PROGRAM PROGRAMME
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Red Seal Occupational Standard

Refrigeration and Air Conditioning Mechanic

INTERPROVINCIAL STANDARD
CANADA
NORME INTERPROVINCIALE

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Employment and Social Development Canada
Emploi et Développement social Canada

Canada

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REFRIGERATION AND AIR CONDITIONING MECHANIC

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Title: Refrigeration and Air Conditioning Mechanic

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FOREWORD

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Red Seal Occupational Standard (RSOS) as the Red Seal standard for the Refrigeration and Air Conditioning Mechanic trade.

Background

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. Employment and Social Development Canada (ESDC) sponsors the Red Seal Program, which, under the guidance of the CCDA, develops a national occupational standard for each of the Red Seal trades.

Standards have the following objectives:

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

Any questions, comments, or suggestions for changes, corrections, or revisions to this standard or any of its related products may be forwarded to:

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STRUCTURE OF THE OCCUPATIONAL STANDARD

To facilitate understanding of the occupation, this standard contains the following sections:

Description of the Refrigeration and Air Conditioning Mechanic trade: an overview of the trade's duties, work environment, job requirements, similar occupations and career progression

Trends in the Refrigeration and Air Conditioning Mechanic trade: some of the trends identified by industry as being the most important for workers in this trade

Essential Skills Summary: An overview of how each of the 9 essential skills is applied in this trade

Roles and Opportunities for Skilled Trades in a Sustainable Future: an overarching description of how in the context of climate change, skilled trades play a large role in implementing solutions and adjusting to changes in the world. In addition to highlighting the importance of this awareness, the standard may also contain more details on activities, skills and knowledge elements that are specific to the trade

Industry Expected Performance: description of the expectations regarding the level of performance of the tasks, including information related to specific codes, regulations and standards that must be observed

Language Requirements: description of the language requirements for working and studying in this trade in Canada

Pie Chart of Red Seal Examination Weightings: a graph which depicts the national percentages of exam questions assigned to the major work activities

Task Matrix: a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard

Major Work Activity (MWA): the largest division within the standard that is comprised of a distinct set of trade activities

Task: distinct actions that describe the activities within a major work activity

Task Descriptor: a general description of the task

Sub-task: distinct actions that describe the activities within a task

Essential Skills: The most relevant essential skills for this sub-task

Skills:

Performance Criteria: description of the activities that are done as the sub-task is performed

Evidence of Attainment: proof that the activities of the sub-task meet the expected performance of a tradesperson who has reached journeyperson level

Knowledge:

Learning Outcomes: describes what should be learned relating to a sub-task while participating in technical or in-school training

Learning Objectives: topics to be covered during technical or in-school training in order to meet the learning outcomes for the sub-task

Range of Variables: elements that provide a more in-depth description of a term used in the performance criteria, evidence of attainment, learning outcomes, or learning objectives

Appendix A – Acronyms: a list of acronyms used in the standard with their full name

Appendix B – Tools and Equipment: a non-exhaustive list of tools and equipment used in this trade

Appendix C – Glossary: definitions or explanations of selected technical terms used in the standard

DESCRIPTION OF THE REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE

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

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
Refrigeration and Air Conditioning Mechanic	■	■	■	■			■	■	■		■	■	■
Refrigeration and Air Conditioning Systems Mechanic						■							
Refrigeration Mechanic					■					■			
Refrigeration System					■								
Refrigeration System - Class 1					■								

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

Refrigeration and air conditioning mechanics maintain and service systems by inspecting and testing components, brazing or soldering parts to repair defective joints, adjusting and replacing worn or defective components and reassembling repaired components and systems. As part of service and commissioning, refrigeration and air conditioning mechanics start up, test, charge, adjust, calibrate, balance, measure, verify maintain and document systems.

In addition to their regular duties, some mechanics may also prepare work estimates and design systems for clients.

Refrigeration and air conditioning mechanics work with a range of tools and equipment including hand, power, charging, diagnostic and measuring, hoisting and rigging, and recovery and recycling tools and equipment.

They may be employed by heating, ventilation, air conditioning and refrigeration contractors and manufacturers, property owners, retail establishments, and institutional and public sector employers. They also may be self-employed. Refrigeration and air conditioning mechanics may work on systems and units in office buildings, restaurants, food and beverage processing plants, ice arenas, supermarkets, hospitals, the marine and mining sectors as well as bio-medical, scientific and research and development fields. They may also work on refrigerated trucks, automotive air conditioning systems, box cars and appliances.

In some jurisdictions, refrigeration and air conditioning mechanics may be required to work on fuel-fired equipment and therefore may require additional licencing.

Refrigeration and air conditioning mechanics work in various locations such as rooftops, mechanical rooms and computer rooms. The work may be performed indoors or outdoors year round and may require extensive travelling. Much of the work is performed independently.

Inherent risks in this trade include working at heights and in confined spaces, and working with compressed gases, flammable and toxic materials, and utilities such as electrical and hazardous chemicals. Hazardous work environments and weather conditions are also factors. Refrigeration and air conditioning mechanics must be aware of the physical demands and potential for personal injury when performing tasks.

Key attributes for people entering this trade are strong client service, writing, oral communication and problem solving skills, an eye for detail, and the ability to be independent and self-directed. Coordination and manual dexterity are also important, as are mechanical and mathematical abilities. Good physical condition and the strength to lift heavy components are also valuable.

This standard recognizes similarities and overlaps with the work of steamfitters/pipefitters, plumbers, gasfitters, sheet metal workers, industrial mechanics (millwrights), electricians, instrumentation and control technicians, riggers and stationary engineers.

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

TRENDS IN THE REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE

TECHNOLOGY:

There is a growing variety of energy efficient equipment such as variable refrigerant flow (VRF) systems and variable speed drives (VSDs). VRFs are being used in all sectors, replacing and retrofitting equipment. There is an increase in the use of variable frequency drives (VFD) and electronically commutated motors (ECM) to control fans, pumps and compressors.

Electronic controls are becoming more sophisticated. There is an increase in the use of advanced electronic control systems such as Wi-Fi and Bluetooth enabled transducers and thermostats that require original equipment manufacturer (OEM) specific software and interface hardware cables. These systems and controls are being engineered with greater detail and complexity due to increasing needs for efficiency and reliable operation. Refrigeration and air conditioning mechanics are required to have an increasing knowledge of computers and automated control systems as a result.

Remote access technology is becoming more common, not just in large commercial but in light commercial and residential applications. It facilitates remote troubleshooting by refrigeration and air conditioning mechanics. Mechanics may have to use electronic devices for troubleshooting and configuring heating, ventilation, air conditioning and refrigeration (HVAC/R) equipment.

In the chiller industry, there is a growth in the use of magnetic bearing technology and compressors to effect an increase in efficiency.

In commercial applications, digital compressor capacity controls are being used more frequently to increase efficiency and effect variable capacity control. There is an increase in the use of hydronic systems and geothermal heat pumps including the generation of hot water via the heat pump.

Some of the changes in these new technologies are driven by Leadership in Energy and Environmental Design (LEED) standards and Green Building technologies.

MATERIALS:

There are new piping materials (copper/iron alloys for higher pressure refrigerants, plastic pipe for small systems) that require changes in installation procedures and pipe sizing charts. There are alternative pipe fastening systems such as pressed or crimped fittings which do not require brazing.

There are a variety of alternative refrigerants (carbon dioxide, ammonia [R717], hydrofluorocarbon [HFC] and hydrofluoroolefin [HFO]) and oils which require increased safety requirements, new regulations and special consideration during installation and servicing. The use of hydrocarbon refrigerants and their more combustible properties are being found in small unitary equipment. The industry's use of new refrigerants has created a greater focus on installing, servicing and piping practices.

The use of microchannel aluminum heat exchangers requires new repair and servicing techniques.

HEALTH AND SAFETY:

Due to increased health and safety concerns and regulations, indoor air quality (IAQ) is a priority when installing and servicing systems. As well, governing agencies have an increasing enforcement causing refrigeration and air conditioning mechanics to be much more aware of compliance requirements such as working with pressure vessels, handling environmental spills, applying refrigerant recovery/disposal procedures, and handling hazardous materials and waste.

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

ENVIRONMENT:

Refrigeration and air conditioning mechanics are often called upon to recommission and update system maintenance procedures to reduce energy consumption and to return to design operating parameters.

In this time of environmental awareness, refrigeration and air conditioning mechanics need to take greater care in the planning, installing and servicing of HVAC/R systems. They must be conscious of issues such as ozone depletion, global warming, noise pollution and the effects of the use of chemicals in the servicing and maintenance of equipment. They should also promote the use of environmentally friendly chemicals, components and accessories.

DOCUMENT USE:

Increased documentation and record keeping now play a greater role in refrigeration and air conditioning mechanics' daily tasks. Electronic document use continues to increase. Cell phones and tablets are used on location for invoicing, work orders and to check manufacturers' specifications. There is an increasing demand for mechanics to work with clients to explain and interpret documentation.

There are a variety of legal requirements to document refrigerant usage, pressure testing and piping systems. These requirements vary from one jurisdiction to another.

ESSENTIAL SKILLS SUMMARY

Essential skills are needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

The tools are available online or for order at: https://www.canada.ca/en/employment-social-development/programs/essential-skills/profiles.html.

The application of these skills may be described throughout this document within the skills and knowledge which support each sub-task of the trade. The most important essential skills for each sub-task have also been identified. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at http://www.red-seal.ca/.

READING

Refrigeration and air conditioning mechanics read a variety of materials including technical bulletins, manufacturers' specifications and manuals to obtain detailed information on equipment installation and troubleshooting procedures. They read work orders to ensure that the correct piece of equipment is being installed or maintained according to client requirements. They may also refer to wholesaler catalogues to assist in the selection and ordering of parts and equipment.

DOCUMENT USE

As part of document use, refrigeration and air conditioning mechanics consult company and work site procedures. They interpret information in tables, charts and graphs, and codes and regulations, and apply that knowledge when performing a task. They also use drawings to understand job requirements. Refrigeration and air conditioning mechanics adhere to hazard signs and warning labels that are part of WHMIS to prevent injury to themselves and others.

WRITING

Refrigeration and air conditioning mechanics update logbooks and complete written documents such as service reports, work orders, warranty claim forms, permits, and legislated and company documents. They may prepare sketches and update as-built drawings.

NUMERACY

Refrigeration and air conditioning mechanics use numeracy in a range of tasks. For example, they measure lengths of ducting and piping. They calculate areas and volumes of ducting and piping assemblies to meet operating specifications. They use diagnostic and measurement tools to troubleshoot and verify the proper operation of equipment. They compare equipment temperature and pressure trend graphs to equipment specifications and operating parameters to monitor systems. They also estimate time and material costs.

ORAL COMMUNICATION

Refrigeration and air conditioning mechanics communicate with other tradespeople to coordinate the installation, maintenance and service of HVAC/R systems. They interact with clients to identify system requirements and to obtain problem descriptions. They may also call suppliers to order parts, speak with manufacturers' representatives to obtain technical information and engineers to discuss design specifications.

THINKING

Refrigeration and air conditioning mechanics use problem-solving skills to troubleshoot equipment problems and resolve client issues. They determine the most efficient and economical equipment for a job and repair options available. Refrigeration and air conditioning mechanics plan their work schedule considering factors such as priority, safety, time to complete and travelling time for a job. They schedule maintenance work to minimize down time.

WORKING WITH OTHERS

Refrigeration and air conditioning mechanics providing installation, maintenance and service can work independently or as part of a team alongside co-workers, subcontractors and other trades. They interact with clients and others in a professional manner. Refrigeration and air conditioning mechanics mentor apprentices.

DIGITAL TECHNOLOGY

Refrigeration and air conditioning mechanics adjust parameters on automated control systems. They use remote access and on-board functions to monitor and diagnose problems. Refrigeration and air conditioning mechanics use electronic instruments for diagnosis. They may use software, electronic devices and the Internet during the course of their work.

CONTINUOUS LEARNING

Continuous learning is important for refrigeration and air conditioning mechanics due to ongoing changes in technology and an increased emphasis on the environment and energy efficiency. They need to keep informed about new types of equipment, energy sources, materials, computer controls and available client options. They must also keep up-to-date on code and regulation changes that govern their work. Refrigeration and air conditioning mechanics learn through reading manufacturers' literature and trade journals, and by visiting manufacturers' websites. They can also take advantage of seminars and information sessions put on by equipment manufacturers, suppliers, unions and their employers.

Roles and Opportunities for Skilled Trades in a Sustainable Future

Climate change affects all of us. Trades play a large role in implementing solutions and adjusting to changes in the world.

Throughout this standard, there may be specific references to tasks, skills and knowledge that clearly show this trade's role in a more sustainable future. Each trade has different roles to play and contributions to make in their own way.

For example:

- Construction tradespeople need to consider the materials they are using, building methods, and improvements to mechanical and electrical installations. There are important changes to codes and standards to help meet the climate change goals and commitments set for 2030 and 2050. Retrofits and new construction of low-energy buildings provide enormous opportunities for workers in this sector. Concepts, such as energy efficiency and regarding buildings as systems are foundational.

- Automotive and mechanical trades are seeing a shift towards the electrification of vehicles and equipment. As a result, new skills and knowledge will be required for tradespeople working in this sector. There are mandates for sales of new light-duty zero-emission vehicles (ZEV) in Canada, with the goal of achieving 100% ZEV sales by 2035. Due to this mandate, the demand for these vehicles is growing quickly among consumers and fleets. With this escalating demand, the need for skilled workers to maintain and repair these vehicles is also increasing.

- In industrial and resource sectors, there is pressure to move towards increased electrification of industrial processes. Many industrial and commercial facilities are also being upgraded to improve energy efficiency in areas such as lighting systems, and new production processes and technologies. There are also opportunities in carbon capture, utilization and storage (CCUS), as well as the production and export of low-carbon hydrogen.

- Trades in the service sector may also need to be aware of responsible sourcing, as well as efficient use of products and materials. New ways of working better are always a part of the job.

There are fast-moving changes in guidelines, codes, regulations and specifications. Many are being implemented for the purpose of energy efficiency and climate change. Those that affect specific trades may be mentioned within the standard. Examples of these guidelines and legislation include:

- The National Energy Code of Canada for Buildings (NECB).

- The Canadian Net-Zero Emissions Accountability Act (CNZEAA).

- programs that encourage sustainable building design and construction such as Leadership in Energy and Environmental Design (LEED) and the Zero Carbon Building (ZCB) standards.

- the Montreal Protocol for phasing out R22 refrigerants.

- energy efficiency programs such as ENERGY STAR.

- principles of the United Nations Declaration for the Rights of Indigenous Peoples pertaining to energy sector development.

Apprentices and tradespeople need to increase their climate literacy and reinforce their own understanding of energy issues and environmental practices. It is important for them to understand why these changes are happening and their effect on trades' work. While individual tradespeople and apprentices may not be able to choose certain elements like; the architectural design of buildings, building material selection, regulatory requirements, use of electric vehicles and technologies, they must understand the impact of using these elements in their work. Impacts include using environmentally friendly products and following requirements related to the disposal and recycling of materials.

In apprenticeship, as well as in ongoing professional development, employers and instructors should encourage learning about these concepts, why they are important, how they are implemented, and the overarching targets they are aiming to achieve.

All in all, it's about doing the work better and building a better world.

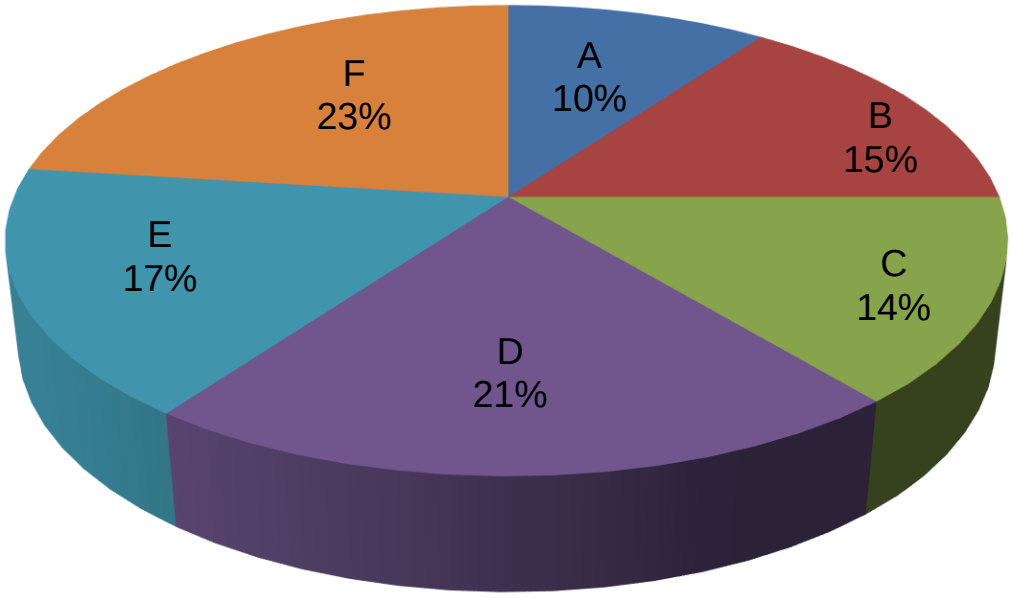
INDUSTRY EXPECTED PERFORMANCE

All tasks must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected and observed. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications, the Occupational Health and Safety (OH&S) Acts, and WHMIS regulations must be met. At a journeyperson level of performance, all tasks must be done with minimal direction and supervision. As a journeyperson progresses in their career, there is an expectation they continue to upgrade their skills and knowledge to keep pace with industry and promote continuous learning in their trade through mentoring of apprentices.

LANGUAGE REQUIREMENTS

It is expected that journeypersons are able to understand and communicate in either English or French, which are Canada's official languages. English or French are the common languages of business as well as languages of instruction in apprenticeship programs.

PIE CHART
OF RED SEAL EXAMINATION WEIGHTINGS



MWA A	Performs common occupational skills	10%
MWA B	Performs routine trade activities	15%
MWA C	Plans installation	14%
MWA D	Performs installation	21%
MWA E	Performs commissioning	17%
MWA F	Performs maintenance and service	23%

This pie chart represents a breakdown of the interprovincial Red Seal examination. Percentages are based on the collective input from workers from the trade from across Canada. The Task Matrix on the next pages indicates the breakdown of tasks and sub-tasks within each Major Work Activity and the breakdown of questions assigned to the Tasks. The Interprovincial examination for this trade has 125 questions.

REFRIGERATION AND AIR CONDITIONING MECHANIC **TASK MATRIX**

A – Performs common occupational skills — 10%

Task A-1 **Performs safety-related functions** **24%**	**A-1.01 Maintains safe work environment**	**A-1.02 Performs lock-out, tag-out and isolation procedures**	**A-1.03 Uses personal protective equipment (PPE) and safety equipment**
Task A-2 **Uses tools and equipment** **36%**	**A-2.01 Uses hand tools**	**A-2.02 Uses portable and stationary power tools**	**A-2.03 Uses brazing and soldering equipment**
	A-2.04 Uses recovery and recycling tools and equipment	**A-2.05 Uses evacuation tools and equipment**	**A-2.06 Uses charging tools and equipment**
	A-2.07 Uses diagnostic and measuring tools and equipment	**A-2.08 Uses access equipment**	**A-2.09 Uses rigging, hoisting and lifting equipment**
	A-2.10 Uses digital technology		
Task A-3 **Organizes work** **24%**	**A-3.01 Interprets drawings and specifications**	**A-3.02 Uses documentation and reference material**	**A-3.03 Plans job tasks and procedures**
Task A-4 **Uses communication and mentoring techniques** **16%**	**A-4.01 Uses communication techniques**	**A-4.02 Uses mentoring techniques**	

B – Performs routine trade activities — 15%

Task B-5 **Performs work site preparation** **25%**	**B-5.01 Prepares work site**	**B-5.02 Handles materials and supplies**	
Task B-6 **Performs trade activities** **75%**	**B-6.01 Performs brazing and soldering**	**B-6.02 Performs leak and pressure tests on system**	**B-6.03 Evacuates systems**
	B-6.04 Uses refrigerants, gases and oils	**B-6.05 Performs field wiring of systems**	**B-6.06 Applies sealants and adhesives**

C – Plans installation — 14%

Task C-7 **Plans installation of HVAC/R systems** **62%**	**C-7.01 Verifies HVAC/R system parameters and requirements**	**C-7.02 Selects HVAC/R equipment, components and accessories**	**C-7.03 Determines placement of HVAC/R equipment, components and accessories**
	C-7.04 Performs HVAC/R material take-off		
Task C-8 **Plans installation of control systems** **38%**	**C-8.01 Verifies control system parameters and requirements**	**C-8.02 Selects control system components and accessories**	**C-8.03 Determines placement of control system components and accessories**
	C-8.04 Performs control system material take-off		

D – Performs installation 21%

Task D-9 **Installs HVAC/R systems** **62%**	**D-9.01 Confirms system layout**	**D-9.02 Assembles HVAC/R equipment, components and accessories**	**D-9.03 Places HVAC/R equipment, components and accessories**
	D-9.04 Installs fasteners, brackets and hangers	**D-9.05 Installs HVAC/R piping and tubing**	**D-9.06 Applies HVAC/R holding charge**
Task D-10 **Installs control systems** **38%**	**D-10.01 Places control system components**	**D-10.02 Connects control systems**	

E – Performs commissioning 17%

Task E-11 **Commissions HVAC/R systems** **61%**	**E-11.01 Performs pre-start-up checks for HVAC/R systems**	**E-11.02 Performs start-up of HVAC/R systems**	**E-11.03 Completes HVAC/R system charge**
	E-11.04 Sets up primary and secondary HVAC/R system components		
Task E-12 **Commissions control systems** **39%**	**E-12.01 Performs start-up checks for control systems**	**E-12.02 Verifies/sets operating parameters**	

F – Performs maintenance and service

23%

Task F-13 **Maintains HVAC/R systems** **30%**	**F-13.01 Inspects HVAC/R systems**	**F-13.02 Performs predictive and scheduled maintenance on HVAC/R systems**	**F-13.03 Tests HVAC/R system components and accessories**
Task F-14 **Services HVAC/R systems** **40%**	**F-14.01 Troubleshoots HVAC/R systems**	**F-14.02 Repairs HVAC/R systems**	
Task F-15 **Maintains and services control systems** **30%**	**F-15.01 Performs maintenance and inspection on control systems**	**F-15.02 Troubleshoots control systems**	**F-15.03 Calibrates operating and safety controls**
	F-15.04 Repairs control systems		

Harmonization of Apprenticeship Training

Provincial and territorial apprenticeship authorities are each responsible for their respective apprenticeship programs. In the spirit of continual improvement, and to facilitate mobility among apprentices in Canada, participating authorities have agreed to work towards harmonizing certain aspects of their programs where possible. After consulting with their stakeholders in the trade, they have reached consensus on the following elements. Note that implementation of these elements may vary from jurisdiction to jurisdiction, depending on their own circumstances. For more information on the implementation in any province and territory, please contact that jurisdiction's apprenticeship authority.

