Refrigeration Mechanic

Occupational Analysis Report

June 2011

Commission
de la construction
du Québec

The purpose of this report is to describe as accurately as possible the refrigeration mechanic trade as currently practiced in Québec's construction industry. It is a record of discussions held by a group of workers who met for the occasion after industry partners recommended them to the Commission de la construction du Québec (CCQ) for their expertise in the trade.

The occupational analysis is a first step in the definition of the competencies required for practicing the trade. This report becomes one of the reference and decision-making tools used by the CCQ for teaching and learning purposes.

The present report does not bind the CCQ in any way. It has no legal effect and is meant as a reflection of discussions held on the date of the analysis workshop.

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APPROVAL

This occupational analysis report was read and approved by Commission de la construction du Québec decision-makers and the following persons on the dates mentioned below:

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December 12, 2011

TABLE OF CONTENTS

List of Tables

INTRODUCTION

In early 2009, the CCQ's Direction de la formation professionnelle launched a large-scale operation to review the occupational analyses [1] of all construction industry trades.

The CCQ undertook this operation for many reasons, particularly the following:

- the project to reform the construction workforce apprenticeship and management system, and the eventual design of qualitative apprenticeship booklets requiring a detailed description of each trade;
- the fact that most construction occupational analyses[2] had been conducted between 1987 and 1991 and had not been reviewed since;
- updates to vocational qualification examination question banks;
- implementation of Chapter 7 of the Agreement on Internal Trade (AIT) and of the Québec-France Understanding on the Mutual Recognition of Professional Qualifications.

These factors demonstrate the necessity of updating the occupational analyses in order to obtain a current and complete profile of the various trades in Quebec.

The analysis of the refrigeration mechanic trade belongs to this context[3]. Its purpose is to describe the trade as currently practiced by journeymen in the construction industry. The present report was written in order to collate and organize the information gathered during the occupational analysis workshop held in Laval on February 2 and 3, 2011.

This analysis aims to draw a portrait of the trade and its working conditions, and to identify the skills and behaviours required. The report of the occupational analysis workshop is an accurate reflection of the consensus reached by a group of experienced refrigeration mechanics. A special effort was made to include in this report all the data collected during the workshop, and to ensure that the data accurately depict the realities of the trade analysed.

1. The terms "profession" and "trade" are considered synonymous.
2. Called "work situation analyses" at the time.
3. This occupational analysis was conducted according to the *Cadre de référence et instrumentation pour l'analyse d'une profession* produced in 2007 by the ministère de l'Éducation, du Loisir et du Sport (Direction générale de la formation professionnelle et technique) and the Commission des partenaires du marché du travail, ministère de l'Emploi et de la Solidarité sociale.

1. GENERAL CHARACTERISTICS OF THE TRADE

1.1 DEFINITION OF THE TRADE

According to the Regulation respecting the vocational training of workforce in the construction industry (Schedule A, section 22.2), the term “refrigeration mechanic” means any person who:

> […] is responsible for refrigeration systems with at least 1/4 h.p. capacity, including their piping, devices, accessories and other apparatus necessary for the distribution of fluids and the production of cold air by the said systems.
>
> Performance of the work described in the first paragraph includes trade-related handling for the purposes of immediate and permanent installation.

The participants in the analysis workshop mentioned that this definition omits:

- the heat reclaim units and heat pumps;
- the installation of unit heaters;
- the installation of low-voltage electronic controls to operate systems.

They also indicated that it is more accurate to say that the systems remove or absorbs heat rather than produce cold.

1.2 JOB TITLES

The job title used for describing the practice of the trade in this occupational analysis is “refrigeration mechanic.” However, other titles may be used elsewhere to designate persons practicing the trade: “refrigeration technician,” “refrigeration maintenance technician,” “refrigeration maintenance mechanic,” etc.

The participants in the analysis workshop mentioned that the trade is little known by the general public and that the title “refrigeration mechanic” should be publicized to a greater extent.

