, heating/cooling capacity and sensible heating ratio
C-7.K10	residential HVAC alternative systems such as solar, air, water, ground and geothermal source heat pumps
C-7.K11	residential HVAC equipment placement factors such as sizing, serviceability, available utilities, structure, aesthetics and client requests
C-7.K12	residential HVAC equipment environmental issues such as noise, exhaust and intake vent locations and environmental conditions
C-7.K13	residential HVAC methods of zoning such as dual duct system, terminal reheat (cool) system, variable air volume system (VAV), variable volume and temperature system (VVT), induction reheat system, hydronic system, multiple unitary/heat pump system
C-7.K14	residential HVAC systems such as heat pumps, split, ductless split, package units, heat reclaim, humidifiers, dehumidifiers, ERVs and HRVs
C-7.K15	residential HVAC material take-off factors such as location, quantity, length, obstacles, coring

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### Sub-task

**C-7.01 Verifies system parameters and requirements**



**Key Competencies**

- C-7.01.01 calculate residential HVAC heat/cool loads according to factors
  - C-7.01.02 identify system capacity according to heat/cool load calculations and physical location
  - C-7.01.03 identify utilities available or required to ensure proper installation and operation of equipment, and to power accessory systems
  - C-7.01.04 determine system parameters using tools, equipment and engineering data
  - C-7.01.05 identify provisions for condensate drainage according to drawings, site surveys and code requirements
- 

**Sub-task****C-7.02 Selects residential HVAC equipment, components and accessories****Key Competencies**

- C-7.02.01 select equipment, residential HVAC components and accessories are selected according to factors
  - C-7.02.02 determine residential HVAC component limitations according to design specifications and operational requirements
  - C-7.02.03 according to energy savings and environmental issues
- 

**Sub-task****C-7.03 Determines placement of residential HVAC equipment, components and accessories****Key Competencies**

- C-7.03.01 determine placement of system according to factors and surrounding environmental issues
  - C-7.03.02 determine placement of system components factors and jurisdictional regulations
  - C-7.03.03 determine limitations for the placement of system equipment, components and accessories according to codes, jurisdictional and design specifications, system requirements and environmental conditions
  - C-7.03.04 take measurements to ensure that equipment will fit in location
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**Sub-task**

**C-7.04 Performs residential HVAC material take-off**

**Key Competencies**

- C-7.04.01 determine quantity of materials required according to component interconnections from working drawings and site visits
- C-7.04.02 determine pipe size and length needed according to pipe run, refrigerant type and equipment capacity
- C-7.04.03 determine insulation size and length according to operating temperature
- C-7.04.04 establish material order list for components according to system requirements
- C-7.04.05 identify alternative options for materials are identified based on availability

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**Task C-8**

**Plans installation of residential HVAC control systems**

**Context** Planning of residential HVAC control systems ensures proper operation of the equipment installed. Control systems are used to operate the system effectively and efficiently.

**Required Knowledge**

- C-8.K1 residential HVAC control systems such as electrical, mechanical, electronic, integrated control circuits.
- C-8.K2 residential HVAC equipment specifications such as maximum allowable distances between components and number of component devices
- C-8.K3 residential HVAC regional considerations such as humidity, elevation, fail-safe requirements, temperature and degree days
- C-8.K4 residential HVAC codes and regulations pertaining to control systems and their components
- C-8.K5 residential HVAC control systems limitations such as effective connection distances, number of inputs/outputs able to be controlled, communication compatibility and interference
- C-8.K6 residential HVAC control strategies such as two position control, pulse width modulation (PWM), proportional (P), proportional integral (PI), proportional integral derivative (PID), AI (artificial intelligence), adaptive
- C-8.K7 residential HVAC control system interference from external forces such as environment, electrical noises and pests

C-8.K8	residential HVAC material take-off factors such as location, quantity, length, obstacles and coring
C-8.K9	residential HVAC materials such as control devices, wiring, tubing, hangers and fasteners

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**Sub-task****C-8.01 Verifies control system parameters and requirements****Key Competencies**

C-8.01.01	determine control system requirements according to clients' needs, efficiency considerations and equipment specifications
C-8.01.02	determine regional considerations according to jurisdictional regulations and environmental conditions
C-8.01.03	determine operating ranges required to ensure safe control of equipment and safety of controlled space/product

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**Sub-task****C-8.02 Selects control system components and accessories****Key Competencies**

C-8.02.01	determine control system requirements according to clients' needs, efficiency considerations and equipment specifications
C-8.02.02	determine control system component limitations
C-8.02.03	determines placement of control system components and accessories

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**Sub-task****C-8.03 Determines placement of control system components and accessories****Key Competencies**

C-8.03.01	assess placement of control systems according to serviceability, code requirements and interference from external forces
C-8.03.02	determine connection routing for control system components according to drawings and site visits

C-8.03.03 determine location of mechanical and electrical controls according to their intended function and operation

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#### Sub-task

C-8.04 Performs control system material take-off

#### Key Competencies

C-8.04.01 determine quantity of materials required according to manufacturers' specifications, control requirements and location

C-8.04.02 identify alternative options for materials according to availability, environmental conditions and regulatory requirements

## MAJOR WORK ACTIVITY D

## PERFORMS INSTALLATION

**Trends** Installation of efficient heat pump technologies are being adapted into different pieces of HVAC equipment new to colder climates in the residential market. This equipment allows for integration of Wi-Fi and cloud based technologies, and a streamlined approach to smart home technologies. The installation practices continue to be simplified with new piping materials, remote sensors and green home initiatives.

### Task D-9

### Installs residential HVAC systems

**Context** Residential refrigeration and air conditioning mechanics assemble, place, secure and connect components of residential HVAC systems for all types of applications.

#### Required Knowledge

C-9.K1 residential HVAC equipment

C-9.K2 residential HVAC components and accessories such as piping, duct work, supports, thermostats, economizers, flow switches, dampers, louvers

C-9.K3 residential HVAC energy sources such as electric, natural gas, propane, fossil fuel and solar

C-9.K4 residential HVAC assembly tools and equipment such as hand tools, power equipment and rigging equipment

C-9.K5 residential HVAC assembly factors such as component placement, tool requirements, material list, scheduling