1. Trade name

The official Red Seal name for this trade is Refrigeration and Air Conditioning Mechanic.

2. Number of Levels of Apprenticeship

The number of levels of technical training recommended for this trade is 4 (four).

3. Total Training Hours During Apprenticeship Training

The total hours of training, including both on-the-job and in-school training for this trade is 9000.

4. Sequencing Topics and Related Sub-tasks

The topic titles in the table below are placed in a column for each apprenticeship level for technical training. Each topic is accompanied by the sub-tasks and their reference number. The topics in the grey shaded cells represent those that are covered "in context" with other training in the subsequent years.

Level 1	Level 2	Level 1	Level 2
	Safety-Related Functions	Safety-Related Functions	Safety-Related Functions
	Tools and Equipment	Tools and Equipment	Tools and Equipment
		HVAC/R Systems (Maintain)	HVAC/R Systems (Maintain)

Safety-Related Functions
1.01 Maintains safe work environment
1.02 Performs lock-out, tag-out and isolation procedures
1.03 Uses personal protective equipment (PPE) and safety equipment

Tools and Equipment 2.01 Uses hand tools 2.02 Uses portable and stationary power tools 2.03 Uses brazing and soldering equipment 2.04 Uses recovery and recycling equipment 2.05 Uses evacuation tools and equipment 2.06 Uses charging tools and equipment 2.07 Uses diagnostic and measuring tools and equipment 2.08 Uses access equipment 2.09 Uses rigging, hoisting and lifting equipment 2.10 Uses digital technology			
Organizes Work 3.02 Uses documentation and reference material 3.03 Plans job tasks and procedures	**Organizes Work** 3.01 Interprets blueprints, drawings and specifications 3.02 Uses documentation and reference material 3.03 Plans job tasks and procedures	**Organizes Work** 3.01 Interprets blueprints, drawings and specifications 3.02 Uses documentation and reference material 3.03 Plans job tasks and procedures	**Organizes Work** 3.01 Interprets blueprints, drawings and specifications 3.02 Uses documentation and reference material 3.03 Plans job tasks and procedures
Communication 4.01 Uses communication techniques			**Communication and Mentoring** 4.01 Uses communication techniques 4.02 Uses mentoring techniques
Work Site Preparation 5.01 Prepares work site 5.02 Handles materials and supplies			
Trade Activities 6.01 Performs brazing and soldering 6.02 Performs leak and pressure tests on system 6.03 Evacuates systems 6.04 Uses refrigerants, gases and oils 6.05 Performs field wiring of systems 6.06 Applies sealants and adhesives	**Trade Activities** 6.04 Uses refrigerants, gases and oils 6.05 Performs field wiring of systems		
Basic HVAC/R Systems (Plans Installation) 7.03 Determines placement of HVAC/R equipment, components and accessories	**HVAC/R Systems (Plans Installation)** 7.02 Selects HVAC/R equipment, components and accessories 7.03 Determines placement of HVAC/R equipment, components and accessories 7.04 Performs HVAC/R material take-off	**HVAC/R Systems (Plans Installation)** 7.01 Verifies HVAC/R system parameters and requirements 7.02 Selects HVAC/R equipment, components and accessories 7.03 Determines placement of HVAC/R equipment, components and accessories 7.04 Performs HVAC/R material take-off	**HVAC/R Systems (Plans Installation)** 7.01 Verifies HVAC/R system parameters and requirements 7.02 Selects HVAC/R equipment, components and accessories 7.03 Determines placement of HVAC/R equipment, components and accessories 7.04 Performs HVAC/R material take-off

Basic Control Systems (Plans Installation) 8.03 Determines placement of control system components and accessories	**Control Systems (Plans Installation)** 8.02 Selects control system components and accessories 8.03 Determines placement of control system components and accessories 8.04 Performs control system material take-off	**Control Systems (Plans Installation)** 8.01 Verifies control system parameters and requirements 8.02 Selects control system components and accessories 8.03 Determines placement of control system components and accessories 8.04 Performs control system material take-off	**Control Systems (Plans Installation)** 8.01 Verifies control system parameters and requirements 8.02 Selects control system components and accessories 8.03 Determines placement of control system components and accessories 8.04 Performs control system material take-off
Basic HVAC/R Systems (Installation) 9.03 Places HVAC/R equipment, components and accessories 9.04 Installs fasteners, brackets and hangers 9.05 Installs HVAC/R piping and tubing 9.06 Applies HVAC/R holding charge	**HVAC/R Systems (Installs)** 9.02 Assembles HVAC/R equipment, components and accessories 9.03 Places HVAC/R equipment, components and accessories	**HVAC/R Systems (Installs)** 9.01 Confirms system layout 9.02 Assembles HVAC/R equipment, components and accessories 9.03 Places HVAC/R equipment, components and accessories	
Basic Control Systems (Installation) 10.01 Places control system components 10.02 Connects control systems	**Control Systems (Installs)** 10.01 Places control system components 10.02 Connects control systems	**Control Systems (Installs)** 10.01Places control system components 10.02 Connects control systems	
		HVAC/R Systems (Commissions) 11.01 Performs pre-start-up checks for HVAC/R systems 11.02 Performs start-up of HVAC/R systems 11.03 Completes HVAC/R system charge 11.04 Sets up primary and secondary HVAC/R system components	**HVAC/R Systems (Commissions)** 11.01 Performs pre-start-up checks for HVAC/R systems 11.02 Performs start-up of HVAC/R systems 11.03 Completes HVAC/R system charge 11.04 Sets up primary and secondary HVAC/R system components
		Control Systems (Commissions) 12.01 Performs start-up checks for control systems 12.02 Verifies/sets operating parameters	**Control Systems (Commissions)** 12.01 Performs start-up checks for control systems 12.02 Verifies/sets operating parameters
HVAC/R Systems (Basic Maintenance) 13.01 Inspects HVAC/R systems 13.02 Performs predictive and scheduled maintenance on HVAC/R systems 13.03 Tests HVAC/R system components and accessories	**HVAC/R Systems (Maintain)** 13.01 Inspects HVAC/R systems 13.02 Performs predictive and scheduled maintenance on HVAC/R systems 13.03 Tests HVAC/R system components and accessories		
	HVAC/R Systems (Basic Service) 14.01 Troubleshoots HVAC/R systems 14.02 Repairs HVAC/R systems	**HVAC/R Systems (Service)** 14.01 Troubleshoots HVAC/R systems 14.02 Repairs HVAC/R systems	**HVAC/R Systems (Service)** 14.01 Troubleshoots HVAC/R systems 14.02 Repairs HVAC/R systems

Control Systems (Basic Maintenance and Service)	Control Systems (Maintain and Service)	Control Systems (Maintain and Service)
15.01 Performs maintenance and inspection on control systems 15.02 Troubleshoots control systems 15.03 Calibrates operating and safety controls 15.04 Repairs control systems	15.01 Performs maintenance and inspection on control systems 15.02 Troubleshoots control systems 15.03 Calibrates operating and safety controls 15.04 Repairs control systems	15.01 Performs maintenance and inspection on control systems 15.02 Troubleshoots control systems 15.03 Calibrates operating and safety controls 15.04 Repairs control systems

MAJOR WORK ACTIVITY A

Performs common occupational skills

TASK A-1 Performs safety-related functions

TASK DESCRIPTOR

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

A-1.01 Maintains safe work environment

Essential Skills	Reading, Working with Others, Document Use

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

RANGE OF VARIABLES

hazards include: high 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

WHMIS and TDG procedures include: disposal, labelling, handling, using personal protective equipment (PPE)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.01.01L	demonstrate knowledge of maintaining a safe work environment	identify workplace ***hazards***
		describe procedures used to maintain a safe work environment
		describe procedures used to handle, store, transport and dispose of hazardous materials
		describe procedures used to remediate the potential dangers related to workplace ***hazards***
A-1.01.02L	demonstrate knowledge of codes and ***regulations*** pertaining to a safe work environment	interpret codes and ***regulations*** pertaining to workplace ***hazards*** and safe work practices

RANGE OF VARIABLES

hazards include: high 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

regulations include: Occupational Health and Safety (OH&S), jurisdictional, TDG, WHMIS

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

Essential Skills	Document Use, Thinking, Writing

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-1.02.01P	notify building authorities of maintenance and repairs and obtain required permits	building authorities are notified of maintenance and repairs prior to and after completion and required permits are obtained
A-1.02.02P	identify ***hazards*** associated with ***equipment*** and ***components***	***hazards*** have been identified by running through a checklist depending on residential or industrial type of site
A-1.02.03P	isolate ***equipment*** and ***components*** and establish a zero energy state	***equipment*** and ***components*** are isolated by implementing the isolating devices and a zero energy state is established and confirmed according to company and client policies
A-1.02.04P	apply ***locking device*** to secure isolation	***locking device*** is applied to secure isolation and to prevent accidental start-up according to company and client policies
A-1.02.05P	record lock-out information on tag attached to ***locking devices***	lock-out information is recorded on tag attached to ***locking devices*** according to company and client policies
A-1.02.06P	verify isolation of ***equipment***	isolation of ***equipment*** is verified to ensure that the equipment can be worked on safely according to company and client policies
A-1.02.07P	remove tags and locks from ***equipment*** after completion of repair	tags and locks are removed from ***equipment*** after completion of repair according to company and client policies

RANGE OF VARIABLES

hazards include: pressure, voltage, thermal, fluids, toxicity, corrosiveness, oxygen displacement/deprivation, asphyxiation, gravity, environmental, rotating devices, pinch hazards, trip hazards

equipment includes: capacitor, rotating fans, rotating wheels, motors, conveyor belts, hydraulics, pneumatics, pressurized tanks, heat exchangers, thermal equipment

components include: disconnect switches, isolation valves, locking clasps, motors, rotating devices, blocking and restraint devices

locking devices include: locks, blocks, chains, hasps, plugs, caps, blank-off plates

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.02.01L	demonstrate knowledge of procedures used to lock-out, tag-out and isolate ***equipment***	describe procedures used to lock-out, tag-out and isolate ***equipment*** and confirm zero energy
		determine when a lock-out procedure is required
		identify energy sources to be locked out
		identify the potential of stored energy

RANGE OF VARIABLES

equipment includes: capacitor, rotating fans, rotating wheels, motors, conveyor belts, hydraulics, pneumatics, pressurized tanks, heat exchangers, thermal equipment

A-1.03 Uses personal protective equipment (PPE) and safety equipment

Essential Skills	Document Use, Writing, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-1.03.01P	select, wear and ensure proper fit of ***PPE***	***PPE*** is selected, worn and fitted according to task, site and company policies, manufacturers' specifications and jurisdictional regulations
A-1.03.02P	inspect and identify expired, ***defective and damaged PPE***	***defective and damaged PPE*** is inspected, identified, removed from service, repaired or replaced and recertified according to company policies and jurisdictional regulations
A-1.03.03P	locate and use ***safety equipment***	***safety equipment*** is located and used according to job requirements, risk assessments, manufacturers' specifications and jurisdictional regulations
A-1.03.04P	clean and store ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are cleaned and stored according to manufacturers' recommendations
A-1.03.05P	inspect and recommend recertification of ***safety equipment***	***safety equipment*** is inspected and recertification is recommended if required, and according to jurisdictional regulations

RANGE OF VARIABLES

PPE includes: hard hats, safety glasses, respirators, boots, gloves, safety vests, harnesses, lanyards

defective and damaged PPE includes: excessively worn boots, cracked safety glasses, expired safety equipment

safety equipment includes: fire extinguishers, eye wash stations, first aid kits, spill kits

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.03.01L	demonstrate knowledge of ***PPE*** and ***safety equipment***, their applications, maintenance and procedures for use	define terminology associated with ***PPE*** and ***safety equipment***
		identify types of ***PPE*** and ***safety equipment***, their applications and procedures for use
		describe the procedures used to maintain and store ***PPE*** and ***safety equipment***
A-1.03.02L	demonstrate knowledge of standards and regulations pertaining to ***PPE*** and ***safety equipment***	identify standards and regulations pertaining to ***PPE*** and ***safety equipment***

RANGE OF VARIABLES

PPE includes: hard hats, safety glasses, respirators, boots, gloves, safety vests, harnesses, lanyards

safety equipment includes: fire extinguishers, eye wash stations, first aid kits, spill kits

TASK A-2 Uses tools and equipment

TASK DESCRIPTOR

Refrigeration and air conditioning mechanics use and maintain tools and equipment to allow them to perform the tasks of their trade safely and efficiently. Use of tools and equipment includes activities such as inspecting, lubricating, storing and performing minor repairs. Certification may be required in some jurisdictions to use equipment.

A-2.01 Uses hand tools

Essential Skills	Thinking, Working with Others, Reading

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.01.01P	select ***hand tools***	***hand tools are*** selected according to job requirements
A-2.01.02P	inspect ***hand tools*** for ***damage***	***hand tools*** are inspected for ***damage***
A-2.01.03P	***maintain hand tools***	***hand tools*** are ***maintained*** to ensure proper operation
A-2.01.04P	clean ***hand tools*** after use	***hand tools*** are cleaned and debris is removed after use to ensure they are clean and rust-free
A-2.01.05P	replace ***hand tool parts***	***hand tool parts*** are replaced if required
A-2.01.06P	tag and remove defective ***hand tools*** from service	defective ***hand tools*** are tagged and removed from service according to job requirements
A-2.01.07P	store ***hand tools*** in a clean and dry location	***hand tools*** are stored in a clean and dry location to ensure they are in operating condition

RANGE OF VARIABLES

hand tools include: flaring tools, pipe cutters, benders, wrenches, screwdrivers
damage includes: dull blades and wheels, cracks
maintain includes: lubricate, sharpen, tighten, drain
hand tool parts include: cutting blades, hacksaw blades

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.01.01L	demonstrate knowledge of ***hand tools***, their applications, maintenance and procedures for use	define terminology associated with ***hand tools***
		identify hazards and describe safe work practices pertaining to the use of ***hand tools***
		identify types of ***hand tools*** and describe their applications and procedures for use
		describe the procedures used to , store and ***maintain hand tools***

RANGE OF VARIABLES

hand tools include: flaring tools, pipe cutters, benders, wrenches, screwdrivers
maintain includes: lubricate, sharpen, tighten, drain

A-2.02 Uses portable and stationary power tools

Essential Skills	Thinking, Working with Others, Reading

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.02.01P	check batteries, chargers and fuel levels	batteries, chargers and fuel levels are checked to ensure they are in good condition, and batteries are fully charged
A-2.02.02P	inspect power tools for ***unsafe conditions***	power tools are inspected and ***unsafe conditions*** are identified
A-2.02.03P	inspect ***power tool parts***	***power tool parts*** are inspected to identify defects, faults and wear
A-2.02.04P	***maintain*** power tools	power tools are ***maintained*** to ensure they are ready for use
A-2.02.05P	replace ***power tool components***	***power tool components*** are replaced if required
A-2.02.06P	store power tools in a clean and dry location	power tools are stored in a clean and dry location to ensure they are in operating condition
A-2.02.07P	tag and remove defective power tools from service	defective power tools are tagged and removed from service according to manufacturers' recommendations and company policies

RANGE OF VARIABLES

unsafe conditions include: missing parts, defective or missing guards, unsafe power cords
power tool parts include: cutting blades, bits, dies, drill chucks
maintain includes: lubricate, sharpen, tighten, drain
power tool components include: drill bits, electric motor brushes, cutting discs

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.02.01L	demonstrate knowledge of portable and stationary power tools, their applications, maintenance and procedures for use	define terminology associated with portable and stationary power tools
		identify hazards and describe safe work practices pertaining to the use of portable and stationary power tools
		identify ***types of portable and stationary power tools*** and describe their applications and procedures for use
		describe the procedures used to , store and ***maintain*** portable and stationary power tools

RANGE OF VARIABLES

types of portable and stationary power tools include: pneumatic, electric, hydraulic, gas, generators
maintain includes: lubricate, sharpen, tighten, drain

A-2.03 Uses brazing and soldering equipment

Essential Skills	Thinking, Reading, Document Use

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.03.01P	inspect hoses	hoses are inspected for ***defects***
A-2.03.02P	inspect regulators and check valves	regulators are inspected and valves are checked for ***problems***
A-2.03.03P	inspect torch tips and O-rings	torch tips and O-rings are inspected and cleaned or replaced if required
A-2.03.04P	check cylinder capacity	cylinder capacity is checked to ensure adequate gas pressure according to job requirements
A-2.03.05P	inspect cylinders for thread and valve damage	cylinders are inspected for thread and valve damage to prevent leakage and fire
A-2.03.06P	verify certification of cylinders	certification of cylinders is verified according to Transport Canada

A-2.03.07P	store cylinders in a secure, upright position, within rated temperatures	cylinders are stored in a secure, upright and vented position, within rated temperatures, and according to WHMIS procedures, OH&S and TDG
A-2.03.08P	tag and remove defective brazing and soldering equipment from service	defective brazing and soldering equipment is tagged and removed from service

RANGE OF VARIABLES

defects include: cracks, loose connections, damage
problems include: damaged gauges and diaphragms, leakage

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.03.01L	demonstrate knowledge of brazing and soldering equipment, their applications, maintenance and procedures for use	define terminology associated with brazing and soldering equipment
		identify hazards and describe safe work practices pertaining to the use of brazing and soldering equipment
		identify types of brazing and soldering equipment and describe their applications and procedures for use
		describe the procedures used to , store and maintain brazing and soldering equipment

A-2.04 Uses recovery and recycling tools and equipment

Essential Skills	Reading, Writing, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.04.01P	inspect ***tools and equipment*** for damage	***tools and equipment*** are inspected for damage from transport and use
A-2.04.02P	clean and test ***tools and equipment***	***tools and equipment*** are cleaned and tested
A-2.04.03P	check, clean or replace screens and filters	screens and filters are checked, cleaned or replaced to prevent blockage and ensure filtration of the refrigerant

A-2.04.04P	store refrigerant cylinders in a secure and upright position within rated temperatures	refrigerant cylinders are stored in a secure and upright position within rated temperatures, and according to WHMIS procedures, OH&S, TDG and ozone depletion substance
A-2.04.05P	verify certification of cylinders	certification of cylinders is verified according to jurisdictional regulations
A-2.04.06P	connect recovery ***tools and equipment*** to system	recovery ***tools and equipment*** are connected to system according to manufacturers' instructions
A-2.04.07P	recover refrigerant from system	refrigerant is recovered from the system according to manufacturers' instructions, tank specifications and jurisdictional regulations
A-2.04.08P	label recovered refrigerants and their state of condition	recovered refrigerants and their state of condition are labelled according to jurisdictional regulations
A-2.04.09P	tag and remove defective recovery and recycling ***tools and equipment*** from service	defective recovery and recycling ***tools and equipment*** are tagged and removed from service according to company policies

RANGE OF VARIABLES

tools and equipment include: recovery units, hoses, cylinders, gauges, scales, filter driers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.04.01L	demonstrate knowledge of recovery and recycling ***tools and equipment***, their applications, maintenance and procedures for use	define terminology associated with recovery and recycling ***tools and equipment***
		identify hazards and describe safe work practices pertaining to the use of recovery and recycling ***tools and equipment***
		identify types of recovery and recycling ***tools and equipment*** and describe their applications and procedures for use
		identify the method of recovery
		identify the capacity of recovery systems
		describe the procedures used to , store and maintain recovery and recycling ***tools and equipment***

