Refrigeration and Air Conditioning Mechanics

NOC 7313

Introduction

Refrigeration and air conditioning mechanics install and maintain, repair and overhaul residential central air conditioning systems, commercial and industrial refrigeration and air conditioning systems and combined heating, ventilation and cooling systems. They are employed by refrigeration and air conditioning installation contractors, various industrial settings, food wholesalers, engineering firms and retail and servicing establishments. Transport refrigeration mechanics are included in this unit group.

The most important Essential Skills for Refrigeration and Air Conditioning Mechanics are:

- Reading Text
- Document Use
- Problem Solving

Document Sections

- Reading Text
- Document Use
- Writing
- Numeracy
- Oral Communication
- Thinking Skills
    - Problem Solving
    - Decision Making
    - Critical Thinking
    - Job Task Planning and Organizing
    - Significant Use of Memory
    - Finding Information
- Working with Others
- Computer Use
- Continuous Learning
- Notes

A. Reading Text

Reading Text

Tasks	Complexity Level	Examples
Typical	1 to 4	Refrigeration and Air Conditioning Mechanics: • read work orders to ensure that the correct piece of equipment is being installed. (1) • read manufacturer's bulletins to learn about new equipment, modifications and solutions for repetitive equipment problems. (2) • review equipment manuals to check for any unusual installation requirements. (2) • review equipment specifications to ensure that customer's needs are being met and to determine the efficiencies of different equipment lines. (3)
Most Complex	4	• interpret a range of codes relating to building, heating, ventilation, air conditioning, and refrigeration to comply with regulations. Codes are typically written using technical and legal terminology and are updated regularly using addenda that are cross-referenced. The practical application of code requirements to a given situation may be ambiguous. (4) • read detailed diagnostic procedures in equipment manuals to determine the root causes of unit malfunctions. These procedures refer to new technologies that were not included in the trades training curriculum, requiring them to update their skills on-the-job. (4)

Reading Summary

The symbol √ is explained in the Use of Symbols section.

	Purpose for Reading			
Type of Text	**To scan for specific information/To locate information**	**To skim for overall meaning, to get the 'gist'**	**To read the full text to understand or to learn**	**To read the full text to critique or to evaluate**
Forms	√			
Labels	√			
Notes, Letters, Memos	√	√	√	
Manuals, Specifications, Regulations	√	√	√	
Reports, Books, Journals		√	√	

B. Document Use

Document Use

Tasks	Complexity Level	Examples
Typical	1 to 3	Refrigeration and Air Conditioning Mechanics: • review equipment lists to find part numbers. (1) • read work orders to identify the names and addresses of customers. (1) • recognize hazard signs such as flammable and combustible materials, high voltage electricity and compressed gases posted at worksites. (1) • read warning labels that are part of the Workplace Hazardous Materials Information System (WHMIS) to prevent injury to themselves or others. (2) • read instructional labels on equipment or parts to ensure correct installation or operation. (2) • use tables such as refrigeration pressure and temperature charts to aid calculations which determine how much refrigerant to use. (2)
Most Complex	4	• analyze temperature graphs of refrigerated unit sensors over a two-week period to diagnose equipment problems. This involves comparing temperature readings to equipment specifications and to the temperature readings of other units. (3) • interpret blueprints to determine sites for equipment installation, routing for ducting and pipes, locations of control boxes, venting, mechanical room, volume or air boxes. They compare blueprints with physical layouts to identify factors that may affect an installation, such as whether there are adequate space allowances for ductwork. (4) • interpret electrical schematics to install or repair equipment controls for systems involving one or more pieces of equipment. Using these schematics requires specialized electrical knowledge. They may provide electricians with information on the electrical schematics of refrigeration and air conditioning equipment to assist with wiring a large commercial or industrial project. (4)

Examples

- sketch ground sources heat pump loops indicating layout and measurement to brief building inspectors and customers.
- draw duct or piping work not on original blueprints to brief builing inspectors.
- sketch as-build refrigeration piping to indicate its actual location versus the planned layout.
- create schematic drawings to show electricians how a trade-specific piece of equipment is wired.