- C-9.K6 residential HVAC placement tools and equipment such as wrenches, chain falls, lifts and ladders
- C-9.K7 residential HVAC isolation components such as cork/rubber pads, canvas connectors and vibration eliminators
- C-9.K8 residential HVAC anchors and supports
- C-9.K9 residential HVAC documentation such as start up reports, commissioning reports, warranty documentation, environmental refrigeration documentation, record of pressure level, jurisdictional requirements and manufacturer's requirements
- C-9.K10 evaporators and components such as: direct expansion, tube and fin, drain lines, drain pan
- C-9.K11 compressors include: reciprocating, scroll, rotary
- C-9.K12 metering devices such as: piston, capillary tube, thermostatic expansion valve, electronic expansion valve, electric expansion valve
- C-9.K13 heating systems such as: forced-air, hydronic, infrared, radiant  
heat pump systems include: air-to-air, liquid-to-air, liquid-to-liquid, air-to-liquid, geothermal, solar
- C-9.K14 refrigerant flow controls and accessory devices such as: direct-acting, reverse-acting, pilot-operated, reversing valves
- C-9.K15 heating systems such as: forced-air, hydronic, infrared, radiant  
heat pump systems include: air-to-air, liquid-to-air, liquid-to-liquid, air-to-liquid, geothermal, solar
- C-9.K16 motors include: multi-lead, dual-voltage, multi-speed, ECM, inverter, air-cooled
- C-9.K17 installation tools and equipment such as hand tools, power tools, measuring tapes and levelling devices
- C-9.K18 base materials such as concrete products, deck, metal (steel and aluminium), wood/lumber, wall board and composite
- C-9.K19 fasteners, brackets and hanger mounting such as place, drill, anchor, adhere, screw, nail
- C-9.K20 piping and tubing installation procedures such as cleaning, threading, reaming, flaring, swaging and annealing

C-9.K21	pipng and tubing joining procedures such as crimp, press, fusion, adhesion, threading, flare, compression fitting connection
C-9.K22	pipng and tubing accessories such as: flow controls , filter driers, isolation valves
C-9.K23	pipng and tubing materials such as copper, brass, steel , aluminum
C-9.K24	brazing, soldering and welding materials include: silver brazing alloys, flux, BCuP and BAg, solder, welding consumables (sticks, gases and tips)
C-9.K25	tools and equipment such as service valve wrenches, charging scales, transfer pumps, gauge manifold
C-9.K26	charge refrigerants such as primary (CFC, HFC, HFO, HCFC), secondary (water, glycol solutions, brine solutions)
C-9.K27	charge records such as refrigerant type, quantity, ambient and space temperature, holding pressure

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#### **Sub-task**

#### **C-9.01 Confirms system layout**

#### **Key Competencies**

C-9.01.01	verify that equipment matches material take-offs to ensure correct components are installed
C-9.01.02	determine modifications for residential HVAC system equipment, components and accessories to accommodate actual site conditions and equipment
C-9.01.03	verify site measurements and clearance for equipment, components and accessories and their location/orientation
C-9.01.03	verify utilities for serviceability and overall function

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#### **Sub-task**

#### **C-9.02 Assembles residential HVAC equipment, components and accessories**

#### **Key Competencies**

C-9.02.01	unpack and perform pre-assembly check of equipment, components and accessories to ensure quantity and type are correct, in good condition and are compatible with the utilities/energy sources, and installation and job specifications
C-9.02.02	select and use tools and equipment to assemble equipment, components and accessories

- C-9.02.03 modify or adjust equipment, components and accessories such as: orientation, flow direction, add-on kits and rotations are modified or adjusted to match system orientation and design
- C-9.02.04 confirm final assembly of components and accessories according to jurisdictional regulations and manufacturers' specifications
- 

#### **Sub-task**

#### **C-9.03 Places residential HVAC equipment, components and accessories**

##### **Key Competencies**

- C-9.03.01 select and use tools and equipment to place equipment and components
- C-9.03.02 install isolation components to eliminate vibration transmission and noise
- C-9.03.03 secure equipment and components according to jurisdictional regulations and manufacturers' specifications
- 

#### **Sub-task**

#### **C-9.04 Installs fasteners, brackets and hangers**

##### **Key Competencies**

- C-9.04.01 select and use tools and equipment according to site conditions
- C-9.04.02 select fasteners, brackets and hangers according to job specifications
- C-9.04.03 lay out fasteners, brackets and hangers according to drawings and site conditions
- C-9.04.04 construct and fabricate hangers and brackets from raw material for custom applications
- C-9.04.05 assess base material dimensions, condition, strength and select appropriate fasteners and hardware are installed securely to base material
- C-9.04.06 mount brackets and hangers securely according to codes, job specifications and environmental conditions
- 

#### **Sub-task**

##### **Key Competencies**

#### **C-9.05 Installs residential HVAC piping and tubing**

C-9.05.01	braze, solder and weld piping and tubing according to jurisdictional regulations using oxy-fuel and air-fuel equipment and is kept free of contaminants
C-9.05.02	purge piping, tubing and components with inert gas to ensure system is clean and has no oxidization inside the piping and tubing. Clean and flush retrofit tubing.
C-9.05.03	cut, flare, fit and connect piping and tubing using procedures according to industry practices and manufacturers' specifications
C-9.05.04	join piping and tubing according to job specifications, materials used and jurisdictional regulations
C-9.05.05	bend tubing according to installation requirements
C-9.05.06	hang piping and tubing using hangers, supports and saddles according to codes and design specifications
C-9.05.07	install accessories according to design specifications, manufacturers' recommendations and site conditions
C-9.05.08	perform pressure test on system to ensure integrity of the joints to ensure system is tight and leak free
C-9.05.09	insulate piping and tubing according to environmental conditions, location, applications, and design and manufacturers' specifications

#### Sub-task

**C-9.06 Applies residential HVAC holding charge**

#### Key Competencies

C-9.06.01	select and use tools and equipment
C-9.06.02	identify refrigerant type according to design specifications
C-9.06.03	introduce refrigerant into the system and monitor quantity according to industry practices to a positive pressure
C-9.06.04	label system and complete records with type and amount of holding charge

### **Task D-10**

#### **Installs residential HVAC control systems**

**Context** Residential refrigeration and air conditioning mechanics assemble, place, secure and connect controls for all types and applications of residential HVAC systems. The controls enable systems to start, stop, modulate, monitor and report conditions.

#### **Required Knowledge**



D-10. K1	Control system tools and equipment such as hand tools, power equipment, instruments, dielectric paste, heat transfer compounds, fittings, clamps, connectors and cable ties
D-10.K2	Control system hardware options such as dip switches, jumpers and clockwise/counter-clockwise setting
D-10.K3	Control system orientation and position such as spring or capacitor action, clockwise vs counter-clockwise
D-10.K4	Control system wiring diagrams such as pictorial, schematic, ladder, component location and installation

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### **Sub-task**

#### **D-10-01          Places control system components**

#### **Key Competencies**

D-10.01.01	select and use tools and equipment according to job requirements
D-10.01.02	unpack and perform pre-assembly check to ensure they are correct and in good condition
D-10.01.03	configure hardware options according to job requirements and manufacturers' specifications
D-10.01.04	determine location, orientation and position of controls and devices according to design specifications and site conditions
D-10.01.05	assemble and install controls and devices according to CEC requirements and manufacturers' specifications
D-10.01.06	mount and secure controls and devices according to manufacturers' specifications and site conditions
D-10.01.07	update documentation to reflect changes