RANGE OF VARIABLES

tools and equipment include: recovery units, hoses, cylinders, gauges, scales, filter driers

A-2.05 Uses evacuation tools and equipment

Essential Skills	Thinking, Reading, Digital Technology

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.05.01P	change oil on vacuum pumps	oil on vacuum pumps is changed to ensure operation of pump according to manufacturers' instructions
A-2.05.02P	clean and flush vacuum pumps	vacuum pumps are cleaned and flushed regularly according to manufacturers' recommendations
A-2.05.03P	store equipment in a secure position	equipment is stored in a secure position to prevent oil spillage
A-2.05.04P	maintain adequate oil level	adequate oil level is maintained to enable evacuation
A-2.05.05P	inspect and replace ***components***	***components*** are inspected and replaced if required
A-2.05.06P	test vacuum pumps using ***tools***	vacuum pumps are tested using ***tools*** to ensure operation according to manufacturers' instructions
A-2.05.07P	tag and remove defective evacuation tools and equipment from service	defective evacuation tools and equipment are tagged and removed from service

RANGE OF VARIABLES

components include: gauges, O-rings, seals, gas ballast valve, hoses
tools include: vacuum gauges, micron gauges, vacuum pumps, cold traps

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.05.01L	demonstrate knowledge of evacuation tools and equipment, their applications, maintenance and procedures for use	define terminology associated with evacuation tools and equipment
		identify hazards and describe safe work practices pertaining to the use of evacuation tools and equipment
		identify types of evacuation tools and equipment and describe their applications and procedures for use
		describe the procedures used to store and maintain evacuation tools and equipment

A-2.06 Uses charging tools and equipment

Essential Skills	Thinking, Reading, Writing

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.06.01P	inspect ***charging tools and equipment*** for ***damage***	***charging tools and equipment*** are inspected for ***damage***
A-2.06.02P	calibrate scales and gauges	scales and gauges are calibrated by adjusting zero point to ensure accurate measurements
A-2.06.03P	clean, isolate and store tools and equipment	tools and equipment are cleaned, isolated and stored according to company policies
A-2.06.04P	tag and remove defective ***charging tools and equipment*** from service	defective ***charging tools and equipment*** are tagged and removed from service according to company policies
A-2.06.05P	connect equipment to system	equipment is connected to system according to job requirements, manufacturers' instructions and industry trade practices

RANGE OF VARIABLES

charging tools and equipment include: scales, cylinders, manifold gauges, hoses, core removal tool, meters, valve core depressor

damage includes: frayed cords, cracked hoses, broken sight glasses, damaged O-rings

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.06.01L	demonstrate knowledge of ***charging tools and equipment***, their applications, maintenance and procedures for use	define terminology associated with ***charging tools and equipment***
		identify hazards and describe safe work practices pertaining to the use of ***charging tools and equipment***
		identify types of ***charging tools and equipment*** and describe their applications and procedures for use
		describe the procedures used to , store and maintain ***charging tools and equipment***

RANGE OF VARIABLES

charging tools and equipment include: scales, cylinders, manifold gauges, hoses, core removal tool, meters, valve core depressor

A-2.07 Uses diagnostic and measuring tools and equipment

Essential Skills	Reading, Numeracy, Document Use

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.07.01P	charge or change batteries	batteries are charged or changed to ensure ***tools and equipment*** are ready for use
A-2.07.02P	inspect leads, probes and sensors for damage and wear and verify ratings	leads, probes and sensors are inspected for damage and wear and replaced as necessary and ratings are verified according to job requirements and manufacturer's specifications
A-2.07.03P	verify calibration of ***tools and equipment***	calibration of ***tools and equipment*** is verified according to manufacturers' specifications
A-2.07.04P	interpret the data, readings and results obtained	data, readings and results are interpreted according to established parameters
A-2.07.05P	store ***tools and equipment*** in a dry, secure location	***tools and equipment*** are stored in a dry, secure location according to manufacturers' recommendations
A-2.07.06P	tag and remove defective diagnostic and measuring ***tools and equipment*** from service	defective diagnostic and measuring ***tools and equipment*** are tagged and removed from service according to company policies

RANGE OF VARIABLES

tools and equipment include: thermometers, scales, leak detectors, meters, calipers, micrometers, gauge manifolds, manometers, hygrometers, hydrometers, refractometer, decibel meters

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.07.01L	demonstrate knowledge of diagnostic and measuring ***tools and equipment***, their applications, maintenance and procedures for use	define terminology associated with diagnostic and measuring ***tools and equipment***
		identify hazards and describe safe work practices pertaining to the use of diagnostic and measuring ***tools and equipment***

	identify types of diagnostic and measuring ***tools and equipment*** and describe their applications and procedures for use
	describe the procedures used to , store and maintain diagnostic and measuring ***tools and equipment***

RANGE OF VARIABLES

tools and equipment include: thermometers, scales, leak detectors, meters, calipers, micrometers, gauge manifolds, manometers, hygrometers, hydrometers, refractometer, decibel meters

A-2.08 Uses access equipment

Essential Skills	Thinking, Working with Others, Reading

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.08.01P	select ladders and work platforms	ladders and work platforms are selected according to site conditions and task being performed
A-2.08.02P	inspect ladders and scaffolding	ladders and scaffolding are inspected for damage and missing components according to jurisdictional regulations
A-2.08.03P	identify ***hazards*** when erecting ladders and scaffolding	***hazards*** are identified when erecting ladders and scaffolding according to jurisdictional regulations
A-2.08.04P	erect, secure, level and dismantle ***access equipment***	***access equipment*** is erected, secured, levelled and dismantled according to jurisdictional regulations and company policies
A-2.08.05P	use equipment within operating limitations	equipment is used within operating limitations according to jurisdictional regulations, manufacturers' instructions and certification requirements
A-2.08.06P	tag and remove defective ***access equipment*** from service	defective ***access equipment*** is tagged and removed from service

RANGE OF VARIABLES

hazards include: power lines, excess loads, equipment damage, uneven ground, weather, slippery surfaces

access equipment includes: ladders, scaffolding, lifts, staging

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.08.01L	demonstrate knowledge of ***access equipment***, their applications, maintenance and procedures for use	define terminology associated with ***access equipment***
		identify types of ***access equipment*** and describe their applications, limitations and procedures for use
		identify hazards and describe safe work practices pertaining to the use of ***access equipment***
		interpret information pertaining to using ***access equipment*** found on drawings and specifications
		identify ***factors*** to consider when selecting ***access equipment***
		describe the procedures used to inspect, store and maintain ***access equipment***
A-2.08.02L	demonstrate knowledge of regulations pertaining to ***access equipment***	interpret codes and regulations pertaining to using ***access equipment***

RANGE OF VARIABLES

access equipment includes: ladders, scaffolding, lifts, staging
factors include: safety, load characteristics, environment, application

A-2.09 Uses rigging, hoisting and lifting equipment

Essential Skills	Oral Communication, Document Use, Working with Others

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.09.01P	select and use ***equipment***	***equipment*** is selected and used according to task and ***factors***
A-2.09.02P	inspect ***equipment*** for wear, damage, defects and certification date	***equipment*** is inspected for wear, damage, defects and certification date and replaced if required
A-2.09.03P	identify ***hazards***	***hazards*** are identified according to hazard risk assessment
A-2.09.04P	verify load size and parameters	load size and parameters are verified according to job and manufacturers' specifications
A-2.09.05P	guide and position loads	loads are guided and positioned using tag lines

A-2.09.06P	rig loads	loads are rigged according to rigging procedures, manufacturers' specifications and jurisdictional regulations to ensure safety
A-2.09.07P	communicate with equipment operators	equipment operators are communicated with using approved ***communication methods***
A-2.09.08P	store ***equipment***	***equipment*** is stored in clean and dry locations according to manufacturers' recommendations
A-2.09.09P	tag and remove defective ***equipment*** from service	defective ***equipment*** is tagged and removed from service according to company policies and jurisdictional regulations

RANGE OF VARIABLES

equipment includes: slings, come-alongs/chain falls, shackles, jacks, hoists, belts, ropes, cables, spreader bars, pry bars

factors include: weight, distance to be travelled, size, obstacles

hazards include: power lines, excavations, excessive loads, weather

communication methods include: standard crane and hoist hand signals, two-way radios, video, radio, mobile phones

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.09.01L	demonstrate knowledge of rigging, hoisting and lifting ***equipment***, their applications, maintenance and procedures for use	define terminology associated with rigging, hoisting and lifting ***equipment***
		identify types of rigging, hoisting and lifting ***equipment*** and describe their applications, limitations and procedures for use
		identify hazards and describe safe work practices pertaining to the use of rigging, hoisting and lifting ***equipment***
		interpret information pertaining to using rigging, hoisting and lifting ***equipment*** found on drawings and specifications
		identify ***factors to consider when selecting rigging, hoisting and lifting equipment***
		identify ***factors to consider when rigging a load*** (material and/or equipment) for hoisting and lifting
		describe procedures used to rig and secure a load (material and/or equipment) for lifting and hoisting

		describe procedures used to inspect, store and maintain rigging, hoisting and lifting ***equipment***
		describe the procedures used to perform a lift
		identify types of knots, hitches and bends, and describe their applications and associated procedures
A-2.09.02L	demonstrate knowledge of regulations pertaining to rigging, hoisting and lifting ***equipment***	interpret codes and regulations pertaining to using rigging, hoisting and lifting ***equipment***
A-2.09.03L	demonstrate knowledge of ***communication methods***	identify and interpret ***communication methods*** used during hoisting, lifting, rigging, and describe their associated procedures

RANGE OF VARIABLES

equipment includes: slings, come-alongs/chain falls, shackles, jacks, hoists, belts, ropes, cables, spreader bars, pry bars

factors to consider when selecting rigging, hoisting and lifting equipment include: safety, load characteristics, environment, application

factors to consider when rigging a load include: load characteristics, equipment and accessories, environment, anchor points/attachment locations, sling angles, machine capacity/load chart

communication methods include: standard crane and hoist hand signals, two-way radios, video, radio, mobile phones

A-2.10 Uses digital technology

Essential Skills	Continuous Learning, Digital Technology, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.10.01P	identify and apply hardware and software requirements to connect to the control system	hardware and software requirements necessary to achieve connection are applied according to manufacturers' specifications
A-2.10.02P	connect ***electronic devices*** to control systems	***electronic devices*** are connected to control systems according to manufacturers' specifications
A-2.10.03P	use ***electronic devices*** to configure parameters	***electronic devices*** are used to configure parameters to set up operation of system
A-2.10.04P	monitor and diagnose problems and retrieve data	problems are monitored and diagnosed using on-board and remote functions, and data is retrieved
A-2.10.05P	back up program files	program files are backed up for easy retrieval

RANGE OF VARIABLES

electronic devices include: computers, laptops, smart phones, user interface modules, tablets

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.10.01L	demonstrate knowledge of ***digital technology***, their applications, maintenance and procedures for use	identify types of ***digital technology*** used to set up operation of systems
		describe procedures used to set up operation of systems
		describe procedures used to diagnose problems

RANGE OF VARIABLES

digital technology includes: direct digital control, programmable logic controller (PLC), micro processor, communication protocols, software

TASK A-3 Organizes work

TASK DESCRIPTOR

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

A-3.01 Interprets drawings and specifications

Essential Skills	Document Use, Reading, Numeracy

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-3.01.01P	determine ***equipment specifications***	***equipment specifications*** are determined according to manufacturers' specifications and ***drawings***
A-3.01.02P	determine equipment required	equipment required is determined according to design specifications
A-3.01.03P	identify electrical, mechanical and communication equipment	electrical, mechanical and communication equipment is identified according to specifications and ***drawings***

A-3.01.04P	scale ***drawings***	***drawings*** are scaled for placement of equipment and accessories, coring of holes and location of utilities
A-3.01.05P	interpret ***drawings,*** schematic and pictorial diagrams	***drawings*** schematic and pictorial diagrams are interpreted to provide information on electrical equipment, piping components and air distribution systems

RANGE OF VARIABLES

equipment specifications include: weight, size, service access locations
drawings include: isometric, elevation, plan views, shop drawings, sketches

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.01.01L	demonstrate knowledge of ***drawings*** and specifications and their applications	define terminology associated with ***drawings*** and specifications
		identify types of ***specification documents*** and describe their applications
		identify types of ***drawings*** and describe their applications
		identify ***views used on drawings***
		identify ***information found on drawings***
		explain the use of ***drawings*** and measurement scales
		describe the procedures used to convert between metric and imperial units of measurement
		describe the procedures used to interpret and extract information from ***drawings*** and specifications

RANGE OF VARIABLES

drawings include: isometric, elevation, plan views, shop drawings, sketches
specification documents include: manufacturers', engineers', contractors', clients'
views used on drawings include: elevation, plan, section, detail, 3-D
information found on drawings includes: lines, legend, symbols and abbreviations, title block, notes and specifications, schedules, units of measurement (metric/imperial), seismic

A-3.02 Uses documentation and reference material

Essential Skills	Document Use, Digital Technology, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-3.02.01P	determine installation procedures and requirements	installation procedures and requirements are determined according to manufacturers' specifications
A-3.02.02P	determine pipe and duct sizes, pressure/temperature (P/T) relationships and pressure/enthalpy relationships	pipe and duct sizes, P/T relationships and pressure/enthalpy relationships are determined according to tables and charts
A-3.02.03P	verify detailed equipment information	detailed equipment information is verified by referring to technical bulletins and manuals
A-3.02.04P	verify warranties	warranties are verified in order to assist in submitting required documentation
A-3.02.05P	submit ***information*** in order to activate and claim warranties	***information*** is submitted in order to activate and claim warranties
A-3.02.06P	select and order parts and equipment	parts and equipment are selected and ordered by referring to ***documentation***
A-3.02.07P	maintain ***log sheets***	***log sheets*** are maintained according to jurisdictional regulations, and client and company policies
A-3.02.08P	complete ***written documents***	***written documents*** are completed according to jurisdictional regulations, and client and company policies

RANGE OF VARIABLES

information includes: start-up, claim sheets, maintenance sheets

documentation includes: manufacturers' specifications, manufacturers' and wholesaler catalogues, drawings, employer-specific forms and reports, material take-offs

log sheets include: refrigerant, repairs, maintenance, equipment, operating

written documents include: work reports, work orders, incident reports, permits, time sheets, estimates

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.02.01L	demonstrate knowledge of ***documentation*** and reference material, its purpose, application and use	identify types and sources of ***documentation*** and reference material, and describe their applications
		describe the procedures used to access, interpret and apply information found in ***documentation*** and reference material
A-3.02.02L	demonstrate knowledge of the procedures used to complete and interpret ***documentation***	describe the procedures used to complete ***documentation***

RANGE OF VARIABLES

documentation includes: manufacturers' specifications, manufacturers' and wholesaler catalogues, drawings, employer-specific forms and reports, material take-offs

A-3.03 Plans job tasks and procedures

Essential Skills	Document Use, Thinking, Working with Others

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-3.03.01P	prepare material list, confirm availability and order materials	material list is prepared, availability is confirmed and materials are ordered according to task
A-3.03.02P	apply for and obtain permits	permits are obtained according to jurisdictional regulations
A-3.03.03P	schedule delivery of equipment and materials	delivery of equipment and materials is scheduled
A-3.03.04P	arrange for storage of materials in a safe and secure location	storage of materials in a safe and secure location is arranged according to site conditions, manufacturers' specifications and company policies
A-3.03.05P	arrange time to access work site	time to access work site is arranged according to client requirements and to avoid downtime and delays
A-3.03.06P	schedule tasks with ***other trades, sectors and professionals***	tasks with ***other trades, sectors and professionals*** are scheduled
A-3.03.07P	select and assign personnel	personnel is selected and assigned according to specific tasks, equipment and certifications

A-3.03.08P	arrange for use of ***major tools and equipment***	use of ***major tools and equipment*** is arranged
A-3.03.09P	organize tools and equipment for availability	tools and equipment are available where and when needed

RANGE OF VARIABLES

other trades, sectors and professionals include: gasfitters, sheet metal workers, plumbers, electricians, roofers, cutting and coring workers, well drillers, steamfitters/pipefitters, excavators, utilities, sprinkler fitters, engineers

major tools and equipment include: cranes, threaders, personnel lifts, press fits

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.03.01L	demonstrate knowledge of planning job tasks and procedures	define terminology associated with job tasks and procedures
		identify ***sources of information*** relevant to job planning and execution
		identify information gathering and communication techniques, and describe their associated procedures
		describe the procedures used to coordinate job tasks and procedures
		describe the procedures used to estimate work requirements

RANGE OF VARIABLES

sources of information include: work permits as applicable (hot, enclosed vessel), drawings, specifications, manufacturers' literature, code books, company policy manual for job requirements, Safety Data Sheets (SDS) sheets, asbestos/lead/workplace hazards assessment report, on-site log book(s)

TASK A-4 Uses communication and mentoring techniques

TASK DESCRIPTOR

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.

A-4.01 Uses communication techniques

Essential Skills	Oral Communication, Working with Others, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-4.01.01P	demonstrate communication practices with ***people in the workplace***	instructions and messages are understood by all parties involved in communication
A-4.01.02P	listen using ***active listening*** practices	steps of ***active listening*** are used
A-4.01.03P	receive and respond to feedback on work	response to feedback indicates understanding and corrective measures are taken
A-4.01.04P	explain and provide feedback	explanation and feedback is provided and task is carried out as directed
A-4.01.05P	use questioning to improve communication	questions enhance understanding, on-the-job training and goal setting
A-4.01.06P	participate in safety and information meetings	meetings are attended, information is relayed to the workforce, and is understood and applied
A-4.01.07P	coordinate communication with other trades during layout and installation of HVAC/R systems	communication between trades is coordinated during layout and installation of HVAC/R systems to avoid interference with other trades

RANGE OF VARIABLES

people in the workplace include: other tradespeople, colleagues, apprentices, supervisors, clients, authorities having jurisdiction (AHJ), manufacturers

active listening includes: hearing, interpreting, reflecting, responding, paraphrasing

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-4.01.01L	demonstrate knowledge of trade terminology	define terminology used in the trade
A-4.01.02L	demonstrate knowledge of effective communication practices	describe the importance of using effective verbal and non-verbal communication with ***people in the workplace***
		identify ***sources of information*** to effectively communicate
		identify communication and ***learning styles***
		describe effective listening and speaking skills
		identify ***personal responsibilities and attitudes*** that contribute to on-the-job success
		identify the value of diversity in the workplace
		identify communication that constitutes ***harassment*** and ***discrimination***

RANGE OF VARIABLES

people in the workplace include: other tradespeople, colleagues, apprentices, supervisors, clients, AHJ, manufacturers

sources of information include: regulations, codes, occupational health and safety requirements, AHJ requirements, prints, drawings, specifications, company and client documentation

learning styles include: seeing it, hearing it, trying it

personal responsibilities and attitudes include: asking questions, working safely, accepting constructive feedback, time management and punctuality, respect for authority, good stewardship of materials, tools and property, efficient work practice

harassment includes: 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

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-4.02 Uses mentoring techniques

Essential Skills	Working with Others, Oral Communication, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-4.02.01P	identify and communicate learning objective and point of lesson	apprentice or learner can explain the objective and point of the lesson
A-4.02.02P	link lesson to other lessons and the job	lesson order and unplanned learning opportunities are defined
A-4.02.03P	demonstrate performance of a skill to an apprentice or learner	***steps required to demonstrate a skill*** are performed
A-4.02.04P	set up conditions required for an apprentice or learner to practice a skill	***practice conditions*** are set up so that the skill can be practiced safely by the apprentice or learner
A-4.02.05P	assess apprentice or learner's ability to perform tasks with increasing independence	performance of apprentice or learner improves with practice to a point where skill can be done with little supervision
A-4.02.06P	give supportive and corrective feedback	apprentice or learner adopts best practice after having been given supportive or corrective feedback
A-4.02.07P	support apprentices in pursuing technical training opportunities	technical training is completed within timeframe prescribed by apprenticeship authority
A-4.02.08P	support equity group apprentices or learners	workplace is harassment and discrimination-free
A-4.02.09P	assess employee suitability to the trade during probationary period	apprentice or learner is given feedback that helps them identify their own strengths and weaknesses and suitability for the trade

RANGE OF VARIABLES

steps required to demonstrate a skill include: understanding the who, what, where, when, why, and how, explaining, showing, giving encouragement, following up to ensure skill is performed correctly

practice conditions means: guided, limited independence, full independence

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-4.02.01L	demonstrate knowledge of strategies for learning skills in the workplace	describe the importance of individual experience
		describe the shared responsibilities for workplace learning
		determine one's own learning preferences and explain how these relate to learning new skills

		describe the importance of different types of skills in the workplace
		describe the importance of ***essential skills*** in the workplace
		identify different ***learning styles***
		identify different ***learning needs*** and strategies to meet ***learning needs***
		identify ***strategies to assist in learning a skill***
A-4.02.02L	demonstrate knowledge of strategies for teaching workplace skills	identify different roles played by a workplace mentor
		describe ***teaching skills***
		explain the importance of identifying the point of a lesson
		identify how to choose a good time to present a lesson
		explain the importance of linking the lessons
		identify the components of the skill (the context)
		describe considerations in setting up opportunities for skill practice
		explain the importance of providing feedback
		identify techniques for giving effective feedback
		describe a skills assessment
		identify methods of assessing progress
		explain how to adjust a lesson to different situations

RANGE OF VARIABLES

essential skills are: reading, writing, document use, oral communication, numeracy, thinking, working with others, digital technology, continuous learning

learning styles include: seeing it, hearing it, trying it

learning needs include: learning disabilities, learning preferences, language proficiency

strategies to assist in learning a skill include: understanding the principles of instruction, developing coaching skills, being mature and patient, providing feedback

teaching skills include: identifying the point of the lesson, linking the lesson, demonstrating the skill, providing practice, giving feedback, assessing skills and progress

MAJOR WORK ACTIVITY B

Performs routine trade activities

TASK B-5 Performs work site preparation

TASK DESCRIPTOR

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.