Job titles not to be confused with that of refrigeration mechanic are:

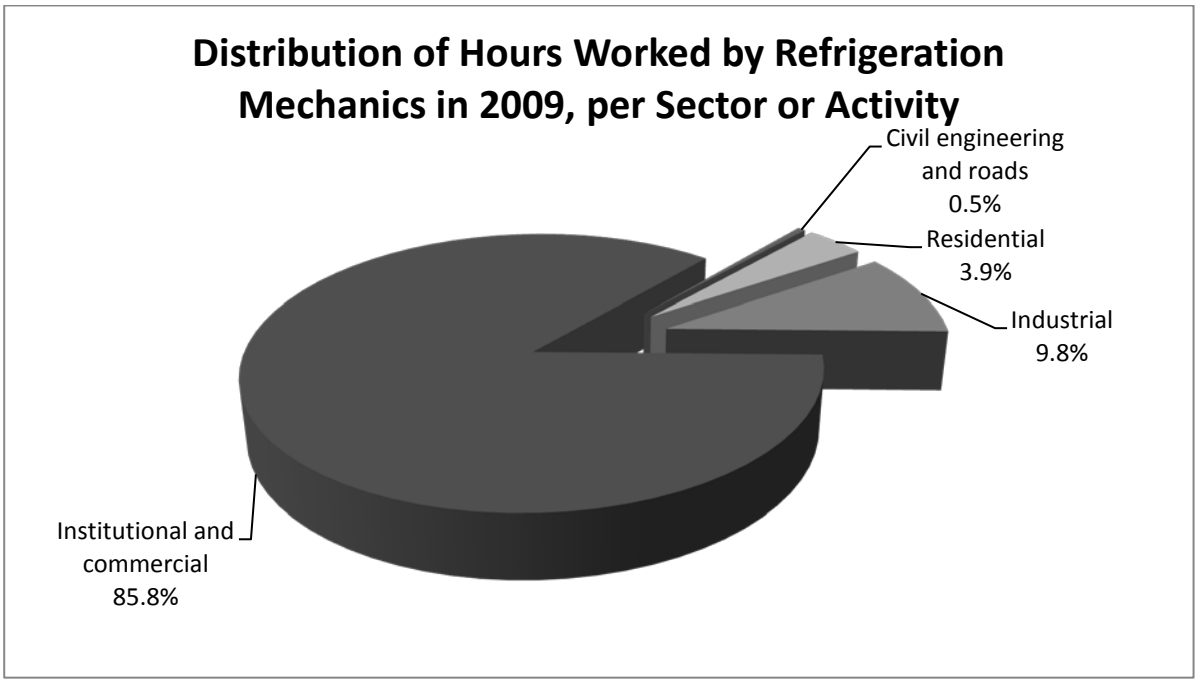
- pipe fitter;
- insulator;
- stationary engineer.

1.3 SECTORS OF ACTIVITY

Refrigeration mechanics are active, to varying degrees, in the four sectors of the construction industry:

- civil engineering and roads;
- industrial;
- institutional and commercial;
- residential.

Below is the work distribution of refrigeration mechanics for the year 2009[4]:



4. Commission de la construction du Québec, *Compilation des données 2009.*

The participants consider that this table corresponds well to their perception of areas where their trade is practiced. However, they point out that the residential sector percentage may be higher, given that the number of work hours in this sector tends to be under-declared, and that there is no obligation to hold a competency card for installing all-in-one systems.

Asked about the sector of activity in which they work, eight participants reported that they work mainly in the institutional and commercial sector, and three in the industrial sector.

Seven participants work in at least one other sector. Thus, three reported that they had also worked in the institutional and commercial sector; two in the industrial sector; and two in the residential sector. So four work exclusively in the institutional and commercial sector.

1.4 FIELD OF PRACTICE

The trade's field of practice is the construction industry. The Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20) defines construction as follows:

> […] the foundation, erection, maintenance, renewal, repair, alteration and demolition work on buildings and civil engineering works carried out on the job site itself and vicinity including the previous preparatory work on the ground;
>
> In addition, the word "construction" includes the installation, repair and maintenance of machinery and equipment, work carried out in part on the job site itself and in part in the shop, moving of buildings, transportation of employees, dredging, turfing, cutting and pruning of trees and shrubs and laying out of golf courses, but solely in the cases determined by regulation.