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### **Sub-task**

#### **D-10-02          Connects control systems**

#### **Key Competencies**

D-10.02.01	select wiring, cabling and tubing according to manufacturer's specifications, codes, standards, trade practices and job specifications
D-10.02.02	layout wiring, cabling and tubing path according to drawings

D-10.02.03	install interconnecting wiring, cabling and tubing according to codes, standards, job specification and wiring diagrams
D-10.02.04	determine circuitry and load requirements based on the voltage and amperage requirements, specifications and CEC requirements
D-10.02.05	prepare wiring and tubing for final connection to control devices using tools and materials
D-10.02.06	select termination points according to system requirements
D-10.02.07	arrange and secure wiring and tubing for aesthetics, protection and serviceability
D-10.02.08	terminate control wiring and tubing according to site-specific drawings, manufacturers' specifications, and jurisdictional regulations
D-10.02.09	update documentation to reflect changes

## MAJOR WORK ACTIVITY F

## PERFORMS COMMISSIONING

<b>Trends</b>	Manufacturers have made it easier to provide supporting documentation for equipment registration and warranty coverage using digital platforms. This detailed process ensures equipment is operating at manufactured design peak performance and customer extended warranty. Home owners have the ability to verify their equipment warranty status by the use of scanned QR codes. This allows access to the equipment commission report, service bulletins and user manuals.
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### Task E-11

### Commissions residential HVAC systems

<b>Context</b>	Commissioning of residential HVAC systems is an important step to ensure the system is complete and properly charged, and that all necessary adjustments have been made. This enables the system to run efficiently, environmentally responsible and according to specifications.
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#### Required Knowledge

E-11.K1	pre-start up tools and equipment such as multimeters, gauges, hand tools and thermometers
E-11.K2	pre-start up factors such as: presence of field installed parts, missing parts, shipping mounts and straps that have not been removed, placement of controls and positioning of valves
E-11.K3	electrical connections such as terminal strips, crimped and wire nuts and connected ground wires

E-11.K4	movable components such as drives, dampers, actuators, fans, motors, pumps and valves
E-11.K5	methods used to determine the charge of an residential HVAC system such as: measuring superheat and subcooling, weighing critical charge, interpreting charge charts and internal volume
E-11.K6	utilities such as electrical, gas and water
E-11.K7	components such as blowers, fans, pumps, compressors, motors, dampers, temperature/pressure controls, valves and safety components
E-11.K8	system conditions such as amperage draws, pressures, temperatures, air flow
E-11.K9	start up factors such as polarity, voltage imbalance and amperage, refrigerant charge adjustments, operating pressures and temperatures, system control adjustments, manufacturers' recommendations and liquid or air requirements
E-11.K10	system charge tools and equipment such as gauge manifolds, scales, thermometers, oil pumps, multimeter and instruments
E-11.K11	system charge refrigerants such as primary (CFC, HFC, HFO, HCFC, ) secondary (glycol solutions, brine solutions)
E-11.K12	system operating load conditions such as amperage, voltage, rpm and discharge temperature
E-11.K13	charge tools and equipment such as gauge manifolds, scales, thermometers, oil pumps, multimeter and instruments
E-11.K14	system charge refrigerant conditions such as saturated condensation temperature, saturated evaporating temperature, sub-cooling, and superheat
E-11.K15	system charge methods/procedures used to determine the charge of a residential HVAC system such as measuring superheat and subcooling, weighing critical charge, interpreting charge charts, internal volume, amperage, voltage, cfm and discharge temperature
E-11.K16	primary and secondary residential HVAC tools and equipment such as hand tools, multimeters, refractometers, thermometers, pressure gauges and instruments
E-11.K17	primary residential HVAC components such as metering devices, flow controls, pressure regulating valves, compressors, fans, pumps and dampers
E-11.K18	secondary residential HVAC components such as valves (balancing), pumps, fans, flow controls and temperature controls

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**Sub-task**

**E-11.01 Performs pre-start-up checks for residential HVAC systems**

**Key Competencies**

E-11.01.01	select and use tools and equipment according to manufacturers' specifications and site conditions
E-11.01.02	ensure that energy/power source and equipment are compatible and verified
E-11.01.03	verify completion of installation by checking for factors
E-11.01.04	check control settings to allow equipment to be operational
E-11.01.05	verify that equipment is securely fastened and mounted according to codes, regulations, site conditions and manufacturers' specifications
E-11.01.06	check electrical connections and components for grounds and shorts to detect loose or damaged wiring according to jurisdictional regulations and manufacturers' specifications
E-11.01.07	ensure free movement of movable components

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**Sub-task****E-11.02 Performs start-up of residential HVAC systems****Key Competencies**

E-11.02.01	turn on and verify utilities to allow equipment to start with the correct rotation
E-11.02.02	verify direction of rotating components visually to allow equipment to operate according to manufacturers' specifications
E-11.02.03	test and adjust operation of residential HVAC control components
E-11.02.04	verify sequence of operation of system
E-11.02.05	verify system operation by measuring system conditions and comparing to design parameters and operating conditions
E-11.02.06	set up components according to design specifications
E-11.02.07	adjust components according to operating conditions

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**Sub-task****E-11.03 Completes residential HVAC system charge****Key Competencies**

E-11.03.01	select and use tools and equipment according to industry practices
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E-11.03.02	verify type of refrigerant required for system by referring to labelling
E-11.03.03	weigh and measure refrigerant to be added as required for start-up by referring to manufacturers' specifications
E-11.03.04	operate system according to manufacturers' specifications and site conditions
E-11.03.05	measure and interpret operating load conditions according to operating pressures, ambient temperatures, superheat and subcooling
E-11.03.06	verify and adjust refrigerant charge as required under all load conditions

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#### Sub-task

**E-11.04        Sets up primary and secondary residential HVAC system components**

#### Key Competencies

E-11.04.01	select and use tools and equipment according to industry practices
E-11.04.02	adjust controls, valves and regulators to confirm operating at design site conditions
E-11.04.03	measure and interpret readings from primary and secondary residential HVAC systems
E-11.04.04	adjust and balance primary residential HVAC components to allow system to operate according to design conditions
E-11.04.05	adjust and balance secondary residential HVAC components according to recommended operating parameters

### **Task E-12**

#### **Commissions control systems**

**Context**        Residential refrigeration and air conditioning mechanics perform start-up checks and set operating parameters of control systems to ensure that controls and safety components are set up correctly and to ensure proper operation of residential HVAC systems.