B-5.01 Prepares work site

Essential Skills	Document Use, Thinking, Oral Communication

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-5.01.01P	identify area for storage of tools, equipment and supplies	area for storage of tools, equipment and supplies is identified according to site condition and job location
B-5.01.02P	locate safety equipment, muster sites and emergency exits	safety equipment, muster sites and emergency exits are located
B-5.01.03P	identify on-site ***hazards***	on-site ***hazards*** are identified
B-5.01.04P	locate ***isolation points***	***isolation points*** are located according to site conditions
B-5.01.05P	coordinate site access for ***equipment***	site access for ***equipment*** is coordinated
B-5.01.06P	erect barricades and signage	barricades and signage are erected according to site safety requirements and jurisdictional regulations to warn others
B-5.01.07P	perform ***job hazard assessment***	***job hazard assessment*** is performed according to job specification, site conditions, company policies and jurisdictional regulations
B-5.01.08P	eliminate or mitigate ***hazards*** in work area	work area ***hazards*** are eliminated or mitigated
B-5.01.09P	identify ***PPE*** required	***PPE*** required for task is identified
B-5.01.10P	determine location and layout of equipment and systems	location and layout of equipment and systems are determined according to site conditions and design specifications

RANGE OF VARIABLES

hazards include: utility distribution, other construction activities, other trade activities
isolation points include: water, gas, electrical shut-offs, fuels, compressed gases, steam, utility services
equipment includes: cranes, personnel lifts, delivery trucks, dollies, carts, hoists, lifts
job hazard assessment includes: job tasks, identify hazards, identify controls, identify PPE
PPE includes: safety glasses, head protection, high-visibility apparel, foot protection, hand protection

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-5.01.01L	demonstrate knowledge of the procedures used to prepare a work site	define terminology associated with job coordination
		describe the procedures used to coordinate work requirements
B-5.01.02L	demonstrate knowledge of safe work practices	identify workplace ***hazards*** and describe safe work practices and equipment
		describe the procedures used to conduct a ***job hazard assessment***
		describe the procedures used to maintain a safe work environment and to remediate the potential dangers related to workplace ***hazards***
B-5.01.03L	demonstrate knowledge of codes and regulations pertaining to work site safety	interpret codes and regulations pertaining to workplace ***hazards*** and safe work practices

RANGE OF VARIABLES

hazards include: utility distribution, other construction activities, other trade activities
job hazard assessment includes: job tasks, identify hazards, identify controls, identify PPE

B-5.02 Handles materials and supplies

Essential Skills	Document Use, Oral Communication, Working with Others

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-5.02.01P	receive and verify delivered materials	delivered materials are received and verified using packing slips, serial numbers, model numbers and catalogue numbers according to specifications
B-5.02.02P	inspect delivered materials	delivered materials are inspected to detect shipping damage and compliance with specifications

B-5.02.03P	label materials and supplies	materials and supplies are labelled according to WHMIS regulations and company policies
B-5.02.04P	secure materials and supplies	materials and supplies are secured by using ***equipment*** when being stored or shipped according to jurisdictional regulations, manufacturers' specifications and site conditions
B-5.02.05P	manually lift materials and supplies	materials and supplies are manually lifted according to OH&S regulations and industry standards to avoid personal injury and damage to materials, supplies and equipment
B-5.02.06P	store materials and supplies	materials and supplies are stored to prevent damage, deterioration, discharge or theft according to jurisdictional regulations, manufacturers' specifications and site conditions
B-5.02.07P	dispose of waste materials	waste materials are disposed of according to jurisdictional regulations and site conditions

RANGE OF VARIABLES

equipment includes: chains, straps, slings, blocks, stickers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-5.02.01L	demonstrate knowledge of the procedures used to handle materials and supplies	identify sources of information relevant to handling materials and supplies
		describe the considerations for handling materials and supplies
B-5.02.02L	demonstrate knowledge of regulations pertaining to the handling of materials and supplies	identify and interpret the regulatory requirements and responsibilities for handling materials and supplies
		identify and interpret the regulatory requirements and responsibilities for disposing of waste materials

TASK B-6 Performs trade activities

TASK DESCRIPTOR

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.

B-6.01 Performs brazing and soldering

Essential Skills	Document Use, Oral Communication, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-6.01.01P	purge pipes with inert gases	pipes are purged with inert gases to prevent oxidation during soldering and brazing
B-6.01.02P	prepare pipe using ***methods***	pipe is prepared using ***methods*** and according to industry standards
B-6.01.03P	select tip size and ***torch type***	tip size and ***torch type*** are selected according to pipe size, job location and industry standards
B-6.01.04P	select ***safety procedures***	***safety procedures*** are selected according to task at hand
B-6.01.05P	select brazing and soldering material	brazing and soldering material are selected according to ***job requirements*** and jurisdictional regulations
B-6.01.06P	select and place ***heat protection materials***	***heat protection materials*** are selected and placed to protect surrounding area or ***components*** according to manufacturers' recommendations and safety procedures
B-6.01.07P	solder and braze ***components***	***components*** are soldered and brazed using ***compressed gases*** and according to jurisdictional regulations and safety procedures

RANGE OF VARIABLES

methods include: cutting, cleaning, sanding, reaming
torch type includes: air fuel, oxy fuel
safety procedures include: identify hot work permit, identify fire watch requirements
job requirements include: metal compatibility, pressure requirements
heat protection materials include: heat blankets, heat sinks
components include: fittings, accessories, compressors, evaporators, metering devices, condensers
compressed gases are oxy-fuel and air-fuel

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-6.01.01L	demonstrate knowledge of the procedures used to solder and braze piping and fittings	identify types of soldering and brazing materials and fillers, and describe their characteristics and applications
		identify ***types of pipe and fittings***
		identify hazards and describe safe work practices pertaining to soldering and brazing
		describe procedures used to solder and braze piping and fittings
B-6.01.02L	demonstrate knowledge of codes and regulations pertaining to soldering and brazing	interpret codes and regulations pertaining to soldering and brazing

RANGE OF VARIABLES

types of pipe and fittings include: copper, stainless steel, steel, copper-iron alloy, brass, aluminum

B-6.02 Performs leak and pressure tests on system

Essential Skills	Document Use, Thinking, Numeracy

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-6.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to manufacturers' specifications
B-6.02.02P	prepare system for leak and/or pressure test	system is prepared for leak and/or pressure test according to manufacturers' recommendations, industry standards and jurisdictional regulations
B-6.02.03P	remove or isolate devices or sections of the system that could be damaged during pressure test	devices or sections of the system that could be damaged during pressure test are removed or isolated
B-6.02.04P	pressurize system with system compatible ***liquids*** and/or ***gases*** to perform pressure test	system is pressurized with system compatible ***liquids*** and/or ***gases*** to perform pressure test to ensure system integrity according to jurisdictional regulations and job requirements
B-6.02.05P	interpret and record leak and pressure test results	leak and pressure test results are interpreted and recorded to verify system integrity within a given period

RANGE OF VARIABLES

tools and equipment include: electronic leak detectors, certified gauges, regulators, leak detection solution

liquids include: water, glycol, brine

gases include: nitrogen, air (for secondary system), helium, argon, CO_2, inert gases

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-6.02.01L	demonstrate knowledge of the procedures used to perform leak and pressure tests on HVAC/R systems	define terminology associated with leak and pressure testing
		identify hazards and describe safe work practices pertaining to leak and pressure testing
		identify ***tools and equipment*** used to leak and pressure test an HVAC/R system, and describe their applications and procedures for use
		describe the procedures used to leak and pressure test an HVAC/R system
		determine approved and compatible ***liquids*** or ***gases*** required for HVAC/R system pressure test
		calculate volumes of ***liquids*** and ***gases*** required to pressure test an HVAC/R system
B-6.02.02L	demonstrate knowledge of codes and regulations pertaining to leak and pressure tests	interpret codes and regulations pertaining to leak and pressure testing

RANGE OF VARIABLES

tools and equipment include: electronic leak detectors, certified gauges, regulators, leak detection solution

liquids include: water, glycol, brine

gases include: nitrogen, air (for secondary system), helium, argon, CO_2, inert gases

B-6.03 Evacuates systems

Essential Skills	Document Use, Continuous Learning, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-6.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to manufacturers' specifications and job requirements
B-6.03.02P	check integrity of vacuum pump	integrity of vacuum pump is checked to meet ***evacuation*** requirements
B-6.03.03P	ensure system is at atmospheric pressure	system is at atmospheric pressure
B-6.03.04P	connect vacuum pump to system	vacuum pump is connected to system according to manufacturers' specifications
B-6.03.05P	perform ***evacuation***	***evacuation*** is performed using evacuation ***tools and equipment*** according to manufacturers' recommendations, industry standards and jurisdictional regulations
B-6.03.06P	perform standing vacuum test	standing vacuum test is performed according to manufacturers' specifications and jurisdictional regulations
B-6.03.07P	interpret and record evacuation test results	evacuation test results are interpreted and recorded to verify system integrity

RANGE OF VARIABLES

tools and equipment include: compound gauges, micron gauges, vacuum pumps
evacuation is removal of non-condensables to accepted levels

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-6.03.01L	demonstrate knowledge of the procedures used to ***evacuate*** HVAC/R systems	define terminology associated with ***evacuation*** of HVAC/R systems
		identify hazards and describe safe work practices pertaining to the ***evacuation*** of HVAC/R systems
		identify ***tools and equipment*** used to ***evacuate*** HVAC/R systems, and describe their applications and procedures for use
		describe the ***procedures*** used to ***evacuate*** and dehydrate HVAC/R systems
B-6.03.02L	demonstrate knowledge of codes and regulations pertaining to ***evacuation*** of HVAC/R systems	interpret codes and regulations pertaining to ***evacuation*** of HVAC/R systems

RANGE OF VARIABLES

evacuation is removal of non-condensables to accepted levels
tools and equipment include: compound gauges, micron gauges, vacuum pumps
procedures include: single evacuation, multiple evacuation (sweeping), use of cold traps

B-6.04 Uses refrigerants, gases and oils

Essential Skills	Document Use, Reading, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-6.04.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to task
B-6.04.02P	select ***refrigerants***	***refrigerants*** are selected according to system, manufacturers' specifications and jurisdictional regulations
B-6.04.03P	select ***refrigerant oils***	***refrigerant oils*** are selected according to ***refrigerant***, temperature range of system and manufacturers' specifications
B-6.04.04P	recover ***refrigerant*** and ***refrigerant oil***	***refrigerant*** and ***refrigerant oil*** are recovered when repairing, relocating, troubleshooting and decommissioning systems according to manufacturers' specifications, codes and jurisdictional regulations
B-6.04.05P	select ***gases***	***gases*** are selected according to task
B-6.04.06P	dispose of ***refrigerants*** and ***refrigerant oils***	***refrigerants*** and ***refrigerant oils*** are disposed of according to environmental protocols and jurisdictional regulations
B-6.04.07P	transport and store ***refrigerants***, ***gases*** and ***refrigerant oils***	***refrigerants, gases*** and ***refrigerant oils*** are transported and stored according to jurisdictional regulations and manufacturers' specifications
B-6.04.08P	charge system with ***refrigerant oil*** and ***refrigerants***	system is charged with ***refrigerant oil*** and ***refrigerants*** according to manufacturers' specifications and job-specific requirements

RANGE OF VARIABLES

tools and equipment include: gauges, scales, pumps, recovery units, regulators, torches

refrigerants include: primary (chlorofluorocarbon [CFC], hydrofluorocarbon [HFC], hydrofluoroolefin [HFO], hydrochlorofluorocarbon [HCFC], hydrocarbons [HC]), natural (R744, R717), secondary (water, glycol solutions, brine solutions)

refrigerant oils include: vacuum pump oil, cutting oil, compressor oil

gases include: nitrogen, acetylene, oxygen, carbon dioxide, argon, helium

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-6.04.01L	demonstrate knowledge of ***refrigerants, gases*** and ***refrigerant oils***, their applications and procedures for use	define terminology associated with ***refrigerants, gases*** and ***refrigerant oils***
		identify hazards and safe work practices pertaining to ***refrigerants, gases*** and ***refrigerant oils***
		identify types of ***refrigerants*** and describe their characteristics and applications
		identify the ***safety classifications of refrigerants***
		identify types of refrigerant containers and colour coding classifications
		identify types of ***refrigerant oils*** and describe their characteristics and applications
		identify types of ***gases*** and describe their characteristics and applications
		explain the ***effects of refrigerants, gases and refrigerant oils on the environment***
		describe the procedures used to perform ***refrigerant*** and ***refrigerant oil*** conversions
		describe the procedures used to store and transport ***refrigerants, gases*** and ***refrigerant oils***
B-6.04.02L	demonstrate knowledge of codes and regulations pertaining to ***refrigerants, gases*** and ***refrigerant oils***	interpret codes and regulations pertaining to ***refrigerants,*** gases and ***refrigerant oils***
B-6.04.03L	demonstrate knowledge of the procedures used to recover and recycle ***refrigerants*** and ***refrigerant oils***	describe the procedures used to recover and recycle ***refrigerants*** and ***refrigerant oils***

RANGE OF VARIABLES

refrigerants include: primary (chlorofluorocarbon [CFC], hydrofluorocarbon [HFC], hydrofluoroolefin [HFO], hydrochlorofluorocarbon [HCFC], hydrocarbons [HC]), natural (R744, R717), secondary (water, glycol solutions, brine solutions)

gases include: nitrogen, acetylene, oxygen, carbon dioxide, argon, helium

refrigerant oils include: vacuum pump oil, cutting oil, compressor oil

safety classifications of refrigerants are: toxicity and flammability

effects of refrigerants, gases and refrigerant oils on the environment include: ozone depletion potential, global warming potential, pollution, contamination

B-6.05 Performs field wiring of systems

Essential Skills	Document Use, Writing, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-6.05.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to manufacturers' specifications
B-6.05.02P	verify circuit is de-energized	circuit is de-energized to avoid personal injury or damage to equipment by following lock-out and tag-out procedures
B-6.05.03P	verify voltage, phasing, and motor wiring configuration	voltage, phasing, and motor wiring configuration is verified to ensure correct component selection according to manufacturers' requirements
B-6.05.04P	identify correctly sized fusing and overloads	correctly sized fusing and overloads are identified according to jurisdictional regulations and manufacturers' specifications
B-6.05.05P	interpret electrical schematics and termination points	electrical schematics and termination points are interpreted according to manufacturers' and design specifications, and jurisdictional regulations
B-6.05.06P	select wire size and type	wire size and type is selected according to amperage, insulation rating, compatibility with other components, and codes and jurisdictional regulations
B-6.05.07P	select ***components***	***components*** are selected according to locations where they will be used and jurisdictional regulations
B-6.05.08P	route and secure wiring	wiring is routed and secured according to codes, jurisdictional regulations and site requirements
B-6.05.09P	terminate wiring to related equipment	wiring to related equipment is terminated using ***components***

B-6.05.10P	label or tag wiring with wire markers	wiring is labelled or tagged with wire markers for identification and service purposes according to jurisdictional regulations and design specifications
B-6.05.11P	update wiring diagrams	wiring diagrams are updated to record changes and modifications

RANGE OF VARIABLES

tools and equipment include: crimpers, cutters, pliers, strippers, screwdrivers, hex keys
components include: connectors, junction boxes, terminal strips

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-6.05.01L	demonstrate knowledge of the fundamental concepts of electricity	define terminology associated with electrical fundamentals
		identify hazards and describe safe work practices pertaining to electricity
B-6.05.02L	demonstrate knowledge of the procedures used to wire systems	describe the procedures used to field wire systems
		identify ***tools and equipment*** used to wire systems, and describe their applications and procedures for use
		identify types of wiring termination
		identify types and gauges of wire
		identify types of ***components***
B-6.05.03L	demonstrate knowledge of ***codes and regulations*** pertaining to wiring of systems	interpret ***codes and regulations*** pertaining to wiring of systems

RANGE OF VARIABLES

tools and equipment include: crimpers, cutters, pliers, strippers, screwdrivers, hex keys
components include: connectors, junction boxes, terminal strips
codes and regulations include: Canadian Electrical Code, jurisdictional regulations

B-6.06 Applies sealants and adhesives

Essential Skills	Document Use, Thinking, Reading

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-6.06.01P	select ***sealants*** and ***adhesives***	***sealants*** and ***adhesives*** are selected according to manufacturers' recommendations, engineers' specifications and compatibility with other materials
B-6.06.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to manufacturers' specifications
B-6.06.03P	ensure adequate ventilation during application of ***sealants*** and ***adhesives***	ventilation is adequate during application of ***sealants*** and ***adhesives*** according to manufacturers' specifications and jurisdictional regulations
B-6.06.04P	inspect and prepare sealing surfaces	sealing surfaces are inspected and prepared before ***sealants*** or ***adhesives*** are applied according to manufacturers' specifications
B-6.06.05P	use ***sealant*** and ***adhesive***	***sealant*** and ***adhesive*** is used according to codes, regulations, manufacturers' specifications and job requirements

RANGE OF VARIABLES

sealants include: silicone, spray foam, thread seal, fire stop, duct seal, mastic
adhesives include: insulation glues, primers, pipe adhesives
tools and equipment include: brushes, caulking guns, paint scrapers, rollers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-6.06.01L	demonstrate knowledge of ***sealants*** and ***adhesives***, their applications and procedures for use	identify types of ***sealants*** and ***adhesives*** and describe their characteristics and applications
		describe the procedures used to apply ***sealants*** and ***adhesives***
		identify ***tools and equipment*** used to apply ***sealants*** and ***adhesives***, and describe their applications and procedures for use
B-6.06.02L	demonstrate knowledge of codes and regulations pertaining to ***sealants*** and ***adhesives***	interpret codes and regulations pertaining to ***sealants*** and ***adhesives***

RANGE OF VARIABLES

sealants include: silicone, spray foam, thread seal, fire stop, duct seal, mastic
adhesives include: insulation glues, primers, pipe adhesives
tools and equipment include: brushes, caulking guns, paint scrapers, rollers

MAJOR WORK ACTIVITY C
Plans installation

TASK C-7 Plans installation of HVAC/R systems

TASK DESCRIPTOR

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

C-7.01 Verifies HVAC/R system parameters and requirements

Essential Skills	Numeracy, Document Use, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-7.01.01P	calculate HVAC/R loads	HVAC/R loads are calculated according to ***factors***
C-7.01.02P	calculate refrigeration heat loads	refrigeration heat loads are calculated according to ***factors***
C-7.01.03P	identify system capacity	system capacity is identified according to heat load calculations and physical location
C-7.01.04P	identify utilities available or required	utilities are identified to ensure proper installation and operation of equipment, and to power ***accessory systems***
C-7.01.05P	determine system parameters	system parameters are determined using tools, equipment and engineering data
C-7.01.06P	identify provisions for condensate drainage	provisions for condensate drainage are identified according to drawings, site surveys and code requirements

RANGE OF VARIABLES

factors include: space and ambient temperature, insulation, windows, doors, internal loads, ventilation, exposure, volume, application, product load, relative humidity

accessory systems include: controls, electrical loads

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-7.01.01L	demonstrate knowledge of HVAC/R system parameters and requirements	explain ***concepts associated with refrigeration***
		identify types of ***compressors***, and describe their characteristics and applications
		identify types of ***basic motors*** and describe their characteristics and applications
		explain air quality, air circulation and ventilation
		describe ***psychrometric processes***
		identify types of ***air movement components***, and describe their characteristics and applications
		describe procedures used to determine system parameters
C-7.01.02L	demonstrate knowledge of load calculations	describe procedures used to perform calculations to determine refrigeration loads
		describe procedures used to perform calculations to determine HVAC loads
		explain how to calculate heat gain and heat loss for HVAC systems
C-7.01.03L	demonstrate knowledge of ***electrical circuits*** and loads	identify the factors used to determine conductor ampacity rating
		identify types of ***electrical circuits*** and describe their characteristics and applications
C-7.01.04L	demonstrate knowledge of codes and regulations pertaining to HVAC/R systems	interpret codes and regulations pertaining to HVAC/R systems