Document Use Summary

- Read signs, labels or lists.
- Complete forms by marking check boxes, recording numerical information or entering words, phrases, sentences or text of a paragraph or more. The list of specific tasks varies depending on what was reported.
- Read completed forms containing check boxes, numerical entries, phrases, addresses, sentences or text of a paragraph or more. The list of specific tasks varies depending on what was reported.
- Read tables, schedules or other table-like text (e.g., read work shift schedules).
- Enter information on tables, schedules or other table-like text.
- Plot information on graphs (e.g. line, pie, bar).
- Obtain specific information from graphs or charts.
- Interpret information on graphs or charts.
- Construct or draw graphs or charts.
- Recognize common angles such as 15, 30, 45 and 90 degrees.
- Interpret scale drawings (e.g. blueprints or maps).
- Take measurements from scale drawings.
- Read assembly drawings (e.g. those found in service and parts manuals).
- Read schematic drawings (e.g. electrical schematics).
- Make sketches.
- Obtain information from sketches, pictures or icons (e.g., computer toolbars).

C. Writing

Writing

Tasks	Complexity Level	Examples
Typical	1 to 2	Refrigeration and Air Conditioning Mechanics: • complete work order forms to record the customer's name, work site location and problem in point form as stated by the customer. (1) • maintain logbooks, as per a pre-set format, to record information such as the amount of refrigerant used and the number of filters changed. This may be a legal requirement of regulatory agencies, such as Environment Canada, or a service contract requirement. (1) • maintain point-form service notes to track such information as belt sizes and part numbers that will be used by the next technician working on that particular equipment. (1)
Most Complex	3	• complete start up sheets for new installations, detailing the make and model of equipment, the operating conditions and the start up settings. These sheets are provided to the customer for reference and used as background information for future service needs. (2) • may prepare technical service reports up to three pages in length required by customers to record such information as a detailed description of the problem, diagnosis, options presented to the customer, how the problem was resolved and servicing recommendations. Billing information related to parts and labour is also included in the report. (3)

Writing Summary

The symbol √ is explained in the Use of Symbols section.

	Purpose for Writing						
Length	**To organize/ to remember**	**To keep a record/to document**	**To inform/ to request information**	**To persuade/ to justify a request**	**To present an analysis or comparison**	**To present an evaluation or critique**	**To entertain**
Text requiring less than one paragraph of new text	√	√	√				
Text rarely requiring more than one paragraph		√	√	√			
Longer text				√	√		

D. Numeracy

The symbol √ is explained in the Use of Symbols section.

Numeracy

Tasks	Complexity Level	Examples
√ Money Math	1 to 2	Refrigeration and Air Conditioning Mechanics: • total the cost of parts when preparing orders for suppliers. (Money Math), (1)
√ Scheduling, Budgeting & Accounting Math	1 to 3	• prepare invoices for customers by calculating costs associated with service call fees, parts, labour at an hourly rate and GST. (Money Math), (2) • schedule work to make the best use of time required for travel. (Scheduling, Budgeting & Accounting Math), (1)
√ Measurement and Calculation Math	1 to 4	• calculate the operating costs of different heating and ventilation to assist customers in selecting the most appropriate option from among those that could potentially meet their needs. (Scheduling, Budgeting & Accounting Math), (3) • measure lengths of ducting and piping using a tape measure to fit for installation. (Measurement and Calculation Math), (1)
√ Data Analysis Math	1 to 3	• convert measurements expressed in feet and inches to metres when the measurement system used in the installation instructions differs from that used on-the-job. (Measurement and Calculation Math), (2)
√ Numerical Estimation	1 to 3	• calculate areas and volumes of ducting and piping assemblies to meet operating specifications of heating and ventilation systems. (Measurement and Calculation Math), (2) • utilize air flow measurement tools, such as digital multi-meters, to diagnose equipment problems and to verify proper equipment operation. These diagnostic tools may be integrated with computers and require special training to operate. (Measurement and Calculation Math), (3) • take a precise measurement using a micrometer to check shaft size for bearings when replacing parts. Operation of a micrometer usually requires additional training. (Measurement and Calculation Math), (3)