1.5 LEGISLATION, REGULATIONS AND STANDARDS

The construction industry's refrigeration mechanics are subject to:

- the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20);
- the Regulation respecting the vocational training of workforce in the construction industry (R-20, r.6.2);

- the four sector-based collective agreements of the construction industry;
- the National Building Code of Canada (NBC);
- the Quebec Building Code, Chapter 1, “Building”;
- the Act Respecting Occupational Health and Safety (R.S.Q., c. S-2.1);
- the Safety Code for the construction industry (R.Q., c. S-2.1, r.6);
- the Federal Halocarbon Regulations (2003) (SOR/2003-289 and SOR/2009-221);
- the Regulation respecting halocarbons of the Environment Quality Act (c. Q-2, r.15.01);
- municipal bylaws, particularly those with regard to lateral setbacks, clearances and accesses.

In addition, many of them must:

- hold a Training Certificate for transporting dangerous goods;
- have taken training in the use of scaffolds and aerial platforms;
- become qualified for some types of welding work (requirements of the Canadian Welding Association).

Finally, the work of refrigeration mechanics must meet the requirements of the Mechanical Refrigeration Code, Standard B52-05 of the Canadian Standards Association (CSA).

1.6 WORKING CONDITIONS[5]

The following data give an overview of the conditions and context of refrigeration mechanics’ work, as commented by the participants in the occupational analysis workshop. To obtain up-to-date and complete information that has legal effect, it is necessary to refer to the four collective agreements of the construction industry sectors.

Salary

The average annual salary of a refrigeration mechanic journeyman in the construction industry who worked at least 500 hours in 2009 was $61,353. At least 86% of refrigeration mechanic journeymen declared at least 500 hours in that year.

5. The general data on working conditions are taken from the four 2010-2013 collective agreements of the construction industry and from the following document, published by the Commission de la construction du Québec: *Carrières construction*, 2010-2011 edition.

A journeyman's hourly wage of varies somewhat according to the sector of activity. At September 26, 2010, the daily hourly wage was as follows:

- Industrial, institutional and commercial: $33.26
- Civil engineering and roads: $33.25
- Light residential: $30.98
- Heavy residential: $33.22

Vacations and time off

Mandatory annual holidays of four weeks – two weeks in summer and two in winter at periods predetermined in collective agreements – are the general rule in the construction industry. To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow certain possibilities for changing the vacation periods prescribed by the general rule. Indeed, the workshop participants mentioned that as an exception provided in the collective agreements, refrigeration mechanics do not take their annual holiday during the fixed periods determined for the industry, but on dates agreed to with the employer.

To these vacation periods are added eight not worked statutory holidays, as well as a lump sum for sick leaves not otherwise paid.

Pension Plan

Construction industry workers participate in a pension plan. They retain their eligibility for this pension plan throughout their career in construction, even if they change employer, trade or sector.

Insurance

The group insurance plan (medications, illness, disability, death) is fully paid by employers. Workers (and their families, as the case may be) are eligible for it so long as they remain active in the construction industry and work the required number of hours, whether or not they change employer.

Physical requirements

According to the participants in the analysis workshop, refrigeration mechanics must:

- be able to lift heavy loads under certain circumstances, for example during the installation or repair of compressors, while following occupational health and safety rules;
- be able to work in enclosed spaces;
- have good endurance, particularly for rooftop work in hot or very cold weather;
- not have vertigo.

Work schedules

A 40-hour work week from Monday to Friday is the general rule in all construction industry sectors. The daily limit is 8 hours a day, except in the light residential sector, where it can be up to 10 hours within a 40-hour week.

To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow many possibilities for changing the schedule prescribed by the general rule: compressed schedule, schedule shift, make-up time in light residential construction, etc. These special schedules confer flexibility to the work schedules in effect in the construction industry.

The participants mentioned that for service work in the institutional and commercial sector, the work week is 45 hours, with a daily limit of 9 hours a day. In addition, refrigeration mechanics must be available during evenings, nights and weekends. Depending on the nature of repairs, the work may take longer.