RANGE OF VARIABLES

concepts associated with refrigeration include: temperature, heat, mass and weight, density, specific gravity, specific volume, pressure

compressors include: reciprocating, scroll, rotary, screw, centrifugal, swing, linear

basic motors include: single-phase, three-phase, electronically commutated motors (ECM)

psychrometric processes include: cooling, evaporative cooling, humidification, heating and humidification, heating, heating and dehumidification, dehumidification, cooling and dehumidification

air movement components include: fans (axial, radial), mechanical drives (belt, direct)

electrical circuits include: series, parallel, series-parallel

C-7.02 Selects HVAC/R equipment, components and accessories

Essential Skills	Thinking, Document Use, Numeracy

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-7.02.01P	select equipment, ***HVAC/R components*** and accessories	equipment, ***HVAC/R components*** and accessories are selected according to ***factors***
C-7.02.02P	determine ***HVAC/R component limitations***	***HVAC/R component limitations*** are determined according to design specifications and operational requirements
C-7.02.03P	determine ***refrigeration component limitations***	***refrigeration component limitations*** are determined according to design specifications and operational requirements
C-7.02.04P	determine ***alternative systems***	***alternative systems*** are determined according to energy savings and environmental issues

RANGE OF VARIABLES

HVAC/R components include: compressors, condensers, evaporators, liquid pumps, metering devices, valves, heat exchangers, pressure vessels, temperature sensors, transducers, valves and regulators

factors include: code requirements, manufacturers' and engineering specifications, system and client requirements, best refrigerant for application, drawings, site conditions, environmental conditions

HVAC/R component limitations include: blower capacity, pressure drops, size, fluid flow, heating/cooling capacity, sensible heating ratio

refrigeration component limitations include: pressure drops, oil return, flow rate capacity, corrosion protection

alternative systems include: building automation systems (BAS), air, water, ground and geothermal source heat pumps, heat reclaim units, district heating and cooling

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-7.02.01L	demonstrate knowledge of HVAC/R equipment, ***components*** and accessories	identify types of ***alternative systems***
		identify the factors to consider when selecting HVAC/R equipment, ***components*** and accessories
		identify capacity ratings of ***HVAC/R system components***
		interpret information pertaining to ***HVAC/R systems*** found on drawings, specifications, graphs and tables

		identify types of ***HVAC/R systems*** and describe their characteristics and applications
		identify types of ***HVAC/R components*** and describe their characteristics and applications
		identify types of ***refrigeration systems***, and describe their characteristics and applications
		identify types of ***electrical components*** and describe their characteristics and applications
		identify types of ***heat pump systems*** and describe their characteristics and applications
C-7.02.02L	demonstrate knowledge of codes pertaining to HVAC/R equipment, ***components*** and accessories	interpret codes pertaining to HVAC/R equipment, ***components*** and accessories

RANGE OF VARIABLES

HVAC/R components include: compressors, condensers, evaporators, liquid pumps, metering devices, valves, heat exchangers, pressure vessels, temperature sensors, transducers, valves and regulators

alternative systems include: building automation systems (BAS), air, water, ground and geothermal source heat pumps, heat reclaim units, district heating and cooling

HVAC/R systems include: heat pumps, split, ductless split, package units, heat reclaim, chillers, humidifiers, dehumidifiers, energy recovery ventilation (ERVs), heat recovery ventilation (HRVs)

refrigeration systems include: coolers, freezers, chillers, process refrigeration systems, ultra-low, cryogenic, absorption ice-machines, plate freezers

electrical components include: motors, transformers, contactors, relays, starters, variable speed drives (VSD), capacitors, resistors

heat pump systems include: air-to-air, liquid-to-air, liquid-to-liquid, air-to-liquid

C-7.03 Determines placement of HVAC/R equipment, components and accessories

Essential Skills	Document Use, Numeracy, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-7.03.01P	determine placement of system	placement of system is determined according to ***factors*** and surrounding ***environmental issues***
C-7.03.02P	determine placement of system components	placement of system components is determined according to ***factors*** and jurisdictional regulations

C-7.03.03P	determine limitations for the placement of system equipment, components and accessories	limitations for the placement of system equipment, components and accessories is determined according to codes, jurisdictional and design specifications, system requirements and environmental conditions
C-7.03.04P	take measurements	measurements are taken to ensure that equipment will fit in location

RANGE OF VARIABLES

factors include: sizing, serviceability, available utilities, structure, aesthetics, client
environmental issues include: noise, exhaust and intake vent locations, environmental conditions

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-7.03.01L	demonstrate knowledge of determining placement of HVAC/R equipment, components and accessories	identify ***factors*** and ***environmental issues*** to consider for the placement of HVAC/R equipment, components and accessories
		identify limitations for the placement of HVAC/R equipment, components and accessories
		describe the procedures used to place HVAC/R equipment, components and accessories
		identify ***methods of zoning*** and describe their applications
		explain the importance of balancing system capacity with system load
C-7.03.02L	demonstrate knowledge of HVAC/R equipment, components and accessories	identify types of ***HVAC systems*** and describe their characteristics and applications
		identify types of ***refrigeration systems***, and describe their characteristics and applications
C-7.03.03L	demonstrate knowledge of codes and regulations pertaining to HVAC/R equipment, components and accessories	interpret codes and regulations pertaining to the placement of HVAC/R equipment, components and accessories

RANGE OF VARIABLES

factors include: sizing, serviceability, available utilities, structure, aesthetics, client

environmental issues include: noise, exhaust and intake vent locations, environmental conditions

methods of zoning include: 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

HVAC systems include: heat pumps, split, ductless split, package units, heat reclaim, chillers, humidifiers, dehumidifiers, ERVs, HRVs

refrigeration systems include: coolers, freezers, chillers, process refrigeration systems, ultra-low, cryogenic, ice machines, plate freezers

C-7.04 Performs HVAC/R material take-off

Essential Skills	Reading, Numeracy, Thinking

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

RANGE OF VARIABLES

component interconnections include: piping, ducting routes, electrical

components include: hangers, flow controls, piping, venting, ducting, drainage, associated accessories

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-7.04.01L	demonstrate knowledge of performing HVAC/R material take-off	identify the ***factors*** to consider when determining materials and pipe required
		describe the procedures used to perform an HVAC/R material take-off list
		identify the types of alternative materials that may be considered as options

RANGE OF VARIABLES

factors include: location, quantity, length, obstacles, coring

TASK C-8 Plans installation of control systems

TASK DESCRIPTOR

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

C-8.01 Verifies control system parameters and requirements

Essential Skills	Reading, Writing, Thinking

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

RANGE OF VARIABLES

control systems include: electrical, mechanical, electronic, integrated control circuits, pneumatic

equipment specifications include: maximum allowable distances between components, number of component devices

regional considerations include: humidity, elevation, fail-safe requirements, temperature, degree days

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-8.01.01L	demonstrate knowledge of ***control systems*** and their components	define terminology associated with ***control systems*** and their components
		explain purpose and operation of ***control systems***, devices and components
		identify types of ***control systems*** and their components, and describe their characteristics and applications
C-8.01.02L	demonstrate knowledge of codes and regulations pertaining to control systems and their components	interpret codes and regulations pertaining to control systems and their components

RANGE OF VARIABLES

control systems include: electrical, mechanical, electronic, integrated control circuits, pneumatic

C-8.02 Selects control system components and accessories

Essential Skills	Reading, Document Use, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-8.02.01P	determine control system components and accessories	control system components and accessories are determined according to application, code requirements, manufacturers' and engineering specifications
C-8.02.02P	determine control system component ***limitations***	control system component ***limitations*** are determined according to system design and application

RANGE OF VARIABLES

limitations include: effective connection distances, number of inputs/outputs able to be controlled, communication compatibility, interference

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-8.02.01L	demonstrate knowledge of ***control systems*** and their components	identify types of ***control systems*** and their components, and describe their characteristics and applications
		interpret information pertaining to ***control systems*** found on drawings and specifications
		identify the factors to consider when selecting ***control systems*** and their components
		explain how to incorporate various ***control strategies*** into ***control systems***
		explain the purpose and operation of ***control systems*** and their components
C-8.02.02L	demonstrate knowledge of codes and regulations pertaining to ***control systems*** and their components	interpret codes and regulations pertaining to ***control systems*** and their components

RANGE OF VARIABLES

control systems include: mechanical, electrical, electronic, integrated control circuits, pneumatic, wireless

control strategies include: two position control, floating control, pulse width modulation (PWM), proportional (P), proportional integral (PI), proportional integral derivative (PID), AI (artificial intelligence), adaptive

C-8.03 Determines placement of control system components and accessories

Essential Skills	Reading, Continuous Learning, Document Use

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-8.03.01P	assess placement of control systems	placement of control systems is assessed according to serviceability, code requirements and ***interference from external forces***
C-8.03.02P	determine connection routing for control system components	connection routing for control system components is determined according to drawings and site visits
C-8.03.03P	determine location of mechanical and electrical controls	location of mechanical and electrical controls is determined according to their intended function and operation

RANGE OF VARIABLES

interference from external forces include: environment, electrical noises, pests

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-8.03.01L	demonstrate knowledge of determining placement of control systems and their components	identify system ***control strategies*** and describe their characteristics and applications
		interpret information pertaining to the placement of control systems found on drawings and specifications
		identify types of mechanical controls, and explain their purpose and operation
C-8.03.02L	demonstrate knowledge of the fundamental concepts of electricity	define terminology associated with electrical fundamentals
		identify units of electrical measurement and symbols
		identify hazards and describe safe work practices pertaining to electricity
		identify types of electronic controls, and explain their purpose and operation
C-8.03.03L	demonstrate knowledge of codes and regulations pertaining to control system components and accessories	interpret codes and regulations pertaining to control system components and accessories

RANGE OF VARIABLES

control strategies include: two position control, floating control, PWM, P, PI, PID, AI, adaptive

C-8.04 Performs control system material take-off

Essential Skills	Document Use, Reading, Numeracy

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-8.04.01P	determine quantity of ***materials*** required	quantity of ***materials*** required is determined according to manufacturers' and engineering specifications, control requirements and location
C-8.04.02P	identify alternative options for ***materials***	alternative options for ***materials*** are identified according to availability, ***environmental conditions*** and ***regulatory requirements***

RANGE OF VARIABLES

materials include: control devices, wiring, tubing, hangers, fasteners
environmental conditions include: indoor/outdoor use of control components, operating temperature
regulatory requirements include: VOC, restricted materials, food grade

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-8.04.01L	demonstrate knowledge of performing control system take-off	identify the ***factors*** to consider when determining ***materials*** required
		describe the procedures used to perform control system take-off
		identify the types of alternative ***materials*** that may be considered as options

RANGE OF VARIABLES

factors include: location, quantity, length, obstacles, coring
materials include: control devices, wiring, tubing, hangers, fasteners

MAJOR WORK ACTIVITY D
Performs installation

TASK D-9 Installs HVAC/R systems

TASK DESCRIPTOR

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

D-9.01 Confirms system layout

Essential Skills	Document Use, Oral Communication, Numeracy

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-9.01.01P	verify that equipment matches material take-offs	equipment is verified that it matches material take-offs to ensure correct components are installed
D-9.01.02P	determine modifications for HVAC/R system ***equipment***, ***components and accessories***	HVAC/R system ***equipment***, ***components and accessories*** and their locations are modified to accommodate actual site conditions and equipment
D-9.01.03P	verify site measurements and clearance for ***equipment, components and accessories*** and their location/orientation	site measurements and clearance for ***equipment, components and accessories*** and their location/orientation are verified for serviceability and overall function
D-9.01.04P	verify utilities	required utilities are available

RANGE OF VARIABLES

equipment includes: chillers, RTU, AHU, pump, fan, heat pump

components and accessories include: piping, duct work, supports, thermostats, economizers, flow switches, head pressure controls, dampers, louvers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-9.01.01L	demonstrate knowledge of procedures used to confirm HVAC/R system layout	interpret information found on material take-offs
		identify the factors to consider when modifying system ***components and accessories*** or their location
		identify utilities required for HVAC/R system
		identify types of ***energy sources*** and describe their application
		describe the procedures used to prepare for HVAC/R installations

RANGE OF VARIABLES

energy sources include: electric, natural gas, propane, fossil fuel, solar, pneumatics, alternative fuels
components and accessories include: piping, duct work, supports, thermostats, economizers, flow switches, head pressure controls, dampers, louvers
equipment includes: chillers, RTU, AHU, pump, fan, heat pump

D-9.02 Assembles HVAC/R equipment, components and accessories

Essential Skills	Document Use, Thinking, Working with Others

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-9.02.01P	unpack and perform pre-assembly check of equipment, components and accessories	equipment, components and accessories are unpacked to ensure quantity and type are correct, in good condition and are compatible with the utilities/energy sources, and installation and job specifications
D-9.02.02P	select and use ***tools and equipment*** to assemble equipment, components and accessories	***tools and equipment*** are selected and used to assemble equipment, components and accessories
D-9.02.03P	modify or adjust equipment, components and accessories including orientation, flow direction, add-on kits and rotations	equipment, components and accessories including orientation, flow direction, add-on kits and rotations are modified or adjusted to match system orientation and design
D-9.02.04P	confirm final assembly of components and accessories	final assembly of components and accessories is confirmed according to jurisdictional regulations and manufacturers' specifications

RANGE OF VARIABLES

tools and equipment include: hand tools, power equipment, rigging equipment

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-9.02.01L	demonstrate knowledge of assembling HVAC/R equipment, components and accessories	identify ***tools and equipment*** used for assembling HVAC/R equipment, components and accessories, and describe their applications and procedures for use
		interpret information found on drawings and manufacturers' specifications
		identify the ***factors to consider*** when assembling HVAC/R system components and accessories
		identify components and accessories used in the assembling of HVAC/R systems, and describe their characteristics and applications
		identify hazards and describe safe work practices pertaining to the assembling of HVAC/R systems

RANGE OF VARIABLES

tools and equipment include: hand tools, power equipment, rigging equipment
factors to consider include: component placement, tool requirements, material list, scheduling

D-9.03 Places HVAC/R equipment, components and accessories

Essential Skills	Document Use, Thinking, Working with Others

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-9.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used to place equipment and components
D-9.03.02P	install ***anchors and supports***	***anchors and supports*** are installed according to jurisdictional regulations and manufacturers' specifications
D-9.03.03P	install ***isolation components***	***isolation components*** are installed to eliminate vibration transmission and noise
D-9.03.04P	secure equipment and components	equipment and components are secured according to jurisdictional regulations and manufacturers' specifications

RANGE OF VARIABLES

tools and equipment include: wrenches, chain falls, lifts, ladders

anchors and supports include: hangers, hurricane straps, seismic restraints

isolation components include: spring isolators, cork/rubber pads, canvas connectors, vibration eliminators

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-9.03.01L	demonstrate knowledge of placing HVAC/R equipment, components and accessories	identify ***tools and equipment*** used for placing HVAC/R equipment, components and accessories, and describe their applications and procedures for use
		identify types of ***anchors and supports*** used to place HVAC/R equipment
		identify types of ***isolation components*** used to eliminate vibration transmission and noise
		identify hazards and describe safe work practices pertaining to HVAC/R installations
		describe the procedures used to place HVAC/R systems
		identify ***documentation*** requirements for HVAC/R system installation
D-9.03.02L	demonstrate knowledge of HVAC/R equipment, components and accessories	identify types of ***refrigeration valves*** and describe their characteristics and applications
		identify types of ***refrigeration accessory devices*** and describe their characteristics and applications
		identify types of ***evaporators*** and their ***components***, and describe their characteristics and applications
		identify types of ***compressors***, and describe their characteristics and applications
		identify types of ***metering devices*** and their components, and describe their characteristics and applications
		identify types of ***refrigerant flow controls and accessory devices***, and describe their characteristics and applications
		identify types of ***heating systems*** and describe their characteristics and applications
		identify types of ***heat pump systems*** and describe their characteristics and applications

		identify types of ***motors*** and their components, and describe their characteristics and applications
		identify types of ***condensers*** and their components, and describe their characteristics and applications
		identify types of fluid coolers and their components, and describe their characteristics and applications
		identify types of ***auxiliary heat rejection devices*** and their components, and describe their characteristics and applications
		identify types of ***chillers*** and describe their characteristics and applications
		identify types of ***chiller components*** and describe their characteristics and applications
		identify types of ***industrial refrigeration systems*** and describe their characteristics and applications
		identify ***alternative heat transfer devices*** and describe their characteristics and applications
D-9.03.03L	demonstrate knowledge of codes and regulations pertaining to HVAC/R equipment, components and accessories	interpret codes and ***regulations*** pertaining to HVAC/R equipment, components and accessories

RANGE OF VARIABLES

tools and equipment include: wrenches, chain falls, lifts, ladders

anchors and supports include: hangers, hurricane straps, seismic restraints

isolation components include: spring isolators, cork/rubber pads, canvas connectors, vibration eliminators

documentation includes: start up reports, commissioning reports, warranty documentation, environmental refrigeration documentation, record of pressure level, jurisdictional requirements, manufacturer's requirements

refrigeration valves include: safety, metering, service/access, flow controls

refrigeration accessory devices include: regulators, filters and driers, liquid/moisture indicators, suction accumulators, oil separators, liquid receivers, pressure relief devices, heat exchangers

evaporators include: direct expansion, flooded and liquid overfeed, forced and induced, brazed plate, primary and secondary surface, chiller barrel (fluid cooler)

evaporator components include: drain pan heaters, evaporator fans and controls, drain lines, flow switches, defrost heaters

compressors include: reciprocating, scroll, rotary, screw, centrifugal, swing, linear

metering devices include: hand expansion valve, piston, capillary tube, thermostatic expansion valve, automatic expansion valve, electronic expansion valve, electric expansion valve, high side and low side float control valve, orifice plate

refrigerant flow controls and accessory devices include: direct-acting, reverse-acting, pilot-operated, pressure regulators, reversing valves

heating systems include: forced-air, hydronic, infrared, radiant

heat pump systems include: air-to-air, liquid-to-air, liquid-to-liquid, air-to-liquid, geothermal, solar

motors include: multi-lead, dual-voltage, multi-speed, ECM, inverter, 3 phase

condensers include: air-cooled, water-cooled, evaporative

auxiliary heat rejection devices include: adiabatic heat exchanger, cooling towers (open and closed), evaporative coolers, internal and external sumps

chillers include: direct expansion, flooded, absorption

chiller components include: compressor, oil pump, condenser, purge unit, chiller barrel, metering device

industrial refrigeration systems include: parallel, compound, cascade, flooded

alternative heat transfer devices include: eutectic plates, plate and frame, counter flow, cross flow and parallel flow

regulations include: local codes, decibel noise level, seismic and hurricane restraints, jurisdictional

D-9.04 Installs fasteners, brackets and hangers

Essential Skills	Document Use, Oral Communication, Numeracy

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-9.04.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to site conditions
D-9.04.02P	select fasteners, brackets and hangers	fasteners, brackets and hangers are selected according to job specifications
D-9.04.03P	lay out fasteners, brackets and hangers	fasteners, brackets and hangers are laid out according to drawings and site conditions
D-9.04.04P	***construct and fabricate*** hangers and brackets from raw material	hangers and brackets are ***constructed and fabricated*** from raw material for custom applications
D-9.04.05P	assess ***base material*** dimensions, condition, strength and select appropriate fasteners and hardware	hangers and hardware are installed securely to ***base material***
D-9.04.06P	***mount*** brackets and hangers securely	brackets and hangers are ***mounted*** securely according to codes, job specifications and environmental conditions

RANGE OF VARIABLES

tools and equipment include: hand tools, power tools, measuring tapes, levelling devices

construct and fabricate include: cut, bend, bolt, weld, fasten

base materials include: concrete products, deck, metal (steel and aluminium), wood/lumber, wall board, composite

mounting includes: place, drill, anchor, adhere, screw, nail

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-9.04.01L	demonstrate knowledge of the procedures used to install fasteners, brackets and hangers, and their applications	define terminology associated with fasteners, brackets and hangers
		identify types of fasteners, brackets and hangers, and describe their characteristics and applications
		interpret information pertaining to fasteners, brackets and hangers found on drawings and specifications
		identify ***tools and equipment*** used in the installation, and describe their applications and procedures for use

		describe the procedures used to install fasteners, brackets and hangers
		identify the procedures to fabricate a bracket or support
		identify when the scope of work requires certified welding
		identify the requirements for selecting hardware and fasteners for specific base materials
D-9.04.02L	demonstrate knowledge of codes and regulations pertaining to the installation of fasteners, brackets and hangers	identify and interpret the code requirements for securing fasteners, brackets and hangers

RANGE OF VARIABLES

tools and equipment include: hand tools, power tools, measuring tapes, levelling devices