#### Required Knowledge

E-12. K1	commissioning tools and equipment such as thermometers, multimeters, electronic devices and instruments
E-12.K2	System controls such as electrical, mechanical, electronic and wireless
E-12.K3	Control system parameters such as alarm, humidity, temperature, pressures, flow and levels

E-12.K4	controllers such as timers, microprocessors, analog and digital control systems and electronic devices
E-12.K5	operating controls such as thermostats, economizer controls and pressure switches
E-12.K6	control components such as thermostats, pressure controls, transducers, thermistors and humidistats
E-12.K7	safety controls such as high and low pressure switches, high and low temperature switches, overload switch and flow switch

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### **Sub-task**

#### **E-12.01 Performs start-up checks for control systems**

#### **Key Competencies**

E-12.01.01	select and use tools and equipment according to industry standards
E-12.01.02	verify that electrical and electronic connections are completed according to manufacturers' specifications and jurisdictional regulations
E-12.01.03	apply power to energize system
E-12.01.04	check transformer output to ensure correct secondary voltage and polarity

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### **Sub-task**

#### **E-12.02 Verifies/sets operating parameters**

#### **Key Competencies**

E-12.02.01	select and use tools and equipment according to industry practices
E-12.02.02	verify parameters according to manufacturers' specifications, site conditions and client requirements
E-12.02.03	program controllers to a defined set of parameters
E-12.02.04	adjust operating controls according to manufacturers' specifications and client requirements
E-12.02.05	adjust parameter set points according to load requirements and ambient conditions
E-12.02.06	record operating parameters in start-up information sheets for reference and warranty issues
E-12.02.07	calibrate components to ensure accurate readings from components to controllers

E-12.02.08 test operation of safety controls

## MAJOR WORK ACTIVITY F

## PERFORMS MAINTENANCE AND SERVICE

**Trends** Technicians are required to interpret feedback from customers and their changing home comfort needs to better recommend suitable changes or equipment options. Service personnel can also access QR Codes, trouble shooting apps, parts identification, and unit history to provide a starting point for the service and maintenance of the equipment.

### Task F-13

### Maintains residential HVAC systems

**Context** Residential refrigeration and air conditioning mechanics maintain systems to increase longevity, reliability and efficiency by analysing the system and ensuring safe operating conditions.

#### Required Knowledge

- F-13.K1 pre-start up types of tools and test equipment such as thermometers, manometer, gauges, hand tools, electrical meters and psychrometers
- F-13.K2 pre-start sensory inspection such as visual, touch, auditory, smell
- F-13.K3 system components such as belts, pulleys and refrigerant piping
- F-13.K4 pre-start up operational checks such as confirm motor operation, variable frequency drive (VFD), actuator and damper, fan cycling and temperature rise/fall
- F-13.K5 pre-start up inspection of non-system items such as door gaskets and plugged condensate drains
- F-13.K6 additional service required such as washing of coils, filter change, chemical treatment and corrosion testing of heat exchange systems
- F-13.K7 consumables such as filters, belts, condensate treatment tablets, grease and lubricants
- F-13.K8 pre-start up inspection of equipment components such as coils, heat exchangers, blower sections, condensate drain, supply and return diffusers and dampers
- F-13.K9 tools and test equipment such as thermometers, gauges, hand tools, electrical meters, psychrometers, instruments, electronic devices, interfaces, computers and analysing devices

F-13.K10	system abnormalities such as incorrect refrigerant charge, plugged/fouled heat exchangers, incorrect valve operation, insufficient system capacity, dirty or plugged filter driers and leaking compressor valves
F-13.K11	electrical components such as relays, motors, coils, circuit boards, transducers, thermistors, controls, defrost timers, defrost heaters, transformers, capacitors and hard start kit
F-13.K12	system test requirements such as voltages, amperages, ambient temperatures, pressures
F-13.K13	mechanical components and accessories such as compressors, condensers, metering devices, evaporators, mechanical valves, linkages, bearings, fans and fan motors, actuators, dampers, accumulator, crankcase heaters, solenoid valves and limit switches
F-13.K14	testing factors such as condensing pressure/temperature, evaporating pressure/temperature, heat of compression, subcooling, superheat, ambient conditions, system design, system load, fluid flow rate, velocity, pressures, temperatures and concentration

### Sub-task

#### **F-13.01 Troubleshoots residential HVAC systems**

#### **Key Competencies**

F-13.01.01	select and use tools and test equipment
F-13.01.02	inspect monitoring and communicating equipment according to manufacturer's specifications
F-13.01.03	perform sensory inspection of system components to determine abnormalities and conformity to codes
F-13.01.04	perform safety and operational checks by simulating demand according to requirements, manufacturers' recommendations and jurisdictional regulations
F-13.01.05	identify source of abnormalities
F-13.01.06	identify non-system items that may affect the overall efficiency of operation
F-13.01.07	identify system components that need to be further investigated
F-13.01.08	determine additional service required according to inspection results

### Sub-task



**F-13.02 Performs predictive and scheduled maintenance on residential HVAC systems**

**Key Competencies**

F-13.02.01	select and use tools and equipment according to task
F-13.02.02	replace consumables according to manufacturers' recommendations, maintenance schedule, normal wear and abnormalities
F-13.02.03	lubricate bearings, motors and linkages as required
F-13.02.04	clean equipment components to maintain system performance using system compatible cleaners
F-13.02.05	visually check and tighten electrical connections of system components to prevent electrical failure
F-13.02.06	verify operation and calibration of safety devices to manufacturers' specifications
F-13.02.07	verify operation of system according to system design
F-13.02.08	update documents and on-site logbooks according to company or property owner policy

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**Sub-task**

**F-13.03 Performs predictive and scheduled maintenance on residential HVAC systems**

**Key Competencies**

F-13.03.01	select and use tools and test equipment according to system requirements
F-13.03.02	check refrigerant pressures and temperatures for system abnormalities
F-13.03.03	check heat transfer fluids including water, air and brine for flow rate, pressure, velocity and temperature
F-13.03.04	test electrical supply and electrical components for abnormalities
F-13.03.05	verify system requirements are within design specifications and system settings
F-13.03.06	test mechanical components and accessories for wear and abnormalities
F-13.03.07	check integrity of secondary heat transfer fluids for freeze point, pH, contaminants and protection
F-13.03.8	test and document operation of safety controls and devices
F-13.03.9	perform test procedures according to manufacturers' specifications

**Task F-14****Services residential HVAC systems**

**Context** Residential refrigeration and air conditioning mechanics will use the most current procedures to troubleshoot, repair and retrofit a system, and to return it to optimal operation in a timely manner.