The participants also specify that many refrigeration mechanics work intensively when installing systems with tight deadlines for putting the systems into service. Finally, the work includes peak periods that differ according to the type of work. For example, when putting systems into service for the summer, some refrigeration mechanics may work up to 60 hours a week.

Stress factors

The refrigeration mechanic trade has stress factors. The stress factors mentioned by the workshop participants are:

- tight deadlines;
- troubleshooting during service calls;
- handling and using dangerous gases and pressurized devices;
- the consequences of malfunctions;
- working under pressure, in the customer's presence;
- certain expectations of demanding customers.

1.7 WORK ORGANIZATION

Refrigeration mechanics usually work under a foreman's supervision.

Persons responsible for service calls usually receive their instructions from a dispatcher. On the customer's premises, they work without supervision.

1.8 JOB MARKET ENTRY CONDITIONS[6]

To obtain the competency certificate-apprentice in the trade, candidates must present to the CCQ the original version of an academic transcript or apprenticeship transcript attesting that they have passed a program of study recognized by the CCQ and giving access to the industry, notably the DEP in refrigeration, as well as a guarantee of employment from an employer registered with the CCQ for at least 150 hours within a period of not more than three consecutive months.

Although the construction industry favours graduates for access to the trade, labour shortages may at times make it necessary to give candidates without a diploma access to the refrigeration mechanic trade.

6. Other conditions than those listed above may apply. For a complete list of conditions for entering the trade, see the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20). You can also consult the CCQ's website: http://www.ccq.org/E_CertificatsCompetence.aspx?sc_lang=en&profil=DevenirTravailleur

Thus, candidates without a diploma[7] are eligible to obtain a competency certificate-apprentice only during a labour shortage and must:

- Supply proof that they have the academic prerequisites for the program leading to a vocational studies diploma (DEP) in the trade referred to in the application or pledge, by signing a consent letter, to take the necessary training to obtain those prerequisites;
- Present a guarantee of employment registered during a labour-pool opening by an employer registered with the CCQ, for at least 150 hours over a period of at most three consecutive months.

The apprentice refrigeration mechanic must have completed four apprenticeship periods of 2,000 hours each (8,000 hours in total) in his trade, in order to be eligible for the provincial qualification examination that, successfully passed, leads to obtaining the competency certificate-journeyman for the trade. Credits are paid into the apprenticeship record book of an apprentice refrigeration mechanic who has obtained his diploma.

Finally, certain qualities are sought by employers hiring new refrigeration mechanics. The following list presents the main qualities, in the order they were mentioned and not in order of importance:

- availability;
- autonomy;
- resourcefulness;
- a customer-based approach and the ability to represent the company for which the refrigeration mechanic is working;
- a sense of responsibility;
- the ability to make decisions on replacing parts and modifying systems;
- for certain contracts, the absence of a criminal record or the possession of specific qualification cards.

7. Ten participants in the analysis workshop held a vocational studies diploma (DEP) in refrigeration, and several had taken retraining offered by the CCQ or manufacturers.

1.9 PLACE OF WOMEN IN THE TRADE

Section 126.0.1 of the Act respecting labour relations, vocational training and workforce management in the construction industry pertains to women's access to the construction industry: "The Commission, after consultation with the Commission des droits de la personne et des droits de la jeunesse, shall develop measures to favour the access of women to and their maintenance and greater representation on the labour market in the construction industry."

According to the CCQ, 5 women practice the refrigeration mechanic trade (out of a total of 2,841 refrigeration mechanics, i.e., a proportion of 0.2% for 2009[8]).

According to the refrigeration mechanics attending the workshop, the low number of women practicing the trade may be explained by:

- the heavy physical requirements involved in some of the trade's tasks;
- the persistence of some prejudice;
- a lack of knowledge of the trade among the public in general and women in particular.

1.10 CAREER PROSPECTS

The trade offers a variety of career prospects. With experience, refrigeration mechanics may become team leaders, foremen, project leaders, project managers or maintenance servicers.

Many also hold positions as manufacturer representatives, dispatchers or technical advisors.