		• calculate the internal area of a closed piping system to determine the volume of refrigerant required in a system. This involves using a formula to calculate the volume of a cylinder. This figure is then applied to a table showing the mass for each unit of piping length and type of refrigerant being used. This mass per unit of piping length is then used to calculate the amount of refrigerant required. (Measurement and Calculation Math), (4) • compare pressure readings and start up readings to determine if a refrigeration system is leaking refrigerant. (Data Analysis Math), (1) • compare equipment temperature and pressure trend graphs to equipment specifications and recommended operating parameters to monitor equipment and diagnose problems. Adjustments or repairs might be required if the data is outside the recommended parameters. (Data Analysis Math), (2) • calculate averages across sets of readings on the energy consumption to compare different systems. (Data Analysis Math), (3) • estimate the length of ducting or pipe required. (Numerical Estimation), (1) • estimate the time and material costs (e.g., brackets) to install an additional run of piping. (Numerical Estimation), (2) • estimate factors such as volume, temperature and average load size to identify the type of refrigeration system required for a mobile unit. (Numerical Estimation), (3)

Math Skills Summary

a. Mathematical Foundations Used

The symbol √ is explained in the Use of Symbols section.

Mathematical Foundations Used

Code	Tasks	Examples
	Number Concepts	
√	Whole Numbers	Read and write, count, round off, add or subtract, multiply or divide whole numbers. For example, rounding off estimates of pipe or duct length.
√	Integers	Read and write, add or subtract, multiply or divide integers. For example, making calculations using positive and negative temperature values.
√	Rational Numbers - Fractions	Read and write, add or subtract fractions, multiply or divide by a fraction, multiply or divide fractions. For example, using measurements to 1/16 of an inch.
√	Rational Numbers - Decimals	Read and write, round off, add or subtract decimals, multiply or divide by a decimal, multiply or divide decimals. For example, using weight expressed in decimals to calculate refrigerant requirements.
√	Rational Numbers - Percent	Read and write percents, calculate the percent one number is of another, calculate a percent of a number. For example, calculating the percentage of fresh air introduction to an air conditioning system relative to outside air.
√	Equivalent Rational Numbers	Convert between fractions and decimals or percentages. Convert between decimals and percentages. For example, converting ounces measured per foot to decimals of ounces to fractions of pounds when recharging a refrigeration system.
√	Other Real Numbers	Use powers and roots, scientific notation, significant digits. For example, using pi in area and volume formulas, such as pi r^2. For example, using powers of a number to express airflow in cubic feet per minute.

Code	Tasks	Examples
		Patterns and Relations
√	Equations and Formulae	Solve problems by constructing and solving equations with one unknown. Use formulae by inserting quantities for variables and solving. For example, using Ohms Watts Law to calculate wattage when determining electrical consumption.
√	Use of Rate, Ratio and Proportion	Use a rate showing comparison between two quantities with different units. Use a ratio showing comparison between two quantities with the same units. For example, expressing the rate of gas flow being pumped into a refrigeration system in litres/second and mixing a 2:1 solution of water and glycol for use in a heat exchange system. Using scale drawings.
		Shape and Spatial Sense
√	Measurement Conversions	Perform measurement conversions. For example, converting temperature from Celsius Fahrenheit.
√	Areas, Perimeters, Volumes	Calculate areas. Calculate perimeters. Calculate volumes. For example, calculating the volume of piping in a cooler or freezer to determine the amount of fluid required.
√	Geometry	Use geometry. For example, calculating angles when bending refrigerant piping by subtracting the two known angles from 180. Recognizing common angles. Drawing, sketching and forming common forms and figures.
		Statistics and Probability
√	Summary Calculations	Calculate averages. For example, averaging data on incoming voltages and the average temperature of space that being heated or cooled. Using tables, schedules or other table-like text. Using graphical presentations.