D-9.05 Installs HVAC/R piping and tubing

Essential Skills	Thinking, Numeracy, Document Use

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-9.05.01P	braze, solder and weld piping and tubing	piping and tubing is brazed, soldered and welded according to jurisdictional regulations using oxy-fuel and air-fuel equipment and is kept free of contaminants
D-9.05.02P	purge piping, tubing and components with inert gas	system is clean and has no oxidization inside the piping and tubing
D-9.05.03P	cut, fit and connect piping and tubing	piping and tubing is cut, fit and connected using ***procedures*** according to industry practices and manufacturers' specifications
D-9.05.04P	***join*** piping and tubing	piping and tubing are ***joined*** according to job specifications, materials used and jurisdictional regulations
D-9.05.05P	bend tubing	tubing is bent according to installation requirements
D-9.05.06P	hang piping and tubing	piping and tubing is hung using hangers, supports and saddles according to codes and design specifications
D-9.05.07P	install ***accessories***	***accessories*** are installed according to design specifications, manufacturers' recommendations and site conditions

D-9.05.08P	perform pressure test on system to ensure integrity of the joints	system is tight and leak free
D-9.05.09P	insulate piping and tubing	piping and tubing is insulated according to environmental conditions, location, applications, and design and manufacturers' specifications

RANGE OF VARIABLES

procedures include: cleaning, threading, reaming, flaring, swaging, annealing

join includes: crimp, press, fusion, adhesion, flanges, grooving, threading, flare, compression fitting connection

accessories include: vibration eliminators, flow controls, oil separators, filter driers, isolation valves

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-9.05.01L	demonstrate knowledge of HVAC/R piping and tubing, their applications and procedures used for installation	describe the procedures used to install HVAC/R piping and tubing
		interpret information found in manufacturers' and code specifications pertaining to the installation of piping and tubing
		identify types of ***piping materials***, fittings and accessories used in HVAC/R systems
		identify ***brazing, soldering and welding materials***
		describe ***procedures*** used to cut, fit and connect piping and tubing
D-9.05.02L	demonstrate knowledge of codes and regulations pertaining to the installation of HVAC/R piping and tubing	interpret codes and regulations pertaining to HVAC/R piping and tubing installations

RANGE OF VARIABLES

piping materials include: copper, brass, steel, stainless steel, aluminum

brazing, soldering and welding materials include: silver brazing alloys, flux, BCuP and BAg, solder, welding consumables (sticks, gases and tips)

procedures include: cleaning, threading, reaming, flaring, swaging, annealing

D-9.06 Applies HVAC/R holding charge

Essential Skills	Numeracy, Thinking, Document Use

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-9.06.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used
D-9.06.02P	select ***refrigerant***	***refrigerant*** is selected according to design specifications
D-9.06.03P	introduce ***refrigerant*** into the system and monitor quantity	***refrigerant*** is introduced into the system and quantity monitored according to industry practices to a positive pressure
D-9.06.04P	label system and complete ***records***	system is labelled and ***records*** completed with type and amount of holding charge

RANGE OF VARIABLES

tools and equipment include: service valve wrenches, charging scales, transfer pumps, gauge manifold

refrigerants include: primary (CFC, HFC, HFO, HCFC, HC), natural (R744, R717), secondary (water, glycol solutions, brine solutions)

records include: refrigerant type, quantity, ambient and space temperature, holding pressure

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-9.06.01L	demonstrate knowledge of applying HVAC/R holding charge	identify ***tools and equipment*** used to apply a holding charge and describe their applications and procedures for use
		describe the procedures used to pressurize system with ***refrigerant*** to achieve a positive pressure
		identify hazards and safe work practices pertaining to ***refrigerants*** and applying a holding charge
D-9.06.02L	demonstrate knowledge of ***refrigerants***, their applications and procedures for use	identify types of ***refrigerants*** and describe their characteristics and applications
D-9.06.03L	demonstrate knowledge of codes and regulations pertaining to applying HVAC/R holding charge	interpret codes and regulations pertaining to ***refrigerants***

RANGE OF VARIABLES

tools and equipment include: service valve wrenches, charging scales, transfer pumps, gauge manifold

refrigerants include: primary (CFC, HFC, HFO, HCFC, HC), natural (R744, R717), secondary (water, glycol solutions, brine solutions)

TASK D-10 Installs control systems

TASK DESCRIPTOR

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

The controls enable systems to start, stop, modulate, monitor and report conditions.

D-10.01 Places control system components

Essential Skills	Document Use, Thinking, Working with Others

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-10.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
D-10.01.02P	unpack and perform pre-assembly check	controls and devices are unpacked and checked to ensure they are correct and in good condition
D-10.01.03P	configure ***hardware options***	***hardware options*** are configured prior to installation according to job requirements and manufacturers' specifications
D-10.01.04P	determine location, ***orientation and position*** of controls and devices	location, ***orientation and position*** of controls and devices is determined according to design specifications and site conditions
D-10.01.05P	assemble and install controls and devices	controls and devices are assembled and installed according to CEC requirements and manufacturers' specifications
D-10.01.06P	mount and secure controls and devices	controls and devices are mounted and secured according to manufacturers' specifications and site conditions
D-10.01.07P	update documentation	documentation is updated to reflect changes

RANGE OF VARIABLES

tools and equipment include: hand tools, power equipment, instruments
hardware options include: dip switches, jumpers, clockwise/counter-clockwise setting
orientation and position include: spring or capacitor action, clockwise vs counter-clockwise

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-10.01.01L	demonstrate knowledge of types of controls and devices, their applications and operation	interpret information pertaining to controls and devices found on drawings and specifications
		interpret codes and regulations pertaining to controls and devices
D-10.01.02L	demonstrate knowledge of installing control systems	identify ***tools and equipment*** used to install control systems, and describe their applications and procedures for use
		describe the method for determining the location, ***orientation and position*** of control systems
		describe the procedures used to install and configure control systems
		interpret information pertaining to control systems found in drawings, wiring diagrams, and schematic diagrams
		identify hazards and describe safe work practices pertaining to control systems

RANGE OF VARIABLES

tools and equipment include: hand tools, power equipment, instruments
orientation and position include: spring or capacitor action, clockwise vs counter-clockwise

D-10.02 Connects control systems

Essential Skills	Document Use, Thinking, Working with Others

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-10.02.01P	select, wiring, cabling and tubing	wiring, cabling and tubing is selected according to manufacturer's specifications, codes, standards, trade practices and job specifications
D-10.02.02P	layout wiring, cabling and tubing path	wiring, cabling and tubing layout is performed according to drawings
D-10.02.03P	install interconnecting wiring, cabling and tubing	interconnecting wiring, cabling and tubing is installed according to codes, standards, job specification and wiring diagrams
D-10.02.04P	determine circuitry and load requirements	calculations are completed based on the voltage and amperage requirements, specifications and CEC requirements
D-10.02.05P	prepare wiring and tubing for final connection to control devices	wiring and tubing is prepared for final connection to control devices using ***tools and materials***
D-10.02.06P	select termination points	termination points are selected according to system requirements
D-10.02.07P	arrange and secure wiring and tubing	wiring and tubing is arranged and secured for aesthetics, protection and serviceability
D-10.02.08P	terminate control wiring and tubing	control wiring and tubing is terminated according to site-specific drawings, manufacturers' specifications, and jurisdictional regulations
D-10.01.09P	update documentation	documentation is updated to reflect changes

RANGE OF VARIABLES

tools and materials include: hand tools, power tools, dielectric paste, heat transfer compounds, fittings, clamps, connectors, cable ties

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-10.02.01L	demonstrate knowledge of connecting system wiring and control tubing	identify ***tools and materials*** used to connect and secure wiring and control tubing, and describe their applications and procedures for use
		identify hazards and describe safe work practices pertaining to control circuits
		describe the sequence of operation of a control circuit and explain its relationship to its physical wiring and tubing configuration
		interpret information pertaining to control systems found in drawings, wiring diagrams, and schematic diagrams
		identify types of ***wiring diagrams*** and describe their characteristics and applications
D-10.02.02L	demonstrate knowledge of codes and regulations pertaining to HVAC/R control system wiring and tubing	interpret codes and regulations pertaining to HVAC/R control system wiring and tubing

RANGE OF VARIABLES

tools and materials include: hand tools, power tools, dielectric paste, heat transfer compounds, fittings, clamps, connectors, cable ties

wiring diagrams include: pictorial, schematic, ladder, component location, installation

MAJOR WORK ACTIVITY E
Performs commissioning

TASK E-11 Commissions HVAC/R systems

TASK DESCRIPTOR

Commissioning of HVAC/R 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.

E-11.01 Performs pre-start-up checks for HVAC/R systems

Essential Skills	Reading, Document Use, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-11.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to manufacturers' specifications and site conditions
E-11.01.02P	ensure that energy/power source and equipment are compatible	compatibility of energy/power source and equipment are verified
E-11.01.03P	verify completion of installation	completion of installation is verified by checking for ***factors***
E-11.01.04P	check control settings	control settings are set to allow equipment to be operational
E-11.01.05P	verify that equipment is securely fastened and mounted	equipment is securely fastened and mounted according to codes, regulations, site conditions and manufacturers' specifications
E-11.01.06P	check ***electrical connections*** and components for grounds and shorts	***electrical connections*** and components are checked to detect loose or damaged wiring according to jurisdictional regulations and manufacturers' specifications
E-11.01.07P	ensure free movement of ***movable components***	***movable components*** are free to move
E-11.01.08P	verify holding charge applied during installation	holding charge applied during installation is verified by checking circuit pressure and referring to holding charge reports
E-11.01.09P	energize crankcase heaters	crankcase heaters are energized according to manufacturers' recommendations

RANGE OF VARIABLES

tools and equipment include: multimeters, gauges, hand tools, thermometers

factors include: presence of field installed parts, missing parts, shipping mounts and straps that have not been removed, placement of controls, positioning of valves

electrical connections include: terminal strips, crimped and wire nuts, connected ground wires

movable components include: drives, dampers, actuators, fans, motors, pumps, valves

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-11.01.01L	demonstrate knowledge of performing pre-start-up checks for HVAC/R systems	identify ***tools and equipment*** used for checking HVAC/R system equipment, components and accessories, and describe their applications and procedures for use
		describe the procedures used to ensure proper installation of HVAC/R systems
		interpret information pertaining to HVAC/R systems found in drawings, wiring diagrams, manufacturers' literature and schematic diagrams
		identify the correct sequence of operation prior to start-up
		describe the ***methods used to determine the charge of an HVAC/R system***
E-11.01.02L	demonstrate knowledge of codes and regulations pertaining to HVAC/R equipment, components and accessories	interpret codes and regulations pertaining to HVAC/R equipment, components and accessories

RANGE OF VARIABLES

tools and equipment include: multimeters, gauges, hand tools, thermometers

methods used to determine the charge of an HVAC/R system include: measuring superheat and subcooling, weighing critical charge, interpreting charge charts, checking sight glass, internal volume

E-11.02 Performs start-up of HVAC/R systems

Essential Skills	Thinking, Numeracy, Writing

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-11.02.01P	turn on and verify ***utilities***	***utilities*** are turned on and verified to allow equipment to start with the correct rotation, an acceptable voltage imbalance and utility parameters are within specifications
E-11.02.02P	verify direction of rotating ***components***	direction of rotating ***components*** is verified visually or by using a phase sequencing meter to allow equipment to operate according to manufacturers' specifications
E-11.02.03P	test and adjust operation of HVAC/R control ***components***	operation of HVAC/R control ***components*** is tested and adjusted
E-11.02.04P	verify sequence of operation of system	sequence of operation of system is verified
E-11.02.05P	verify system operation	system operation is verified by measuring ***system conditions*** and comparing to design parameters and operating conditions and ensuring that the voltage and current imbalance are acceptable
E-11.02.06P	set up ***components***	***components*** are set up according to design specifications
E-11.02.07P	adjust ***components***	***components*** are adjusted according to operating conditions

RANGE OF VARIABLES

utilities include: electrical, gas, water

components include: blowers, fans, pumps, compressors, motors, dampers, temperature/pressure controls, valves, safety components

system conditions include: amperage draws, pressures, temperatures, air and fluid flow

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-11.02.01L	demonstrate knowledge of performing start-up of HVAC/R systems	identify the ***factors*** to consider when performing an HVAC/R system start-up
		identify documentation requirements for system start-up and commissioning
		describe the procedures required to start up and commission HVAC/R systems

		describe the procedures used to test and adjust ***components***
		describe the sequence of operation of systems
E-11.02.02L	demonstrate knowledge of codes and regulations pertaining to HVAC/R systems	interpret codes and regulations pertaining to HVAC/R systems

RANGE OF VARIABLES

factors include: phasing, voltage imbalance and amperage, refrigerant charge adjustments, oil levels, operating pressures and temperatures, system control adjustments, manufacturers' recommendations, liquid or air requirements

components include: blowers, fans, pumps, compressors, motors, dampers, temperature/pressure controls, valves, safety components

E-11.03 Completes HVAC/R system charge

Essential Skills	Thinking, Numeracy, Document Use

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-11.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to industry practices
E-11.03.02P	verify type of ***refrigerant*** required for system	type of ***refrigerant*** required for system is verified by referring to labelling
E-11.03.03P	weigh and measure ***refrigerant*** to be added as required for start-up	***refrigerant*** to be added is weighed and measured by referring to manufacturers' specifications
E-11.03.04P	operate system	system is operated according to manufacturers' specifications and site conditions
E-11.03.05P	measure and interpret ***operating load conditions***	***operating load conditions*** are measured and interpreted according to operating pressures, temperatures, superheat and subcooling
E-11.03.06P	verify and adjust refrigerant charge and oil level as required	oil level and refrigerant charge is verified under all load conditions
E-11.03.07P	label system	system is labelled with type and amount of oil and ***refrigerant*** according to code and jurisdictional regulations

RANGE OF VARIABLES

tools and equipment include: gauge manifolds, scales, thermometers, oil pumps, multimeter, instruments

refrigerants include: primary (CFC, HFC, HFO, HCFC, HC), natural (R744, R717) secondary (water, glycol solutions, brine solutions)

operating load conditions include: amperage, voltage, rpm, discharge temperature

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-11.03.01L	demonstrate knowledge of completing HVAC/R system charge	identify types of ***tools and equipment*** used to complete HVAC/R system charge
		describe the pressure/temperature chart and its use in determining ***refrigerant conditions***
		describe the ***methods used to determine the charge of an HVAC/R system***
		describe the ***procedures used to charge a HVAC/R system***
E-11.03.02L	demonstrate knowledge of ***refrigerants***, their applications and procedures for use	identify types of ***refrigerants*** and describe their characteristics and applications
E-11.03.03L	demonstrate knowledge of codes and regulations pertaining to ***refrigerants***	identify codes and regulations pertaining to ***refrigerants***

RANGE OF VARIABLES

tools and equipment include: gauge manifolds, scales, thermometers, oil pumps, multimeter, instruments

refrigerant conditions include: dew point, bubble point, subcooled, superheated, triple point (R744)

methods used to determine the charge of an HVAC/R system include: measuring superheat and subcooling, weighing critical charge, interpreting charge charts, checking sight glass, internal volume, condenser flooding considerations, amperage, voltage, rpm, discharge temperature

procedures used to charge a HVAC/R system include: weighing, sight glass, measuring superheat and subcooling

refrigerants include: primary (CFC, HFC, HFO, HCFC, HC), natural (R744, R717), secondary (water, glycol solutions, brine solutions)

E-11.04 Sets up primary and secondary HVAC/R system components

Essential Skills	Document Use, Numeracy, Thinking

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-11.04.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to industry practices
E-11.04.02P	adjust controls, valves and regulators	controls, valves and regulators are operating at design site conditions
E-11.04.03P	measure and interpret readings from primary and secondary HVAC/R systems	readings from primary and secondary HVAC/R systems are measured and interpreted
E-11.04.04P	adjust and balance ***primary HVAC/R components***	***primary HVAC/R components*** are adjusted and balanced to allow system to operate according to design conditions
E-11.04.05P	adjust and balance ***secondary HVAC/R components***	***secondary HVAC/R components*** are adjusted and balanced according to recommended operating parameters

RANGE OF VARIABLES

tools and equipment include: hand tools, multimeters, refractometers, thermometers, pressure gauges, instruments

primary HVAC/R components include: metering devices, flow controls, pressure regulating valves, compressors, fans, pumps, dampers

secondary HVAC/R components include: valves (balancing), pumps, fans, flow controls, temperature controls

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-11.04.01L	demonstrate knowledge of setting up ***primary*** and ***secondary HVAC/R components***	identify types of ***tools and equipment*** used to set up ***primary*** and ***secondary HVAC/R components***
		describe the procedures used to set up ***primary*** and ***secondary HVAC/R components***
		identify types of ***HVAC/R primary components***, their characteristics, applications and operation
		identify types of ***HVAC/R secondary components***, their characteristics, applications and operation
E-11.04.02L	demonstrate knowledge of codes and regulations pertaining to ***primary*** and ***secondary HVAC/R components***	identify codes and regulations pertaining to ***primary*** and ***secondary HVAC/R components***

RANGE OF VARIABLES

tools and equipment include: hand tools, multimeters, refractometers, thermometers, pressure gauges, instruments

primary HVAC/R components include: metering devices, flow controls, pressure regulating valves, compressors, fans, pumps, dampers

secondary HVAC/R components include: valves (balancing), pumps, fans, flow controls, temperature controls

TASK E-12 Commissions control systems

TASK DESCRIPTOR

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 HVAC/R systems.

E-12.01 Performs start-up checks for control systems

Essential Skills	Digital Technology, Thinking, Reading

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-12.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to industry standards
E-12.01.02P	verify that electrical, pneumatic and electronic connections are completed	electrical, pneumatic and electronic connections on ***controls*** are completed according to manufacturers' specifications and jurisdictional regulations
E-12.01.03P	apply power	power is applied to energize system
E-12.01.04P	check transformer output	transformer output is checked to ensure correct secondary voltage and polarity

RANGE OF VARIABLES

tools and equipment include: thermometers, multimeters, electronic devices, instruments

controls include: electrical, mechanical, electronic, pneumatic, wireless

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-12.01.01L	demonstrate knowledge of performing start-up checks for control systems	identify types of ***tools and equipment*** used to start up control systems
		describe the procedures used to start up and commission control systems

		describe the procedures used to verify basic electrical control circuit systems and components using schematic wiring diagrams
		interpret information pertaining to HVAC/R electronic controls found on drawings, specifications and service manuals
		describe the procedures used to perform a basic diagnosis of electronic controls
E-12.01.02L	demonstrate knowledge of codes and regulations pertaining to HVAC/R control systems	identify the codes and regulations pertaining to HVAC/R control systems
E-12.01.03L	demonstrate knowledge of digital technology used with control systems	describe the procedures used to start up control systems with digital technology

RANGE OF VARIABLES

tools and equipment include: thermometers, multimeters, electronic devices, instruments

E-12.02 Verifies/sets operating parameters

Essential Skills	Thinking, Document Use, Digital Technology

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-12.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to industry practices
E-12.02.02P	verify ***parameters***	***parameters*** are verified according to manufacturers' specifications, site conditions and client requirements
E-12.02.03P	program ***controllers*** to a defined set of ***parameters***	***controllers*** are programmed to a defined set of ***parameters***
E-12.02.04P	adjust ***operating controls***	***operating controls*** are adjusted according to manufacturers' specifications and client requirements
E-12.02.05P	adjust parameter set points	parameter set points are adjusted according to load requirements and ambient conditions
E-12.02.06P	record operating parameters in start-up information sheets	operating parameters are recorded in start-up information sheets for reference and warranty issues
E-12.02.07P	calibrate ***components***	***components*** are calibrated to ensure accurate readings from components to controllers
E-12.02.08P	test operation of ***safety controls***	operation of ***safety controls*** is tested

RANGE OF VARIABLES

tools and equipment include: meters, gauges, hand tools, instruments

parameters include: alarm, humidity, temperature, pressures, flow, levels

controllers include: timers, microprocessors, analog and digital control systems, electronic devices

operating controls include: thermostats, economizer controls, pressure switches

components include: thermostats, pressure controls, transducers, pneumatic devices, enthalpy controllers

safety controls include: high and low pressure switches, high and low temperature switches, compressor overload switch, oil pressure safety switch, flow switch

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-12.02.01L	demonstrate knowledge of setting operating parameters	identify types of ***tools and equipment*** used to set operating parameters
		describe the procedures used to verify and set operating parameters
		interpret information pertaining to control systems found on drawings and specifications
		describe the procedures used to calibrate ***components***
		describe the procedures used to adjust parameter set points
E-12.02.02L	demonstrate knowledge of codes and regulations pertaining to verifying and setting safety parameters	identify and interpret codes and regulations pertaining to verifying and setting safety parameters

RANGE OF VARIABLES

tools and equipment include: meters, gauges, hand tools, instruments

components include: thermostats, pressure controls, transducers, pneumatic devices, enthalpy controllers