**Required Knowledge**

- F-14.K1 tools and equipment such as hand tools, power tools, instruments, electronic devices, interfaces and computers, analysing devices, meters and air quality monitors, recovery and evacuation equipment
- F-14.K2 troubling primary systems such as compressor, metering device, evaporator, condenser, heat exchanger and accessories
- F-14.K3 troubling secondary systems such as heat exchangers, pumps, fans, blowers, duct work, piping, valves, dampers, isolation devices, flow controls, safety and protective devices, operating controls, vessels and accessories
- F-14.K4 problems such as defective components, ground faults, open circuits, utility issues and leaks
- F-14.K5 documentation requirements such as service orders (verbal or written), ozone depletion prevention records, site/client specific documents and warranty requirements, utility infraction/repair notice
- F-14.K6 residential HVAC systems such as heat pumps, split, ductless split, package units, humidifiers, dehumidifiers, ERVs, HRVs, boilers
- F-14.K7 HVAC components such as compressors, condensers, evaporators, metering devices, fans and blowers
- F-14.K8 HVAC accessories include: IAQ sensors, outdoor temperature sensors, thermistors, transducers
- F-14.K9 electrical components such as motors, transformers, contactors, relays, starters, capacitors, circuit boards
- F-14.K10 heat pump systems such as air-to-air, liquid-to-air, liquid-to-liquid, air-to-liquid and geothermal
- F-14.K11 protection methods such as sealing, capping and isolating system components
- F-14.K12 documents such as wiring diagrams, piping diagrams, flow diagrams, sequence of operations, schematics, site layout diagrams

**Sub-task**

- F-14.01 Troubleshoots residential HVAC systems

**Key Competencies**

F-14.01.01	interview client about equipment concerns and history
F-14.01.02	select and use tools and equipment to diagnose problems based on information obtained
F-14.01.03	interpret temperature, pressure, concentration, flow rate and velocity readings from primary and secondary systems
F-14.01.04	use electrical schematics and diagrams to diagnose problems
F-14.01.05	perform troubleshooting procedures on primary and secondary systems according to industry practices
F-14.01.06	interpret data to identify cause of problems
F-14.01.07	identify components and accessories that need to be replaced or repaired
F-14.01.08	present options for repair, replacement or improvement and complete documentation requirements

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**Sub-task****F-14.02 Repairs residential HVAC systems****Key Competencies**

F-14.02.01	select and use tools and equipment according to task being performed
F-14.02.02	shut down and/or isolate failed component or accessory
F-14.02.03	recover refrigerant according to recovery procedures
F-14.02.04	drain, store, dispose of and refill/recharge lubricants, fluids and heat transfer fluids including, water, brine and glycol according to jurisdictional regulations and manufacturers' recommendations
F-14.02.05	protect system from contamination
F-14.02.06	select compatible replacement components according to manufacturers' specifications, jurisdictional regulations, certifications and job requirements
F-14.02.07	repair or replace residential HVAC components and accessories according to requirements
F-14.02.08	perform pressure and leak tests according to codes
F-14.02.09	evacuate system according to industry practices, jurisdictional regulations and manufacturers' specifications

F-14.02.10	retrofit system refrigerant, as required according to manufacturers' specifications, codes and jurisdictional regulations
F-14.02.11	charge/add refrigerant according to charging procedures according to jurisdictional regulations
F-14.02.12	test operation of system to verify performance is within parameters and according to system design
F-14.02.13	update documents, on-site logbooks and operating and maintenance instructions according to company and client needs, and jurisdictional regulations
F-14.02.14	present options for additional repair, replacement or improvement

### Task F-15

### Maintains and services control systems

<b>Context</b>	Control systems need to be maintained to ensure accuracy, reliability and efficiency of systems. Maintenance includes routine inspection, testing and calibration activities. When control systems malfunction, residential refrigeration and air conditioning mechanics need to troubleshoot and repair or replace the system components.
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#### Required Knowledge

F-15.K1	control system tools and equipment such as hand tools, power tools, instruments, electronic devices, interfaces and computers, analysing devices, meters and air quality monitors
F-15.K2	control systems such as safeties, circuit boards, and operating controls
F-15.K3	control system components such as thermostats, low/high pressure switches, limit switches, flow switches (air, water), timers, transducers, thermocouples, thermistors, and transmitters
F-15.K4	run checks such as verifying operating and safety controls
F-15.K5	safety controls such as limit switches, current sensing device, flow switches, low/high pressure switches and refrigerant monitors
F-15.K6	test procedures such as cycling safety controls, simulating out of range/unsafe conditions
F-15.K7	communication protocols such as Wi-Fi, Bluetooth, near field communication, manufacturer's proprietary systems
F-15.K8	troubleshooting problems such as incorrect design/installation, user misuse, defective components, utility issues, open/closed circuits, irregularities in the sequence of operation, missing components, poor environmental control, sensor inaccuracy, interference, lack of shielding, improper grounding, improper polarity,

	harmonic interference, termination issues, inappropriate wiring scheme, equipment and calibration issues
F-15.K9	system readings such as temperature, humidity, pressure, voltage, amperage
F-15.K10	interpret and implement manufacturers' digital applications, information from test equipment and access stored information (cloud, circuit board, interface, data logger)
F-15.K11	calibration conditions such as temperature, pressure, humidity, flow, levels (air quality), voltage, current, resistance and velocity
F-15.K12	operating and safety controls such as thermostats, humidity controls, limit switches, current sensing device, flow switches, low/high pressure switches, refrigerant and gas monitors, timers, transducers, thermocouples, thermistors and transmitters
F-15.K13	stakeholders such as electricians, network and IT technicians, sheet metal workers, utilities, monitoring and alarm supplier and jurisdictional regulators
F-15.K14	tools and equipment such as hand tools, power tools, instruments, electronic devices, interfaces and computers, analysing devices, meters, air quality monitors
F-15.K15	control system components such as thermostats, low/high pressure switches, limit switches, flow switches, timers

### Sub-task

#### **F-15.01 Performs maintenance and inspection on control systems**

#### **Key Competencies**

F-15.01.01	select and use tools and equipment according to task being performed
F-15.01.02	perform visual inspection of control systems and control system components according to manufacturers' specifications, client requirements and jurisdictional regulations
F-15.01.03	perform run checks according to system documentation
F-15.01.04	verify safety controls according to jurisdictional regulations
F-15.01.05	perform test procedures according to manufacturers' specifications, client requirements and jurisdictional regulations
F-15.01.06	secure and clean connections on control system components
F-15.01.07	identify components that need to be replaced or repaired
F-15.01.08	present options for additional repair, replacement or improvement

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**Sub-task****F-15.02 Performs maintenance and inspection on control systems****Key Competencies**

- F-15.02.01 discuss client concerns about equipment
  - F-15.02.02 select and use tools and equipment to diagnose problem based on information obtained from client
  - F-15.02.03 use system documentation and schematics to diagnose problems
  - F-15.02.04 interpret system readings from gathered information
  - F-15.02.05 identify problems identified by sensory inspection and use of test equipment
  - F-15.02.06 combine system readings and data to identify cause and source of problem
  - F-15.02.07 identify components or accessories that need to be reconfigured, repaired or replaced
  - F-15.02.08 present options for reconfiguration, repair, replacement or improvement
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**Sub-task****F-15.03 Calibrates operating and safety controls****Key Competencies**

- F-15.03.01 select and use tools and equipment according to task being performed
- F-15.03.02 test and record conditions to compare to system settings
- F-15.03.03 verify that operating and safety controls operate according to system design settings and manufacturers' specifications
- F-15.03.04 adjust controls that are operating outside parameters according to manufacturers' specifications
- F-15.03.05 identify and replace faulty controls that cannot be calibrated according to manufacturers' specifications
- F-15.03.06 update documentation and on-site logbooks according to manufacturers' specifications and client needs