Finally, refrigeration mechanics may become owners of refrigeration or air conditioning companies.

1.11 DEVELOPMENT OF THE TRADE

For several years, the trade has seen major changes, such as:

- new environmental regulations;

8. Commission de la construction du Québec: *Carrières construction*, 2010-2011 edition.

- new refrigeration gases (from three types of gases in the past to over fifty nowadays);
- the increasing use of carbon dioxide (CO_2);
- the “return” of ammonia and natural gases, which are less damaging to the environment, although very dangerous to handle;
- computerized system management, which may be done on site or remotely;
- the introduction of new refrigeration and heat recovery processes and equipment;
- increased automation of refrigeration and air conditioning systems;
- stricter occupational health and safety standards;
- improved work tools.

Those changes require refrigeration mechanics to adapt continually. For example, they must:

- take many retaining courses;
- develop new work methods;
- systematically take precautions to prevent any release of harmful gases;
- carefully and safely handle various types of gases and cylinders;
- meticulously document the gases used and recovered.

Some of the participants pointed out that those changes involve the creation of specialties and that many refrigeration mechanics choose to work in specific fields and with specific refrigerant gases. In addition, given the growing competition in the field of refrigeration, refrigeration mechanics are under pressure to improve their productivity.

1.12 IMPACT OF ENVIRONMENTAL STANDARDS ON THE PRACTICE OF THE TRADE

According to the participants, the new environmental regulations and the introduction of new refrigeration gases are fundamental to the development of the trade and largely explain the changes observed in the trade. It is thought that stricter environmental standards and their harmonization across the world will continue for many years and will make additional changes to the practice of the trade, particularly for handling and recovering gases and cylinders.

2. DESCRIPTION OF THE WORK

2.1 TASKS AND OPERATIONS

List of tasks

The following list presents the main tasks performed by refrigeration mechanics. The order in which the tasks are presented does not necessarily reflect their importance in the trade.

Task 1 Install refrigeration or air conditioning components

Task 2 Connect refrigeration or air conditioning components

Task 3 Check the refrigeration or air conditioning system when stopped

Task 4 Turn on and adjust the refrigeration or air conditioning system

Task 5 Do preventive maintenance on the refrigeration or air conditioning system

Task 6 Troubleshoot the refrigeration or air conditioning system

The table of refrigeration mechanics tasks and operations is presented in the following pages.

Refrigeration mechanics work on the following systems or units:

Residential Sector

Refrigeration Systems or Units	*Air Conditioning Systems or Units*
• Home refrigerator • Freezer • Cold room	• Dehumidifier • Humidifier • Heat pump (geothermics, bienergy) • Heat exchanger • Air conditioning

Industrial, Institutional and Commercial Sectors

Refrigeration Systems or Units

- Ice bank
- Controlled atmosphere room
- Refrigerated counter
- Refrigerated warehouse
- Ice-making machine
- Water cooler (screw system)
- Blast freezer
- Centrifugal system
- Absorption system
- Refrigeration system (cold room, refrigerator)
- Cascade system
- System for arena
- Water tower
- Cryogenic tunnel

Air Conditioning Systems or Units

- Dryer
- Air conditioner
- Dehumidifier
- Heat exchanger
- Humidifier
- Heat reclaim system
- Office air treatment or purifying system (comfort), computer room, laboratory, etc.
- Heat pump (geothermics, bienergy)