MAJOR WORK ACTIVITY F

Performs maintenance and service

TASK F-13 Maintains HVAC/R systems

TASK DESCRIPTOR

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

F-13.01 Inspects HVAC/R systems

Essential Skills	Thinking, Document Use, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-13.01.01P	select and use ***tools and test equipment***	***tools and test equipment*** are selected and used
F-13.01.02P	inspect monitoring equipment and system operational logs to identify operation history	operational checks are performed according to manufacturer's specifications and jurisdictional regulations
F-13.01.03P	perform ***sensory inspection*** of ***system components***	***sensory inspection*** of ***system components*** is performed to determine abnormalities and conformity to codes
F-13.01.04P	perform safety and ***operational checks***	safety and ***operational checks*** are performed by simulating demand according to requirements, manufacturers' recommendations and jurisdictional regulations
F-13.01.05P	identify source of abnormalities	source of abnormalities is identified
F-13.01.06P	identify ***non-system items*** that may affect the overall efficiency of operation	***non-system items*** that may affect the overall efficiency of operation are identified
F-13.01.07P	identify ***system components*** that need to be further investigated	***system components*** that need to be investigated are identified
F-13.01.08P	determine ***additional service required***	***additional service required*** is determined according to inspection results

RANGE OF VARIABLES

tools and test equipment include: thermometers, gauges, hand tools, electrical meters, psychrometers

sensory inspection includes: visual, touch, auditory, smell

system components include: belts, pulleys, sight glasses, refrigeration piping

operational checks include: confirm motor operation, variable frequency drive (VFD), actuator and damper, fan cycling, oil levels

non-system items include: door gaskets, anti-sweat heaters, plugged condensate drains

additional service required includes: power washing of coils, filter change, chemical treatment, corrosion testing of heat exchange systems

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-13.01.01L	demonstrate knowledge of HVAC/R systems, their applications and ***components***	explain the purpose and operation of HVAC/R systems and their ***components***
		identify sequence of operation required for correct operation of HVAC/R systems
F-13.01.02L	demonstrate knowledge of inspecting HVAC/R systems	identify types of ***tools and test equipment*** used to inspect HVAC/R systems
		describe the procedures used to inspect HVAC/R systems and their ***components***
		identify HVAC/R system and ***component*** abnormalities, and describe their causes and procedures for repair
F-13.01.03L	demonstrate knowledge of codes and regulations pertaining to HVAC/R systems	interpret codes and regulations pertaining to HVAC/R systems

RANGE OF VARIABLES

tools and test equipment include: thermometers, gauges, hand tools, electrical meters, psychrometers

system components include: belts, pulleys, sight glasses, refrigeration piping

F-13.02 Performs predictive and scheduled maintenance on HVAC/R systems

Essential Skills	Thinking, Document Use, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-13.02.01.P	select and use tools and equipment	tools and equipment are selected and used according to task
F-13.02.02P	replace ***consumables***	***consumables*** are replaced according to manufacturers' recommendations, maintenance schedule, normal wear and abnormalities
F-13.02.03P	lubricate bearings, motors and linkages	bearings, motors and linkages are lubricated as required
F-13.02.04P	replace oil in gear boxes and compressors	oil in gear boxes and compressors is replaced according to manufacturers' recommendations
F-13.02.05P	clean ***equipment components***	***equipment components*** are cleaned to maintain system performance using system compatible cleaners
F-13.02.06P	perform motor winding insulation tests	motor winding insulation tests are performed to identify breakdown of winding and wire insulation
F-13.02.07P	visually check and tighten electrical connections of system components	electrical connections of system components are visually checked and tightened to prevent electrical failure
F-13.02.08P	verify operation and calibration of safety devices	operation and calibration of safety devices are verified according to manufacturers' specifications
F-13.02.09P	verify operation of system	system is operating according to system design
F-13.02.10P	update documents and on-site logbooks	documents and on-site logbooks are updated according to company and client policies

RANGE OF VARIABLES

consumables include: filters, belts, condensate treatment tablets, grease, lubricants

equipment components include: coils, heat exchangers, blower sections, condensate drain, supply and return diffusers, dampers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-13.02.01.L	demonstrate knowledge of HVAC/R systems, their applications and components	explain the purpose and operation of HVAC/R systems and their components
F-13.02.02L	demonstrate knowledge of performing predictive and scheduled maintenance on HVAC/R systems	identify types of tools and equipment used to perform maintenance on HVAC/R systems
		describe the procedures used to maintain HVAC/R systems, components and accessories
		describe the procedures used to recover and recycle refrigerants and oils
		describe the procedures used to store and transport refrigerants, gases and oils
		describe the procedures used to perform a basic diagnosis of electronic controls
		identify sequence of operation required for proper function of HVAC/R systems
F-13.02.03L	demonstrate knowledge of codes and regulations pertaining to HVAC/R systems	interpret codes and regulations pertaining to HVAC/R systems

F-13.03 Tests HVAC/R system components and accessories

Essential Skills	Thinking, Document Use, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-13.03.01P	select and use ***tools and test equipment***	***tools and test equipment*** are selected and used according to system requirements
F-13.03.02P	check refrigerant pressures and temperatures	refrigerant pressures and temperatures are checked for ***system abnormalities***
F-13.03.03P	check heat transfer fluids including water, air and brine	heat transfer fluids are checked for flow rate, pressure, velocity and temperature
F-13.03.04P	test electrical supply and ***electrical components***	electrical supply and ***electrical components*** are tested for abnormalities
F-13.03.05P	verify ***system requirements***	***system requirements*** are within design specifications and system settings
F-13.03.06P	test ***mechanical components and accessories***	***mechanical components and accessories*** are tested for wear and abnormalities

F-13.03.07P	retrieve oil and fluid samples and send for analysis	oil and fluid samples are retrieved and sent for lab analysis and results are interpreted according to manufacturers' recommendations
F-13.03.08P	perform acid test on oil sample	acid test is performed on oil sample to determine level of system contamination
F-13.03.09P	check integrity of secondary heat transfer fluids	secondary heat transfer fluids are checked for freeze point, pH, contaminants and protection
F-13.03.10P	test and document operation of safety controls and devices	operation of safety controls and devices are tested and documented
F-13.03.11P	perform test procedures	test procedures are performed according to manufacturers' specifications

RANGE OF VARIABLES

tools and test equipment include: thermometers, gauges, hand tools, electrical meters, psychrometers, instruments, electronic devices, interfaces and computers, analysing devices

system abnormalities include: incorrect refrigerant charge, plugged/fouled heat exchangers, incorrect valve operation, insufficient system capacity, dirty or plugged filter driers, leaking compressor valves

electrical components include: relays, motors, coils, controls, defrost timers, defrost heaters, drain pan heaters

system requirements include: voltages, amperages, temperatures, pressures

mechanical components and accessories include: compressors, condensers, metering devices, evaporators, mechanical valves, linkages, bearings, fans and fan motors, actuators, dampers, accumulator, crankcase heaters, solenoid valves, limit switches

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-13.03.01L	demonstrate knowledge of HVAC/R systems, their applications and components	explain the purpose and operation of HVAC/R systems and their components
		identify HVAC/R ***system abnormalities*** and describe their causes and procedures for repair
F-13.03.02L	demonstrate knowledge of testing HVAC/R systems and components	identify types of ***tools and test equipment*** and their procedures for use
		describe the procedures used to verify ***system requirements***
		describe the procedures used to test ***electrical components***
		describe the procedures used to test ***mechanical components and accessories***
		identify ***factors*** that affect HVAC/R system capacity and performance
		describe defrost cycle and operation
F-13.03.03L	demonstrate knowledge of codes and regulations pertaining to HVAC/R systems	interpret codes and regulations pertaining to HVAC/R systems

RANGE OF VARIABLES

system abnormalities include: incorrect refrigerant charge, plugged/fouled heat exchangers, incorrect valve operation, insufficient system capacity, dirty or plugged filter driers, leaking compressor valves

tools and test equipment include: thermometers, gauges, hand tools, electrical meters, psychrometers, instruments, electronic devices, interfaces and computers, analysing devices

system requirements include: voltages, amperages, temperatures, pressures

electrical components include: relays, motors, coils, controls, defrost timers, defrost heaters, drain pan heaters

mechanical components and accessories include: compressors, condensers, metering devices, evaporators, mechanical valves, linkages, bearings, fans and fan motors, actuators, dampers, accumulator, crankcase heaters, solenoid valves, limit switches

factors include: condensing pressure/temperature, evaporating pressure/temperature, heat of compression, subcooling, superheat, ambient conditions, system design, system load, fluid flow rate, velocity, pressures, temperatures, concentration

TASK F-14 Services HVAC/R systems

TASK DESCRIPTOR

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.

F-14.01 Troubleshoots HVAC/R systems

Essential Skills	Thinking, Continuous Learning, Working with Others

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

RANGE OF VARIABLES

tools and equipment include: hand tools, power tools, data loggers, instruments, electronic devices, interfaces and computers, analysing devices, meters, air quality monitors

primary systems include: compressor, metering device, evaporator, condenser, heat exchanger, accessories

secondary systems include: heat exchangers, pumps, fans, blowers, duct work, piping, valves, dampers, isolation devices, flow controls, safety and protective devices, operating controls, vessels, accessories

problems include: defective components, ground faults, open circuits, utility issues, leaks

documentation requirements include: service orders (verbal or written), ozone depletion prevention records, site/client specific documents, warranty requirements

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-14.01.01L	demonstrate knowledge of HVAC/R systems, their applications and components	identify types of ***HVAC systems*** and describe their characteristics and applications
		identify types of ***HVAC components*** and describe their characteristics and applications
		identify types of ***HVAC accessories*** and describe their characteristics and applications
		identify types of ***refrigeration systems*** and describe their characteristics and applications
		identify types of ***refrigeration components*** and describe their characteristics and applications
		identify types of ***refrigeration accessories*** and describe their characteristics and applications
		identify types of ***electrical components*** and describe their characteristics and applications
		identify types of ***heat pump systems*** and describe their characteristics and applications
		explain the purpose and operation of air movement and indoor air quality (IAQ) components
F-14.01.02L	demonstrate knowledge of procedures used to troubleshoot HVAC/R systems	identify types of ***tools and equipment*** used to troubleshoot HVAC/R systems
		describe the procedures used to troubleshoot HVAC/R systems and their components
		identify HVAC/R system and component ***problems***, and describe their causes
		identify pressure and temperature scales, and describe the procedures used to perform conversion calculations
		describe the procedures used to troubleshoot HVAC/R electronic components and control boards
		identify troubleshooting techniques using schematics and wiring diagrams and describe their associated procedures

		interpret information pertaining to HVAC/R systems and components found on drawings, specifications and service manuals
		identify types of air distribution systems and their components, and describe the procedures used to troubleshoot them
		describe the procedures used to troubleshoot electrical control circuit systems and components using schematic wiring diagrams
		identify the sequence of operations and procedures used to troubleshoot
F-14.01.03L	demonstrate knowledge of codes and regulations pertaining to HVAC/R systems	interpret codes and regulations pertaining to HVAC/R systems

RANGE OF VARIABLES

HVAC systems include: heat pumps, split, ductless split, package units, heat reclaim, chillers, humidifiers, dehumidifiers, ERVs, HRVs

HVAC components include: compressors, condensers, evaporators, metering devices

HVAC accessories include: IAQ sensors, outdoor temperature sensors, enthalpy sensors

refrigeration systems include: coolers, freezers, chillers, process refrigeration systems, ice machines, ultra-low, cascade, compound

refrigeration components include: compressors, condensers, evaporators, metering devices, valves, oil separators, accumulators, heat exchangers

refrigeration accessories include: temperature sensors, transducers, head pressure controls, site glasses/level indicators, protective devices, reversing valves, liquid receivers/vessels, pressure controls

electrical components include: motors, transformers, contactors, relays, starters, VSD, capacitors, resistors, VFD

heat pump systems include: air-to-air, liquid-to-air, liquid-to-liquid, air-to-liquid, geothermal

tools and equipment include: hand tools, power tools, data loggers, instruments, electronic devices, interfaces and computers, analysing devices, meters, air quality monitors

problems include: defective components, ground faults, open circuits, utility issues, leaks

F-14.02 Repairs HVAC/R systems

Essential Skills	Thinking, Continuous Learning, Working with Others

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-14.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to task being performed
F-14.02.02P	shut down and/or isolate failed ***component*** or ***accessory***	failed ***component*** or ***accessory*** is shut down and/or isolated for repair using procedures according to system configuration

F-14.02.03P	recover refrigerant	refrigerant is recovered and measured according to recovery procedures
F-14.02.04P	drain, store, dispose of and refill/recharge lubricants, fluids and heat transfer fluids including oils, water, brine and glycol	lubricants, fluids and heat transfer fluids including oils, water, brine and glycol are drained, disposed, stored and refilled/recharged according to jurisdictional regulations and manufacturers' recommendations
F-14.02.05P	protect system from contamination	system is protected from contamination using ***protection methods***
F-14.02.06P	select compatible replacement ***components***	compatible replacement ***components*** are selected according to manufacturers' specifications, jurisdictional regulations, certifications and job requirements
F-14.02.07P	repair or replace HVAC/R ***components*** and ***accessories***	HVAC/R ***components*** and ***accessories*** are repaired or replaced according to requirements
F-14.02.08P	perform pressure and leak tests	pressure and leak tests are performed according to codes
F-14.02.09P	evacuate system	system is evacuated according to industry practices, jurisdictional regulations and manufacturers' specifications
F-14.02.10P	retrofit system refrigerant/oil, as required	retrofit is completed according to manufacturers' specifications, codes and jurisdictional regulations
F-14.02.11P	charge/add refrigerant	refrigerant is charged/added according to charging procedures
F-14.02.12P	test operation of system	operation of the system is tested to verify performance is within parameters and according to system design
F-14.02.13P	update ***documents***, on-site logbooks and operating and maintenance instructions	***documents***, on-site logbooks and operating and maintenance instructions are updated according to company and client policies, and jurisdictional regulations
F-14.02.14P	present options for additional repair, replacement or improvement	options for additional repair, replacement or improvement are presented

RANGE OF VARIABLES

tools and equipment include: hand tools, power tools, data loggers, meters, air quality monitors, instruments, electronic devices, interfaces and computers, analysing devices, recovery equipment, evacuation equipment

components include: compressors, condensers, evaporators, metering devices, valves, oil separators, accumulators

accessories include: IAQ sensors, temperature sensors, pressure sensors, pumps, transducers

protection methods include: sealing, capping, isolating system components

documents include: wiring diagrams, piping diagrams, flow diagrams, P&I diagrams, sequence of operations, schematics, site layout diagrams, as-builts, jurisdictional approvals

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-14.02.01L	demonstrate knowledge of HVAC/R systems, their applications and ***components***	identify HVAC/R systems, their applications and ***components***
		explain the purpose and operation of HVAC/R systems and their ***components***
F-14.02.02L	demonstrate knowledge of repairing HVAC/R systems	identify types of ***tools and equipment*** used to repair HVAC/R systems
		identify HVAC/R system and ***component*** failures, and describe their causes and procedures for repair
		identify air and secondary refrigerant distribution systems, and component failures, and describe their causes and procedures for repair
F-14.02.03L	demonstrate knowledge of codes and regulations pertaining to HVAC/R systems	identify and interpret codes and regulations pertaining to HVAC/R systems
F-14.02.04L	demonstrate knowledge of codes and regulations pertaining to HVAC/R refrigerant and oil retrofits	identify codes and regulations pertaining to retrofit requirements
		identify safety regulations pertaining to retrofitting HVAC/R systems
F-14.02.05L	demonstrate knowledge of procedures used to retrofit refrigerant and oil in HVAC/R systems	identify procedures used to retrofit refrigerant and oil in HVAC/R systems

RANGE OF VARIABLES

components include: compressors, condensers, evaporators, metering devices, valves, oil separators, accumulators

tools and equipment include: hand tools, power tools, data loggers, meters, air quality monitors, instruments, electronic devices, interfaces and computers, analysing devices, recovery equipment, evacuation equipment

TASK F-15 Maintains and services control systems

TASK DESCRIPTOR

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, refrigeration and air conditioning mechanics need to troubleshoot and repair or replace the system components.

F-15.01 Performs maintenance and inspection on control systems

Essential Skills	Thinking, Writing, Working with Others

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-15.01.01P	select and use ***tools and equipment***	**tools and equipment** are selected and used according to task being performed
F-15.01.02P	perform visual inspection of ***control systems*** and ***control system components***	visual inspection of ***control systems*** and ***control system components*** is performed according to manufacturers' specifications, client requirements and jurisdictional regulations
F-15.01.03P	perform ***run checks***	***run checks*** are performed to determine sequence of operations according to system documentation
F-15.01.04P	verify ***safety controls***	***safety controls*** are within system parameters according to jurisdictional regulations
F-15.01.05P	perform ***test procedures***	***test procedures*** are performed according to manufacturers' specifications, client requirements and jurisdictional regulations
F-15.01.06P	secure and clean connections on ***control system components***	connections are secured and cleaned on ***control system components***
F-15.01.07P	identify components that need to be replaced or repaired	components that need to be replaced or repaired are identified
F-15.01.08P	present options for additional repair, replacement or improvement	options for additional repair, replacement or improvement are presented

RANGE OF VARIABLES

tools and equipment include: hand tools, power tools, data loggers, instruments, electronic devices, interfaces and computers, analysing devices, meters, air quality monitors

control systems include: safeties, circuit boards, PLCs, BAS, operating controls

control system components include: thermostats, low/high pressure switches, limit switches, flow switches (air, water, secondary), timers, transducers, thermocouples, thermistors, RTDs, transmitters

run checks include: verifying operating and safety controls

safety controls include: limit switches, current sensing device, loss of charge switch, flow switches, low/high pressure switches, refrigerant monitors

test procedures include: cycling safety controls, simulating out of range/unsafe conditions

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-15.01.01L	demonstrate knowledge of ***control systems***, their applications and ***components***	explain the purpose and operation of ***control systems*** and their ***components***
F-15.01.02L	demonstrate knowledge of the procedures used to maintain ***control systems*** and their ***components***	identify types of ***tools and equipment*** used to perform maintenance on ***control systems*** and their ***components***
		describe the procedures used to maintain ***control systems*** and their ***components***
		describe the procedures used to inspect ***control systems*** and their ***components***
		describe sequence of operation required for proper function of ***control systems***
		describe the procedures used to perform a diagnosis of controls
		interpret information pertaining ***to control systems*** and their ***components*** found on manufacturers' specifications and maintenance schedule
		describe ***communication protocols*** for control systems
F-15.01.03L	demonstrate knowledge of codes and regulations pertaining to ***control systems***	interpret codes and regulations pertaining to ***control systems***

RANGE OF VARIABLES

control systems include: safeties, circuit boards, PLCs, BAS, operating controls

control system components include: thermostats, low/high pressure switches, limit switches, flow switches (air, water, secondary), timers, transducers, thermocouples, thermistors, RTDs, transmitters

tools and equipment include: hand tools, power tools, data loggers, instruments, electronic devices, interfaces and computers, analysing devices, meters, air quality monitors

run checks include: verifying operating and safety controls

safety controls include: limit switches, current sensing device, loss of charge switch, flow switches, low/high pressure switches, refrigerant monitors

test procedures include: cycling safety controls, simulating out of range/unsafe conditions

communication protocols include: ethernet, Wi-Fi, Bluetooth, MODbus, BACnet, LON, open and generic protocols, manufacturer's proprietary systems

F-15.02 Troubleshoots control systems

Essential Skills	Thinking, Reading, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-15.02.01P	discuss client concerns about equipment	client's concerns about equipment are discussed
F-15.02.02P	select and use tools and equipment	tools and equipment are selected and used to diagnose problem based on information obtained from client
F-15.02.03P	use system documentation and schematics	system documentation and schematics are used to diagnose ***problems***
F-15.02.04P	interpret ***system readings***	***system readings*** are interpreted from gathered information
F-15.02.05P	identify ***problems***	***problems*** are identified by sensory inspection and use of test equipment
F-15.02.06P	combine ***system readings*** and ***data***	***system readings*** and ***data*** are interpreted to identify cause and source of ***problem***
F-15.02.07P	identify components or accessories that need to be reconfigured, repaired or replaced	components or accessories that need to be reconfigured, repaired or replaced are identified
F-15.02.08P	present options for reconfiguration, repair, replacement or improvement	options for reconfiguration, repair, replacement or improvement are presented

RANGE OF VARIABLES

problems include: 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 phasing, harmonic interference, termination issues, inappropriate wiring scheme, equipment address issues, sensor drift/calibration issues

system readings include: temperature, humidity, pressure, voltage, amperage, flow, graphics

data includes: trend logs, data loggers, information from test equipment, sensory information, system documentation, graphics

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-15.02.01L	demonstrate knowledge of schematics and wiring diagrams	define terminology associated with schematic wiring diagrams
		identify symbols on schematics and wiring diagrams and their application
		interpret schematics and wiring diagrams
F-15.02.02L	demonstrate knowledge of the procedures used to troubleshoot ***control systems***	identify tools and equipment used with ***control systems***, and describe their applications and procedures for use
		describe the procedures used to inspect ***control systems*** and their components
		describe the procedures used to troubleshoot ***control systems***
F-15.02.03L	demonstrate knowledge of codes and regulations pertaining to ***control systems***	interpret codes and regulations pertaining to ***control systems***

RANGE OF VARIABLES

control systems include: electrical, mechanical, electronic, integrated control circuits, pneumatic, hybrid systems