- F-15.03.07 repair or replace cabling, wiring and terminations according to manufacturers' specifications, job requirements and industry practices
- F-15.03.08 communicate with trade supports using various methods according to manufacturers' specifications and jurisdictional regulations
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**Sub-task****F-15.04 Repairs control systems****Key Competencies**

- F-15.04.01 select and use tools and equipment according to task being performed
- F-15.04.02 select compatible and acceptable replacement control system components according to manufacturers' specifications, availability and retrofit requirements
- F-15.04.03 adjust, repair or replace control system components, wiring, cabling and connections that are operating outside parameters
- F-15.04.04 test operation of repaired or replaced control system component
- F-15.04.05 update control system schematics, documentation and on-site logbooks according to jurisdictional regulations and company and client needs

## **APPENDICES**



**Hand Tools**

bending tools and springs	nut drivers
brushes (wire, paint, acid, tube)	orifice drill sets
caulking guns	O-ring removal tools
chalk lines	paint equipment
chisels	pipe dies
crowbars	pipe threaders
crimpers (wire, tin, pipe, fitting)	pliers
Cutters (side, wire, bolt, pipe, tube)	pry bars
drywall saws	pullers
files	punches
fin combs	reamers
fish tapes	regulators (CO <sub>2</sub> , nitrogen, oxygen, acetylene)
Flare nut wrenches	Schrader removers
flaring tools	scrapers
flashlights	screw extractors
folding pliers	screwdrivers
funnels	snap ring pliers
fuse pullers	socket sets
grease guns	squares
hack saws	staplers
hammers	straight edges
hand carts	swaging tools
hand sprayers	torx drivers and tips
hex keys	tin snips
Knock-out kits	utility knives
labelling machine	wire strippers
levels (laser, bubble, precision, line, transit)	wrenches (pipe, open end, adjustable, valve, torque)
inspection mirrors	vices

### Portable and Stationary Power Tools

air compressors and regulators	powder-actuated tools
drill index	power washers
drills (electric, cordless, hammer)	pumps (circulating, transfer, sump)
glue guns	Saws (jig, reciprocating, band, chop, circular)
grinders	trouble lights
heat guns	vacuum cleaners
hole saw kits	power threaders
impact guns	

### Brazing and Soldering Tools

air fuel equipment	soldering iron/gun
brazing barriers (fire blankets)	striker
cloth (sand, emery, sandpaper)	torch kits
oxy-fuel equipment	

### Recovery and Recycling Equipment

filter/driers	recovery hose and recycle unit
hazardous waste containers	recovery and storage cylinders
liquid pumps	
pressure/temperature charts	

### Charging Tools and Equipment

charging cylinders	refrigerant oil pumps
charging manifolds	tank heater (heat blankets)
charging scales	vacuum pumps
refrigerant hoses	

## Diagnostic and Measuring Equipment

Air velocity tester	magnahelic gauges
air quality testers	manifold gauge sets
	manometers
	measuring tapes
	mega-ohmmeters
black lights	micrometers
calculators	micron gauges (mechanical, electronic)
calipers	multimeters (true root mean square [RMS])
	non-contact voltage (NCV) testers
capacitor tester	
circuit tracers	
carbon monoxide analyzers/detectors	
combustion analyzers	
compound gauges	
computers	
digital mobile applications	potentiometers
data loggers	proximity meters
decibel meters	refractometers
dial indicators	refrigerant scales (mechanical, electronic)
dye penetrant kits	rulers
ecm tester	psychrometers
flame safeguard testers	
gauges	millivolt tester
hydrometers	thermometers (infrared, electronic, mechanical)
	Transducers (humidity, pressure, current, voltage, temperature)
hygrometers	vacuum gauges
Infrared thermography cameras and display units	
leak detectors (electronic, ultrasonic, soap tests, ultraviolet)	
	video scope (inspection camera)
	water analysis kits

## Access Equipment

Ladders (step, extension)	Scaffolding/staging
Personnel lifts	

## Rigging, Hoisting and Lifting Equipment

blocks and tackles	jacks (hydraulic, mechanical)
Chain falls	
chains and cables	material lifts
come-alongs	ropes
cranes (gantry, mobile)	shackles
dollies	slings
eye bolts	spreader bars
	stair climber trolley
hoists	
	winches

### **Personal Protective Equipment and Safety Equipment**

absorbent spill kit	rain suits
barricades/pylons	respirators
eye wash (portable)	rubber aprons and coveralls
fall arrest equipment	rubber boots
fire blankets	safety boots
fire extinguishers	safety face shields
first aid kits/stations	safety glasses
flagging	safety goggles
gas detector (hazardous gases)	tape (caution, danger)
gloves (rubber, insulated, leather)	two-way radios
hard hats	warning signs
hearing protection (ear plugs, muffs)	welding gloves
High-visibility apparel	welding goggles
lock-out kits	welding helmets
masks (dust, particle, filter, vapour)	

**APPENDIX B****GLOSSARY**

<b>accessories</b>	optional parts added to equipment or system
<b>access equipment</b>	equipment used to allow mechanics to reach work location (e.g. ladder, scaffolds, personnel lift)
<b>accumulator</b>	a vessel in the suction line that collects liquid refrigerant to be boiled off
<b>analog controls</b>	controls which are continuously variable between two points
<b>commission</b>	final start-up activities before a system is fully functional that ensures the system meets design specifications and client requirements
<b>component</b>	parts required as part of a system
<b>compressor</b>	component that creates pressure differential in a system that allows a refrigerant to flow
<b>condenser</b>	heat rejection component that provides a state change of refrigerant (from vapour to a liquid)
<b>control system</b>	electrical, electronic, mechanical and pneumatic components and wiring that are used to operate and protect the system
<b>digital controls</b>	control that use an on/off signal
<b>evaporator</b>	heat absorption component that provides a state change of refrigerant (from liquid to a vapour)
<b>field wiring</b>	wiring required to be done on site
<b>flow control</b>	device for controlling the flow of primary and secondary refrigerants (e.g. crankcase pressure regulator [CPR], evaporator pressure regulator [EPR], solenoid valve)
<b>fluid cooler</b>	a heat rejection device that cools a secondary heat transfer medium
<b>heat exchanger</b>	device used to transfer heat energy from one medium to another
<b>holding charge</b>	temporary or partial charge used for the protection of the system until commissioning
<b>humidifier</b>	device that introduces water vapour to conditioned space in order to raise relative humidity
<b>humidity</b>	a measurement of moisture in air
<b>internal wiring</b>	wiring inside the system that includes factory and optional wiring
<b>maintain</b>	performing functions to prevent premature deterioration and breakdown of system