b. How Calculations are Performed

- In their heads.
- Using a pen and paper.
- Using a calculator.
- Using a computer.

c. Measurement Instruments Used

- Time. For example, using a watch.
- Weight or mass. For example, using an automated electronic scale.
- Distance or dimension. For example, using a tape measure, calipers or a micrometer.
- Liquid volume. For example, using a flow meter or volume meter.
- Temperature. For example, using digital thermometers, pressure temperature gauges or temperature sensors.
- Pressure. For example, using a manometer or a pressure temperature gauge.
- Wattage. For example, using a protractor, a level, a square and a plumb bob.
- Angles. For example, using a protractor, a level, a square and a plumb bob.
- Density. For example, using a hydrometer.
- Velocity. For example, using a flow meter.
- Humidity. For example, using a psychrometer.
- Amount of refrigerant in the air. For example, using a refrigerant detector, an electronic air quality measuring device that provides readings in parts per million (ppm).
- Use the SI (metric) measurement system.
- Using the imperial measurement system.

E. Oral Communication

Oral Communication

Tasks	Complexity Level	Examples
Typical	1 to 2	Refrigeration and Air Conditioning Mechanics: • interact with dispatchers to receive work emergency assignments and to report work site delays and other problems. (1) • call suppliers to order parts or obtain information on equipment availability. (1) • instruct apprentices on how to complete a task or give directions to assist with a task. (1) • speak with manufacturers' representatives to obtain technical information on equipment, such as specifications and installation instructions. (2) • interact with drivers of refrigerated transportation units to obtain information that would help in diagnosing the equipment problem. (2) • speak to customers to discuss the operation of the heating, ventilation or air conditioning equipment and the related maintenance programs. (2)
Most Complex	2	• speak to engineers on large commercial work sites to discuss equipment issues. (2) • coach apprentices to build their technical competence by explaining trade-related theory and practice and providing feedback on their performance. This communication is an important part of apprenticeship training. (2) • communicate with other trades to ensure that work can meet scheduling and code requirements and to promote a safe working environment. Miscommunication could result in inefficiencies and in injury or death to themselves or others. (2)

Modes of Communication Used

- In person.
- Using a telephone.
- Using a two-way radio or other such means.
- Using specialized communications signals. For example, hand signals.

Environmental Factors Affecting Communication

Refrigeration and air conditioning mechanics travel from job to job and typically stay in touch with their office or customers by cell phone. Background noise from, for example, construction sites and trucks hinders communication when speaking with people face to face or by phone. They may be required to use personal protective equipment, such as ear protection, which impedes oral communication.

Oral Communication Summary

The symbol √ is explained in the Use of Symbols section.

	Purpose for Oral Communication (Part I)					
Type	**To greet**	**To take messages**	**To provide /receive information, explanation, direction**	**To seek, obtain information**	**To co-ordinate work with that of others**	**To reassure, comfort**
Listening (little or no interaction)						
Speaking (little or no interaction)						
Interact with co-workers			√	√	√	
Interact with those you supervise or direct			√		√	
Interact with supervisor/ manager			√	√	√	
Interact with peers and colleagues from other organization						
Interact with customers/ clients/ public			√	√		√
Interact with suppliers, servicers			√	√		
Participate in group discussion			√	√		
Present information to a small group						
Present information to a large group						

The symbol √ is explained in the Use of Symbols section.