Table 2.1 Tasks and Operations

TASKS	OPERATIONS					
1. INSTALL REFRIGERATION OR AIR CONDITIONING COMPONENTS	1.1 Interpret system plans and specifications	1.2 Tour the premises and collect data	1.3 Plan the work and organize the construction site	1.4 Determine a component installation sequence	1.5 Maintain coordination with other trades during installation	1.6 Check the condition of bases and supports
	1.7 Prepare bases and supports	1.8 Ensure that components are accessible for maintenance and repairs	1.9 Install system units	1.10 Write a report on work done		
2. CONNECT REFRIGERATION OR AIR CONDITIONING COMPONENTS	2.1 Interpret system plans and specifications	2.2 Tour the premises and collect data	2.3 Locate, install and connect tubes	2.4 Connect accessories and controls	2.5 Leak test piping	2.6 Repair leaks, if applicable
	2.7 Notify system inspectors, if applicable	2.8 Purge and dehydrate the system	2.9 Turn the system on	2.10 Precharge the system	2.11 Align the direct or belt drive motor(s) and compressor(s)	2.12 Identify units, components and tubes
	2.13 Write a report on work done					
3. CHECK THE REFRIGERATION OR AIR CONDITIONING SYSTEM WHEN STOPPED	3.1 Interpret system plans and specifications	3.2 Tour the premises and collect data	3.3 Check and tighten electrical connections	3.4 Check and preset controls	3.5 Check the operation of all components and related systems	3.6 Fill out the check sheet
	3.7 Check motor direction of rotation	3.8 Write a report on work done				

TASKS	OPERATIONS					
4. TURN ON AND ADJUST THE REFRIGERATION OR AIR CONDITIONING SYSTEM	4.1 Consult user, startup and installation manuals	4.2 Prepare startup	4.3 Start the system	4.4 Make final adjustments to the system	4.5 Perform leak tests at set points	4.6 Inform the customer about system operation and maintenance
	4.7 Clean the premises before leaving the construction site	4.8 Write a report on work done				
5. DO PREVENTIVE MAINTENANCE ON THE REFRIGERATION OR AIR CONDITIONING SYSTEM	5.1 Inspect the system	5.2 Establish system maintenance points and frequency	5.3 Allocate areas of responsibility	5.4 Check system maintenance or repairs done by other trades	5.5 Shut down the system, if applicable	5.6 Perform maintenance operations
	5.7 Turn the system on, if applicable	5.8 Make recommendations for refurbishing the system	5.9 Write a service report			
6. TROUBLESHOOT THE REFRIGERATION OR AIR CONDITIONING SYSTEM	6.1 Make a diagnosis	6.2 Plan the work	6.3 Shut down the system	6.4 Remove and dismantle defective components or accessories	6.5 Replace defective or worn parts or units	6.6 Make conversions or improvements to the system
	6.7 Turn the system on	6.8 Check and adjust components and accessories, as well as the system	6.9 Write a service report			

2.2 OPERATIONS, SUB-OPERATIONS AND CLARIFICATIONS

In the following pages are presented the sub-operations related to some of the operations, as well as a few clarifications made by the participants.

Table 2.2 Sub-Operations and Operation Clarifications

TASK 1 INSTALL REFRIGERATION OR AIR CONDITIONING COMPONENTS

Operations		Sub-Operations		Clarifications
1.1	Interpret system plans and specifications	1.1.1 1.1.2 1.1.3 1.1.4	Check accessibility Check sizes and distances Learn requirements and specifications Obtain information on weight, anchors, etc.	
1.2	Tour the premises and collect data	1.2.1 1.2.2 1.2.3	Locate the electrical room Locate conduits Locate installation areas	
1.3	Plan the work and organize the construction site	1.3.1 1.3.2 1.3.3 1.3.4	Check in the equipment Check the equipment and inventory Classify the equipment Decide where to work	
1.4	Determine a component installation sequence			
1.5	Maintain coordination with other trades during installation	1.5.1 1.5.2	Coordinate with other trades Define work spaces	
1.6	Check the condition of bases and supports	1.6.1 1.6.2 1.6.3 1.6.4	Check the level Take measurements Check sturdiness Check data with plans and specifications	
1.7	Prepare bases and supports	1.7.1 1.7.2 1.7.3 1.7.4 1.7.5 1.7.6	Determine sizes Cut supports Drill in bases Install anchors Align anchors, bases or supports Weld or braze supports	

TASK 1 INSTALL REFRIGERATION OR AIR CONDITIONING COMPONENTS

Operations	Sub-Operations	Clarifications
1.8 Ensure that components are accessible for maintenance and repairs	1.8.1 Check the unit's position 1.8.2 Make sure to have the necessary distance between units	
1.9 Install system units		See the equipment listed in Table 2.3.
1.10 Write a report on work done	1.10.1 Calculate work time 1.10.2 Note the equipment used	