<b>metering device</b>	device designed to regulate flow of liquid refrigerant entering the evaporator
<b>oil separator</b>	device used to remove oil from refrigerant
<b>material take-off</b>	the listing of material and components required for a project as taken from design drawings and job requirements
<b>predictive maintenance</b>	monitoring system components for future replacement or repair using methods such as vibration analysis and sensory inspection
<b>pressure control</b>	pressure-activated safety or operational control
<b>receiver</b>	storage vessel for liquid refrigerant
<b>refrigerant</b>	heat transfer fluid used in a primary or secondary refrigeration system
<b>refrigeration</b>	transferring of heat from a place where it is not wanted to a place where it is unobjectionable
<b>regulator</b>	device that controls voltage or the pressure of liquid or gases
<b>repair</b>	fix system by repairing or replacing components and accessories
<b>replace</b>	change a component on a system
<b>sensory inspection</b>	inspection done without tools using sight, smell, touch and sound
<b>service</b>	troubleshoot and repair system
<b>solenoid valve</b>	device that permits or stops liquid and gas flow
<b>terminate</b>	final connection of wiring or tubing to any device
<b>trade standards</b>	procedures based on codes, regulations, manufacturers' recommendations and best practices
<b>transducer</b>	electronic device that sends a digital or analog signal to a control board
<b>troubleshoot</b>	diagnosing system failures and malfunctions
<b>utilities</b>	services such as electricity, drainage, water or gas provided by the city or utility companies

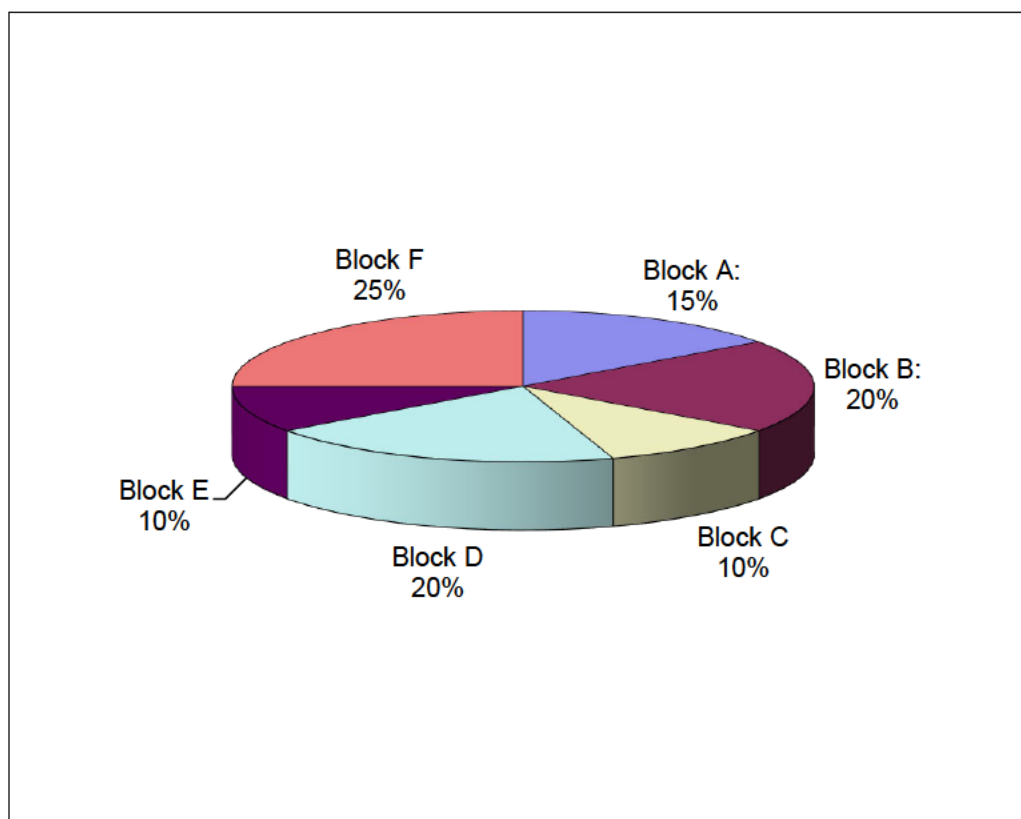
**APPENDIX C****ACRONYMS**

<b>BAS</b>	building automation systems
<b>CFC</b>	chlorofluorocarbon
<b>CPR</b>	crankcase pressure regulator
<b>ECM</b>	electronically commutated motors
<b>EPR</b>	evaporator pressure regulator
<b>ERV</b>	energy recovery ventilation
<b>HC</b>	hydrocarbons
<b>HCFC</b>	hydro chlorofluorocarbon
<b>HFC</b>	hydrofluorocarbon
<b>HFO</b>	hydrofluoroolefin
<b>HRV</b>	heat recovery ventilation
<b>residential HVAC</b>	heating, ventilation, air conditioning and refrigeration
<b>IAQ</b>	indoor air quality
<b>LEED</b>	Leadership in Energy and Environmental Design
<b>OEM</b>	original equipment manufacturer
<b>OH&amp;S</b>	Occupational Health and Safety
<b>P</b>	proportional
<b>PI</b>	proportional integral
<b>PID</b>	proportional integral derivative
<b>PLC</b>	programmable logic controllers
<b>PPE</b>	personal protective equipment
<b>P/T</b>	pressure/temperature
<b>PWM</b>	pulse width modulation
<b>SDS</b>	Safety Data Sheet
<b>SOP</b>	safe operating procedures
<b>TDG</b>	transportation of dangerous goods
<b>VFD</b>	variable frequency drives
<b>VRF</b>	variable refrigerant flow
<b>VSD</b>	variable speed drive
<b>WHMIS</b>	Workplace Hazardous Materials Information System

**APPENDIX D****MAJOR WORK ACTIVITY (MWA)  
AND TASK WEIGHTING**

<b>MWA A</b>	<b>COMMON OCCUPATIONAL SKILLS</b>	<b>15%</b>
Task A-1	Performs safety-related functions	2%
Task A-2	Uses tools and equipment	9%
Task A-3	Organizes work	2%
Task A-4	Uses communication and mentoring techniques	2%
<b>MWA B</b>	<b>ROUTINE TRADE ACTIVITIES</b>	<b>20%</b>
Task B-5	Performs work site preparation	5%
Task B-6	Performs trade activities	15%
<b>MWA C</b>	<b>PLANS RESIDENTIAL HVAC INSTALLATION</b>	<b>10%</b>
Task C-7	Plans installation of residential HVAC systems	5%
Task C-8	Installs residential HVAC control systems	5%
<b>MWA D</b>	<b>RESIDENTIAL HVAC INSTALLATION</b>	<b>20%</b>
Task D-9	Installs residential HVAC systems	13%
Task D-10	Installs residential HVAC control systems	7%
<b>MWA E</b>	<b>RESIDENTIAL HVAC COMMISSIONING</b>	<b>10%</b>
Task E-11	Commissions residential HVAC systems	6%
Task E-12	Commissions control systems	4%
<b>MWA E</b>	<b>RESIDENTIAL HVAC MAINTENANCE AND SERVICE</b>	<b>25%</b>
Task E-13	Maintains residential HVAC systems	5%
Task E-14	Services residential HVAC systems	5%
Task E-15	Maintains and services control systems	15%



**APPENDIX E****PIE CHART\*****TITLES OF MAJOR WORK ACTIVITIES**

MWA A	Common Occupational Skills	MWA D	Residential HVAC Installation
MWA B	Routine Trade Activities	MWA E	Residential HVAC Commissioning
MWA C	Plans residential HVAC Installation	MWA F	Residential HVAC Maintenance and Service

\*Average percentage of the total number of questions on a provincial examination, assigned to assess each major work activity of the occupational standard, as derived from the collective input from workers within the occupation. Provincial certification examinations typically have from 100 to 150 multiple-choice questions.