	Purpose for Oral Communication (Part II)					
Type	**To discuss (exchange information, opinions)**	**To persuade**	**To facilitate, animate**	**To instruct, instill understanding, knowledge**	**To negotiate, resolve conflict**	**To entertain**
Listening (little or no interaction)						
Speaking (little or no interaction)						
Interact with co-workers	√					
Interact with those you supervise or direct				√		
Interact with supervisor/ manager	√					
Interact with peers and colleagues from other organization						
Interact with customers/ clients/ public				√		
Interact with suppliers, servicers	√					
Participate in group discussion	√					
Present information to a small group						
Present information to a large group						

F. Thinking Skills

1. Problem Solving

Problem Solving

Tasks	Complexity Level	Examples
Typical	1 to 3	Refrigeration and Air Conditioning Mechanics: • find their work becomes backed up when a job takes longer than anticipated. They call customers to inform them of delays and to provide an estimate of when they expect to arrive or to reschedule. This problem is most prevalent during peak work seasons. (1) • may deal with a customer who is disputing a service bill. They review the bill with customer to explain each cost item. If the dispute cannot be resolved they refer the customer to their supervisor. (2) • discover that the physical work site does not match the layout shown in the blueprints and that the equipment that was to be used may not comply with code requirements. They advise their foreperson of the problem and collaborate in resolving the problem by discussing options. (2) • are assigned to troubleshoot a furnace that is not providing heat. They collect as much information as possible about the circumstances leading up to the problem by questioning people on site and by reviewing any applicable service records. They determine what diagnostic procedures to use under the circumstances and systematically eliminate possible causes for the malfunction. Once the problem has been identified, they make the necessary repairs and verify that the furnace is running efficiently. (3) • troubleshoot equipment that has multiple problems affecting its ability to operate correctly. Resolving one problem reveals that there is still another underlying problem. A logical diagnostic procedure is used and repairs or adjustments are made until the equipment functions properly. It may be necessary to consult equipment manuals and co-workers or to access manufacturer's technical support. Often it is necessary to explain the need for more time and increased material and labour costs to the customer. (3)
Most Complex	3	

2. Decision Making

Decision Making

Tasks	Complexity Level	Examples
Typical	1 to 2	Refrigeration and Air Conditioning Mechanics: • determine which equipment or part to use for a particular job based on the specifications and the building codes. (1) • decide what parts need to be replaced for general maintenance and schedule the work to minimize disruption of service. (2)
Most Complex	3	• determine the most efficient, safe and economic equipment selection or repair options to offer customers. (2) • decide whether to refuse a job that is potentially dangerous. Safety-related decision making is a top priority for the industry. (3)

3. Critical Thinking

Critical Thinking information was not collected for this profile.

4. Job Task Planning and Organizing

Job Task Planning and Organizing

Complexity Level	Description
3	Own job planning and organizing • Refrigeration and air conditioning mechanics may encounter a wide variety of tasks if they are involved in repair work or may be involved in repetitious tasks if their focus is long term maintenance contracts. The variety of work experience they encounter is dependent on the scope of the company they work for. They may be given their work orders for the day and be able to set them up according to efficient use of travel time or they may be given assignments with priorities already established. They may have to work on more than one project at a time and must reorder their schedules accordingly. They may be called away from a work site for an emergency job and then return to complete the first job later. They may have to integrate their work plans with others to meet deadlines, such as inspection dates and meet the needs of their customers. They may also have to coordinate their work with other trades, especially on large worksites. Mechanics that service refrigerated transportation units may be on call 24 hours a day, 7 days a week and travel to rural locations. • Refrigeration and air conditioning mechanics plan and direct the work of apprentices when one is assigned to them.

5. Significant Use of Memory

Examples

- remember where streets and work sites are located when planning routes to minimize travel time.
- recall phone numbers of office and suppliers. This contributes to efficiency.
- remember names of customers, especially those on service contracts, to personalize customer service.
- remember where to find technical information (e.g., codes, product information) when it is needed.