F-15.03 Calibrates operating and safety controls

Essential Skills	Thinking, Numeracy, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-15.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to task being performed
F-15.03.02P	test and record ***conditions***	***conditions*** are tested and recorded to compare to system settings
F-15.03.03P	verify that ***operating and safety controls*** operate at system design settings	***operating and safety controls*** operate according to system design settings and jurisdictional regulations

F-15.03.04P	adjust controls that are operating outside parameters	controls are adjusted to meet parameters according to jurisdictional regulations
F-15.03.05P	identify and replace faulty controls that cannot be calibrated	faulty controls that cannot be calibrated are replaced according to jurisdictional regulations
F-15.03.06P	update documentation and on-site logbooks	documentation and on-site logbooks are updated according to jurisdictional regulations and company and client policies
F-15.03.07P	repair or replace cabling and wiring	cabling and wiring are installed and terminated according to manufacturers' specifications, job requirements and industry practices
F-15.03.08P	communicate with ***stakeholders***	***stakeholders*** are communicated with using various methods according to job specifications and jurisdictional regulations

RANGE OF VARIABLES

tools and equipment include: hand tools, power tools, data loggers, instruments, electronic devices, interfaces and computers, analysing devices, meters, air quality monitors

conditions include: temperature, pressure, humidity, flow, levels (air quality), voltage, current, resistance, velocity

operating and safety controls include: thermostats, humidity controls, limit switches, current sensing device, loss of charge switch, flow switches, low/high pressure switches, refrigerant and gas monitors, timers, transducers, thermocouples, thermistors, RTDs, transmitters

stakeholders include: electricians, network and IT technicians, plumbers, engineers, sheet metal workers, site personnel (i.e. building operators), utilities, monitoring and alarm supplier, jurisdictional regulators

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-15.03.01L	demonstrate knowledge of calibrating ***operating and safety controls***	identify ***tools and equipment*** used to calibrate ***operating and safety controls***, and describe their applications and procedures for use
		describe the procedures used to calibrate ***operating and safety controls***
F-15.03.02L	demonstrate knowledge of codes and regulations pertaining to control systems	interpret codes and regulations pertaining to control systems

RANGE OF VARIABLES

operating and safety controls include: thermostats, humidity controls, limit switches, current sensing device, loss of charge switch, flow switches, low/high pressure switches, refrigerant and gas monitors, timers, transducers, thermocouples, thermistors, RTDs, transmitters

tools and equipment include: hand tools, power tools, data loggers, instruments, electronic devices, interfaces and computers, analysing devices, meters, air quality monitors

F-15.04 Repairs control systems

Essential Skills	Thinking, Working with Others, Continuous Learning

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-15.04.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to task being performed
F-15.04.02P	select compatible and acceptable replacement ***control system component***	compatible and acceptable replacement ***control system component*** is selected according to manufacturers' specifications, availability and retrofit requirements
F-15.04.03P	adjust, repair or replace ***control system components***, wiring, cabling and connections that are operating outside parameters	***control system components,*** wiring, cabling and connections that are operating outside parameters are adjusted, repaired or replaced
F-15.04.04P	test operation of repaired or replaced ***control system component***	operation of repaired or replaced ***control system component*** is tested
F-15.04.05P	update control system schematics, documentation and on-site logbooks	control system schematics, documentation and on-site logbooks are updated according to jurisdictional regulations and company and client policies

RANGE OF VARIABLES

tools and equipment include: hand tools, power tools, data loggers, instruments, electronic devices, interfaces and computers, analysing devices, meters, air quality monitors

control system components include: thermostats, low/high pressure switches, limit switches, flow switches (air, water, secondary), timers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-15.04.01L	demonstrate knowledge of repairing control systems	identify ***tools and equipment*** used to repair control systems, and describe their applications and procedures for use
		identify control system failures and describe their causes and sources
		explain procedures used to isolate, de-energize and lock out control systems
		describe procedures used to repair control systems, ***components,*** wiring, cabling and connections
F-15.04.02L	demonstrate knowledge of codes and regulations pertaining to control systems	interpret codes and regulations pertaining to control systems

RANGE OF VARIABLES

tools and equipment include: hand tools, power tools, data loggers, instruments, electronic devices, interfaces and computers, analysing devices, meters, air quality monitors

control system components include: thermostats, low/high pressure switches, limit switches, flow switches (air, water, secondary), timers

APPENDIX A
ACRONYMS

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

APPENDIX B

TOOLS AND EQUIPMENT / OUTILS ET ÉQUIPEMENT

Hand Tools / Outils à main

bending tools and springs	outils et ressorts de cintrage
brushes (wire, paint, acid, tube)	brosses (métallique, pinceau, pour application d'acide, goupillon)
caulking guns	pistolets de calfeutrage
chalk lines	Cordeaux
chisels	burins
crowbars	pinces monseigneur
crimpers (wire, tin, pipe, fitting)	pinces à sertir (câbles, fils en étain, tuyaux, raccords)
cutters (side, wire, bolt, pipe, tube)	pinces coupantes (de côté, coupe-câble, coupe-boulons, coupe-tuyaux, coupe-tubes)
drywall saws	scies pour cloison sèche
files	limes
fin combs	peignes à ailettes
fish tapes	câbles de tirage
flare nut wrenches	clé polygonale ouverte
flaring tools	outils à évaser
flashlights	lampes de poche
folding pliers	pinces à plier
funnels	entonnoirs
fuse pullers	arrache-fusibles
grease guns	pistolets graisseurs
hack saws	scie à métaux
hammers	marteaux
hand carts	chariot à bras
hand sprayers	pulvérisateurs à main
hex keys	clés hexagonales
knock-out kits	ensemble d'emporte-pièce
labelling machine	machine à étiqueter
levels (laser, bubble, precision, line, transit)	niveaux (à laser, à bulle d'air, de précision, de cordeau, à lunette)
inspection mirrors	miroirs d’examen
nut drivers	tournevis à douille
orifice drill sets	jeux de forêts d’orifices
O-ring removal tools	outils de dépose de joints toriques
paint equipment	matériel à peinture
pipe dies	filières à tuyaux
pipe threaders	machines à fileter les tuyaux
pliers	pinces
pry bars	leviers
pullers	extracteurs
punches	poinçons
reamers	alésoirs
regulators (CO_2, nitrogen, oxygen, acetylene)	régulateurs (CO_2, azote, oxygène, acétylène)
rivet gun	riveteuse pneumatique

Schrader removers	extracteurs de valve Schrader
scrapers	grattoirs
screw extractors	extracteurs à vis
screwdrivers	tournevis
snap ring pliers	pinces pour anneau élastique
socket sets	jeux de douilles
squares	équerres
staplers	agrafeuses
straight edges	règles
swaging tools	outils à rétreindre
tap and die sets	jeux de tarauds et de filières
tin snips	cisailles de ferblantier
utility knives	couteaux universels
wire strippers	pinces à dénuder
wrenches (pipe, open end, adjustable, valve, torque)	clés (à tuyaux, à fourche, réglable, de vanne, dynamométrique)
vices	étaux

Portable and Stationary Power Tools / Outils électriques portatifs et fixes

air compressors and regulators	compresseurs d'air et régulateurs
drill index	calibre à forets
drills (electric, cordless, hammer)	perceuses (électriques, sans fil, à percussion)
glue guns	pistolets à colle
generators	génératrices
grinders	meuleuses
heat guns	pistolet thermique
hole saw kits	jeux de scies-cloche
impact guns	pistolets à clouer
powder-actuated tools	fixateurs à cartouche
power washers	laveuses à pression
pumps (circulating, transfer, sump)	pompes (de circulation, de transfert, de puisard)
router	toupies
saws (jig, reciprocating, band, chop, circular)	scies (sauteuses, alternative, à ruban)
trouble lights	lampes baladeuses
vacuum cleaners	aspirateurs
power threaders	filière mécanique

Brazing and Soldering Tools / Outils de brasage et de soudage

air-fuel equipment	matériel à aérogaz
brazing barriers (fire blankets)	barrières de brasage (couvertures ignifuges)
cloth (sand, emery, sandpaper)	toiles (abrasive, émeri, papier de verre)
oxy-fuel equipment	matériel à oxy-gaz
soldering iron/gun	fer/pistolet à souder
striker	gâches
torch kits	jeux de chalumeaux

Recovery and Recycling Equipment / Matériel de récupération et de recyclage

filter/driers	déshydrateur/filtres
hazardous waste containers	conteneurs de déchet dangereux
liquid pumps	pompes à liquide
pressure/temperature charts	diagrammes pression/température
recovery and recycle units	appareils de récupération et de recyclage

recovery and storage cylinders	bouteilles de récupération et de stockage
subcoolers	sous-refroidisseur

Charging Tools and Equipment / Outils et équipement de charge

charging cylinders	bouteilles de charge
charging manifolds	collecteurs de charge
charging scales	balances de charge
refrigerant hoses	tuyaux souples de frigorigène
refrigerant oil pumps	pompes à huile frigorigène
tank heater (heat blankets)	chauffe-réservoir
vacuum pumps	pompes à vide

Diagnostic and Measuring Equipment / Équipement de diagnostic et de mesure

air flow hoods	débitmètres à hotte
air flow/volume test equipment	appareil de vérification du débit/volume
air quality testers	appareil d'analyse de la qualité de l'air
alignment tools	outils d'alignement
belt tension indicators	indicateurs de tension de courroie
black lights	lampes à lumière noire
calculators	calculatrices
calipers	pied à coulisse
capacitor testers	capacimètres
circuit tracers	traceurs de circuit
carbon monoxide analyzers/detectors	analyseurs/détecteurs de monoxyde de carbone
combustion analyzers	analyseurs de gaz de combustion
compound gauges	manovacuomètres
computers	ordinateurs
control signal generator	générateur de signaux de commande
data loggers	enregistreurs de données
decibel meters	décibelmètres
dial indicators	comparateur à cadran
dye penetrant kits	appareils de liquide pénétrant coloré
eddy current testers	testeurs des courants de Foucault
feeler gauges	jauges d'épaisseur à lames
flame safeguard testers	dispositifs de surveillance de flamme
flowmeters	débitmètres
gauges	jauges
hydrometers	hydromètres
hygrometers	hygromètres
infrared thermography cameras and display units	appareil de visualisation et caméra de thermographie infrarouge
leak detectors (electronic, ultrasonic, halide, soap tests, litmus test, sulphur test, ultraviolet)	détecteurs de fuites (électroniques, ultrasons, halogénures, solution savonneuse, papier de tournesol, soufre, ultraviolets)
litmus paper	papiers de tournesol
magnahelic gauges	manomètres différentiels
manifold gauge sets	jauges de collecteurs
manometers (U-tube, incline, electronic)	manomètres (à tube en U, inclinés, électroniques)
measuring tapes	rubans à mesurer
mega-ohmmeters	mégohmmètres
micrometers	micromètres
micron gauges (mechanical, electronic)	microvacuomètre (mécanique, électronique)
multimeters (true root mean square [RMS])	multimètre (valeur efficace)
non-contact voltage (NCV) testers	détecteur de courant sans contact

oil test kits	trousses à essai d'huile
pH testing kits	nécessaire d'analyse du pH
phase meters (mechanical, electronic)	phasemètres (mécanique, électronique)
Pitot tubes	tubes de Pitot
pneumatic calibration kits	nécessaire d'étalonnage pneumatique
potentiometers	potentiomètres
proximity meters	détecteurs de proximité
refractometers	réfractomètres
refrigerant scales (mechanical, electronic)	balances à frigorigène (mécanique, électronique)
rulers	règles
psychrometers	psychromètres
smoke testers	testeurs de fumée
stethoscopes	stéthoscopes
tachometers	tachymètres
thermocouple testers	contrôleurs de thermocouple
thermometers (infrared, electronic, mechanical)	thermomètres (à infrarouges, électroniques, mécaniques)
transducers (humidity, pressure, current, voltage, temperature)	transducteurs (humidité, pression, intensité, tension)
vacuum gauges	vacuomètres
vibration analysis equipment	équipement d'analyse de vibrations
video scope (inspection camera)	vidéoscopes (caméra d'inspection)
water analysis kits	trousses d'analyse d'eau

Access Equipment / Équipement d'accès

ladders (step, extension)	échelles (escabeau, à rallonge)
personnel lifts	plateforme de levage de personnel
scaffolding/staging	échafaudages/plateformes de travail

Rigging, Hoisting and Lifting Equipment / Équipement de gréage, de hissage et de levage

blocks and tackles	palans à moufle
chain falls	palans à chaîne
chains and cables	chaînes et câbles
come-alongs	treuils manuels
cranes (gantry, mobile)	grues
dollies	plateaux roulants
eye bolts	boulons à œil
fork lifts	chariots élévateurs à fourche
hoists	palans
jacks (hydraulic, mechanical)	crics (hydrauliques, mécaniques)
material lifts	appareils de levage
ropes	cordes
shackles	manilles
slings	élingues
spreader bars	palonniers
stair climber trolley	diable d’escaliers
toe jacks	cric relève-voie
winches	treuils

Personal Protective Equipment (PPE) and Safety Equipment / Équipement de protection individuelle (EPI) et de sécurité

barricades/pylons	palissades/cônes de signalisation
electrical live test safety equipment /arc flash	équipement de sécurité d'épreuve sous tension d'un outillage électrique et équipement de protection contre l'arc électrique
fall arrest equipment	équipement antichute
fire blankets	couvertures ignifuges
fire extinguishers	extincteurs
first aid kits/stations	trousses/postes de premiers soins
flagging	signalisation
gas detector (hazardous gases)	détecteur de gaz (gaz dangereux)
gloves (rubber, insulated, leather)	gants (en caoutchouc, isolés, en cuir)
hard hats	casques de protection
hearing protection (ear plugs, muffs)	protège-oreilles (bouchons d'oreilles, serre-tête antibruit)
high-visibility apparel	vêtement de sécurité à haute visibilité
lock-out kits	nécessaire de cadenassage
masks (dust, particle, filter, vapour)	masques (anti-poussière, contre les particules, filtrant)
rain suits	vêtements de pluie
respirators	respirateurs
rubber aprons and coveralls	tabliers et combinaisons en caoutchouc
rubber boots	bottes en caoutchouc
safety boots	bottes de sécurité
safety face shields	écrans protecteurs
safety glasses	lunettes de sécurité
safety goggles	lunettes de protection
tape (caution, danger)	ruban (d'avertissement, de danger)
two-way radios	radios bidirectionnelles
warning signs	panneaux de mise en garde
welding gloves	gants de soudeur
welding goggles	lunettes de soudeur
welding helmets	casque de soudage

APPENDIX C
GLOSSARY / GLOSSAIRE

accessories	optional parts added to equipment or system	**accessoires**	pièces optionnelles ajoutées à l'équipement ou au système
access equipment	equipment used to allow mechanics to reach work location (e.g. ladder, scaffolds, personnel lift)	**équipement d'accès**	équipement utilisé par le mécanicien ou la mécanicienne pour atteindre l'emplacement des travaux (p. ex., échelle, échafaudages, plateforme de levage de personnel)
accumulator	a vessel in the suction line that collects liquid refrigerant to be boiled off	**réservoir tampon**	réservoir monté sur le circuit frigorifique basse pression permettant d'accumuler du frigorigène liquide en vue de son ébullition ultérieure
analog controls	controls which are continuously variable between two points	**commandes analogiques**	commandes qui sont variables de façon continue entre deux points
commission	final start-up activities before a system is fully functional that ensures the system meets design specifications and client requirements	**mise en service**	dernières activités de démarrage effectuées pour vérifier si le système est entièrement fonctionnel afin de s'assurer que le système respecte les spécifications de conception et les exigences du client
component	parts required as part of a system	**composant**	pièce nécessaire faisant partie d'un système
compressor	component that creates pressure differential in a system that allows a refrigerant to flow	**compresseur**	composant qui crée la différence de pression dans un système qui permet à un réfrigérant de s'écouler
condenser	heat rejection component that provides a state change of refrigerant (from vapour to a liquid)	**condenseur**	composant qui permet d'effectuer un changement d'état du frigorigène par rejet de chaleur (de vapeur à liquide)

control system	electrical, electronic, mechanical and pneumatic components and wiring that are used to operate and protect the system	**système de commandes**	composants électriques, électroniques, mécaniques et pneumatiques et câblage utilisés pour faire fonctionner le système
digital controls	control that use an on/off signal	**commandes numériques**	commande utilisant un signal tout-ou-rien
evaporator	heat absorption component that provides a state change of refrigerant (from liquid to a vapour)	**évaporateur**	composant qui permet d'effectuer un changement d'état du frigorigène par absorption de chaleur (de liquide à vapeur)
field wiring	wiring required to be done on site	**câblage sur place**	câblage qu'il est nécessaire d'effectuer sur le chantier
flow control	device for controlling the flow of primary and secondary refrigerants (e.g. crankcase pressure regulator [CPR], evaporator pressure regulator [EPR], solenoid valve)	**régulateur de debit**	dispositif permettant de réguler le débit des frigorigènes primaire et secondaire (p. ex., RPA, RPE, vanne électromagnétique)
fluid cooler	a heat rejection device that cools a secondary heat transfer medium	**refroidisseur de liquide**	dispositif de rejet de la chaleur qui refroidit un milieu de transfert de chaleur secondaire
heat exchanger	device used to transfer heat energy from one medium to another	**échangeur de chaleur**	dispositif utilisé pour transférer l'énergie thermique d'un milieu à un autre
holding charge	temporary or partial charge used for the protection of the system until commissioning	**charge d'attente**	charge temporaire ou partielle utilisée pour protéger le système jusqu'à la mise en service
humidifier	device that introduces water vapour to conditioned space in order to raise relative humidity	**humidificateur**	dispositif qui permet d'ajouter de la vapeur d'eau à l'air distribué dans les locaux climatisés afin d'augmenter l'humidité relative
humidity	a measurement of moisture in air	**humidité**	quantité totale de vapeur d'eau dans l'air
internal wiring	wiring inside the system that includes factory and optional wiring	**câblage interne**	câblage à l'intérieur du système comprenant le câblage effectué en usine et le câblage en option
maintain	performing functions to prevent premature deterioration and breakdown of system	**entretenir**	exécuter des fonctions pour empêcher la détérioration et la défaillance prématurée du système

metering device	device designed to regulate flow of liquid refrigerant entering the evaporator	**dispositif de régulation**	dispositif conçu pour réguler le débit de frigorigène liquide qui entre dans l'évaporateur
oil separator	device used to remove oil from refrigerant	**séparateur d'huile**	dispositif utilisé pour enlever l'huile du frigorigène
material take-off	the listing of material and components required for a project as taken from design drawings and job requirements	**liste des matériaux**	préparation des matériaux et des composants nécessaires à un projet selon les dessins des devis descriptifs et les exigences de la tâche
predictive maintenance	monitoring system components for future replacement or repair using methods such as vibration analysis and sensory inspection	**entretien préventif**	surveiller les composants du système en vue de les remplacer ou de les réparer ultérieurement, à l'aide de méthodes comme les analyses de vibration et les inspections sensorielles
pressure control	pressure-activated safety or operational control	**régulateur de pression**	commande de sécurité ou de fonctionnement réagissant à la pression
receiver	storage vessel for liquid refrigerant	**réservoir de liquide**	réservoir destiné au stockage de frigorigène liquide
refrigerant	heat transfer fluid used in a primary or secondary refrigeration system	**frigorigène**	fluide de transfert thermique utilisé dans un système de réfrigération primaire ou secondaire
refrigeration	transferring of heat from a place where it is not wanted to a place where it is unobjectionable	**réfrigération**	le transfert de la chaleur d'un endroit où elle n'est pas désirée vers un autre sans conséquence
regulator	device that controls voltage or the pressure of liquid or gases	**régulateur**	dispositif qui permet de réguler la tension et la pression du liquide et des gaz
repair	fix system by repairing or replacing components and accessories	**réparer le système**	réparer le système en réparant ou en remplaçant les composants et les accessoires
replace	change a component on a system	**remplacer**	changer le composant d'un système
sensory inspection	inspection done without tools using sight, smell, touch and sound	**inspection sensorielle**	inspection effectuée sans outil, en utilisant la vue, l'odorat, le toucher et l'ouïe
service	troubleshoot and repair system	**entretien**	établir un diagnostic et réparer le système

solenoid valve	device that permits or stops liquid and gas flow	**vanne électromagné-tique**	dispositif permettant ou arrêtant le passage du débit d'un liquide et d'un gaz
terminate	final connection of wiring or tubing to any device	**raccorder**	terminaison du câblage ou de la tubulure à un dispositif quelconque
trade standards	procedures based on codes, regulations, manufacturers' recommendations and best practices	**normes du métier**	procédures élaborées en se fondant sur les codes, la réglementation, les recommandations des fabricants et les meilleures pratiques
transducer	electronic device that sends a digital or analog signal to a control board	**transducteur**	appareil électrique qui transmet un signal numérique ou analogique vers un tableau de commande
troubleshoot	diagnosing system failures and malfunctions	**diagnostiquer**	déterminer les défaillances et les anomalies du système
utilities	services such as electricity, drainage, water or gas provided by the city or utility companies	**services publics**	services comme l'électricité, l'évacuation des eaux, l'alimentation en eau ou en gaz fournis par la ville ou par les services publics