## APPENDIX F

## TASK PROFILE CHART – RACM (Residential)

MWA	TASKS	SUB-TASKS			
<b>A</b> <b>COMMON</b> <b>OCCUPATIONAL</b> <b>SKILLS</b>	<b>A-1</b> <b>Performs safety-</b> <b>related functions</b>	<b>A-1.01</b> Maintains safe work environment	<b>A-1.02</b> Consults with project team and subtrades on project requirements.	<b>A-1.03</b> Uses personal protective equipment (PPE) and safety equipment	
	<b>A-2</b> <b>Uses tools and</b> <b>equipment</b>	<b>A-2.01</b> Uses hand tools	<b>A-2.02</b> Uses portable and stationary power tools	<b>A-2.03</b> Uses brazing and soldering equipment	<b>A-2.04</b> Uses recovery and recycling tools and equipment
		<b>A-2.05</b> Uses evacuation tools and equipment	<b>A-2.06</b> Uses charging tools and equipment	<b>A-2.07</b> Uses diagnostic and measuring tools and equipment	<b>A-2.08</b> Uses access equipment
		<b>A-2.09</b> Uses rigging, hoisting and lifting equipment	<b>A-2.10</b> Uses digital technology		
		<b>A-3</b> <b>Organizes work</b>	<b>A-3.01</b> Interprets drawings and specifications	<b>A-3.02</b> Uses documentation and reference material	<b>A-3.03</b> Plans job tasks and procedures
	<b>A-4</b> <b>Uses</b> <b>communication</b> <b>and mentoring</b> <b>techniques</b>	<b>A-4.01</b> Uses communication techniques.	<b>A-4.02</b> Uses mentoring techniques		

<b>B</b> <b>ROUTINE TRADE</b> <b>ACTIVITIES</b>	<b>B-5</b> Performs work site preparation	<b>B-5.01</b> Prepares work site	<b>B-5.02</b> Handles materials and supplies		
	<b>B-6</b> Performs trade activities	<b>B-6.01</b> Performs brazing and soldering	<b>B-6.02</b> Performs leak and pressure tests on system	<b>B-6.03</b> Evacuates systems	<b>B-6.04</b> Uses refrigerants, gases and oils
		<b>B-6.05</b> Performs field wiring of system	<b>B-6.06</b> Applies sealants and adhesives		
	<b>C</b> <b>PLANS</b> <b>RESIDENTIAL</b> <b>HVAC</b> <b>INSTALLATION</b>	<b>C-7</b> Plans installation of residential HVAC systems	<b>C-7.01</b> Verifies system parameters and requirements	<b>C-7.02</b> Selects residential equipment, components and accessories	<b>C-7.03</b> Placement of residential HVAC equipment, components and accessories
<b>C-8</b> Plans installation of control systems		<b>C-8.01</b> Verifies control system parameters and requirements	<b>C-8.02</b> Selects control system components and accessories	<b>C-8.03</b> Determines placement of control system components and accessories	<b>C-8.04</b> Performs control system material take-off
<b>D</b> <b>RESIDENTIAL</b> <b>HVAC</b> <b>INSTALLATION</b>	<b>D-9</b> Installs residential HVAC systems	<b>D-9.01</b> Confirms system layout	<b>D-9.02</b> Assembles residential HVAC equipment, components and accessories	<b>D-9.03</b> Places residential HVAC equipment, components and accessories	<b>D-9.04</b> Installs fasteners, brackets and hangers
		<b>D-9.05</b> Installs residential HVAC piping and tubing	<b>D-9.06</b> Applies residential HVAC holding charge		
	<b>D-10</b> Installs control systems	<b>D-10.01</b> Places control system components	<b>D-10.02</b> Connects control systems		

<b>E</b> <b>RESIDENTIAL</b> <b>HVAC</b> <b>COMMISSIONING</b>	<b>E-11</b> <b>Commissions</b> <b>residential HVAC</b> <b>systems</b>	<b>E-11.01</b> <b>Performs pre-start-</b> <b>up checks for</b> <b>residential HVAC</b> <b>systems</b>	<b>E-11.02</b> <b>Performs start-up</b> <b>of residential HVAC</b> <b>systems</b>	<b>E-11.03</b> <b>Completes</b> <b>residential HVAC</b> <b>system charge</b>	<b>E-11.04</b> <b>Sets up primary</b> <b>and secondary</b> <b>residential HVAC</b> <b>system</b> <b>components</b>
	<b>E-12</b> <b>Commissions</b> <b>control systems</b>	<b>E-12.01</b> <b>Performs start-up</b> <b>checks for control</b> <b>systems</b>	<b>E-12.02</b> <b>Verifies/sets</b> <b>operating</b> <b>parameters</b>		
<b>F</b> <b>RESIDENTIAL</b> <b>HVAC</b> <b>MAINTENANCE</b> <b>AND SERVICE</b>	<b>F-13</b> <b>Maintains</b> <b>residential HVAC</b> <b>systems</b>	<b>F-13.01</b> <b>Troubleshoots</b> <b>residential HVAC</b> <b>systems</b>	<b>F-13.02</b> <b>Performs</b> <b>predictive and</b> <b>scheduled</b> <b>maintenance on</b> <b>residential HVAC</b> <b>systems</b>	<b>F-13.03</b> <b>Tests residential</b> <b>HVAC system</b> <b>components and</b> <b>accessories</b>	
	<b>F-14</b> <b>Serves</b> <b>residential HVAC</b> <b>systems</b>	<b>F-14.01</b> <b>Performs start-up</b> <b>checks for control</b> <b>systems</b>	<b>F-14.02</b> <b>Repairs residential</b> <b>HVAC systems</b>		
	<b>F-15</b> <b>Maintains and</b> <b>services control</b> <b>systems</b>	<b>F-15.01</b> <b>Performs</b> <b>maintenance and</b> <b>inspection on</b> <b>control systems</b>	<b>F-15.02</b> <b>Troubleshoots</b> <b>control systems</b>	<b>F-15.03</b> <b>Calibrates</b> <b>operating and</b> <b>safety controls</b>	<b>F-15.04</b> <b>Repairs control</b> <b>systems</b>

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