6. Finding Information

Finding Information

Tasks	Complexity Level	Examples
Typical	1 to 2	Refrigeration and Air Conditioning Mechanics: • use manuals and manufacturer's bulletins to check schematics and installation requirements or to determine diagnostic procedures. (1) • use parts books to look up prices when working out costs for billings and quotations. (1) • contact manufacturers' technical support staff to obtain assistance with specialized computer programs and refrigerated transportation units' on-board microprocessors. (2) • obtain information from supervisors and fellow journeypersons to take advantage of their past experience. (2) • locate information in code regulations to comply with requirements. (2)

G. Working with Others

Participation in Supervisory or Leadership Activities

- Participate in formal discussions about work processes or product improvement.
- Have opportunities to make suggestions on improving work processes.
- Monitor the work performance of others.
- Inform other workers or demonstrate to them how tasks are performed.
- Orient new employees.
- Select contractors and suppliers.
- Assign routine tasks to other workers.

H. Computer Use

Computer Use

Tasks	Complexity Level	Examples
Typical	1 to 2	Refrigeration and Air Conditioning Mechanics: • may use word processing. For example, they prepare technical reports. (1) • may use a database. For example, they input customer contract information and the model number of heating and ventilation systems installed. (1) • may use communications software. For example, they may use e-mail to communicate with clients and use the Internet to access web sites. (2) • may use hand-held computers for real-time billing. (2)

Computer Use Summary

- Use word processing.
- Use a database.
- Use communications software.

I. Continuous Learning

How Learning Occurs

Learning may be acquired:

- As part of regular work activity.
- From co-workers.
- Through training offered in the workplace.
- Through reading or other forms of self-study
  - at work.
  - on worker's own time.
  - using materials available through work.
  - using materials obtained through a professional association or union.
  - using materials obtained on worker's own initiative.
- Through off-site training
  - during working hours at no cost to the worker.
  - partially subsidized.
  - with costs paid by the worker.

J. Other Information

In addition to collecting information for this Essential Skills Profile, our interviews with job incumbents also asked about the following topics.

Attitudes
The refrigeration and air conditioning mechanics interviewed felt that refrigeration and air conditioning mechanics should be patient and positive to deal with problems in a logical and sequential manner. They need to be flexible with work hours and conduct themselves in a professional manner. They have to be friendly and approachable and have good people skills, because in addition to their trade skills they are also providing customer service.

Future Trends Affecting Essential Skills
Although the basic mechanics of refrigeration and heating have not changed that much, equipment is becoming more integrated with computerization, especially in the area of controls. The use of microelectronics has allowed controls to become more complex and more accurate. Computerized monitoring, on-board diagnostics and sensor equipment will require familiarity with new types of diagnostic devices and specialized computer programs. The essential skill area of computer use will expand not only in the area equipment, but also in the delivery of services. Use of hand-held computer equipment for billing, the use of laptop computers and palm pilots is increasing. There is an industry focus on providing customer service which is not part of the refrigeration and air conditioning trade, but is increasingly becoming an expectation of employers. This focus will impact the essential skill areas of oral communication, finding information and continuous learning. Customers are much more informed and expect a higher level of service and knowledge from mechanics. The industry is becoming more conscious of the demands for energy efficiency and environmental safety. There is an increase in the number of codes and regulations that are being applied, for example; regulation requires monitoring and documentation of the use and handling of refrigerant, the disposal of hydrochlorofluorocarbon (HCFC) and the use of propane and other fuels. The use of new materials in the manufacture of refrigeration and air conditioning equipment and parts is ongoing as technology in the areas of plastics and fibres continues to expand. These trends will impact the essential skill areas of finding information and continuous learning as there will be in increased need for mechanics to keep on top of new codes and regulations and technological and environmental changes in their industry.

K. Notes

This profile is based on interviews with job incumbents across Canada and validated through consultation with industry experts across the country.
For information on research, definitions, and scaling processes of Essential Skills Profiles, please consult the Readers' Guide to Essential Skills Profiles (http://www.hrsdc.gc.ca/eng/jobs/les/profiles/readersguide.shtml).