TASK 2 CONNECT REFRIGERATION OR AIR CONDITIONING COMPONENTS

Operations	Sub-Operations	Clarifications
2.1 Interpret system plans and specifications	2.1.1 Check tube gauges 2.1.2 Check tube lengths 2.1.3 Learn insulation requirements	
2.2 Tour the premises and collect data	2.2.1 Locate obstacles 2.2.2 Review the planning, if applicable 2.2.3 Reorganize the construction site, if applicable	
2.3 Locate, install and connect tubes	2.3.1 Drill walls 2.3.2 Cut tubes 2.3.3 Sand and clean tube ends 2.3.4 Join the tubes 2.3.5 Oxy-acetylene or braze weld 2.3.6 Make threaded fittings 2.3.7 Bond tubes 2.3.8 Insulate tubes with an elastomer 2.3.9 Install supports to protect insulation	

TASK 2	CONNECT REFRIGERATION OR AIR CONDITIONING COMPONENTS		
Operations		**Sub-Operations**	**Clarifications**
2.4	Connect accessories and controls	2.4.1 Install: • low-pressure controls • high-pressure controls • expansion valves • access valves • ball valves • one-way valves • etc. 2.4.2 Supervise electric and electronic connection work: • temperature sensors • relays • contactors • solenoids • electric modules • etc.	
2.5	Leak test piping	2.5.1 Apply Régie du bâtiment du Québec standards 2.5.2 Use nitrogen to pressurize piping 2.5.3 Check the tank safety valve	
2.6	Repair leaks, if applicable	2.6.1 Discharge the nitrogen 2.6.2 Make repairs 2.6.3 Repeat the pressure test with nitrogen	
2.7	Notify system inspectors, if applicable	2.7.1 Set up a meeting with the Régie du bâtiment du Québec inspector 2.7.2 Take readings and give the data to the inspector	
2.8	Purge and dehydrate the system	2.8.1 Discharge the nitrogen 2.8.2 Install a filter dryer 2.8.3 Install a sight glass 2.8.4 Connect a vacuum pump 2.8.5 Create a vacuum according to specifications	The vacuum pump may be connected using copper tubing when the pressure is high.
2.9	Turn the system on	2.9.1 Apply the lockout procedure 2.9.2 Turn on the crankcase heater, if applicable	The crankcase heater may be turned on for preloaded units or certain industrial process units, for example.
2.10	Precharge the system	2.10.1 Put the system at the atmospheric pressure 2.10.2 Insulate the tank 2.10.3 Fill the tank with refrigerant	

TASK 2 CONNECT REFRIGERATION OR AIR CONDITIONING COMPONENTS

Operations	Sub-Operations	Clarifications
2.11 Align the direct or belt drive motor(s) and compressor(s)		
2.12 Identify units, components and tubes		
2.13 Write a report on work done	2.13.1 Calculate the work time 2.13.2 Note the equipment used 2.13.3 Fill out the register on gases used	

TASK 3 CHECK THE REFRIGERATION OR AIR CONDITIONING SYSTEM WHEN STOPPED

Operations	Sub-Operations	Clarifications
3.1 Interpret system plans and specifications		
3.2 Tour the premises and collect data	3.2.1 Check the location of components 3.2.2 Detect omissions 3.2.3 Detect defects 3.2.4 Check the work done by other trades regarding: • electricity • tubing (drain) • lagging • the control system • electronic components • fire protection • putting heating cables in place	
3.3 Check and tighten electrical connections	3.3.1 Inspect connections 3.3.2 Measure the voltage 3.3.3 Detect looseness 3.3.4 Tighten connections	

TASK 3 CHECK THE REFRIGERATION OR AIR CONDITIONING SYSTEM WHEN STOPPED

Operations	Sub-Operations	Clarifications
3.4 Check and preset controls	3.4.1 Check controls 3.4.2 Adjust pressure depending on the type of refrigerant 3.4.3 Check compressor safety mechanisms (oil protection, high or low pressure protection, phase protection) 3.4.4 Adjust the internal temperature of compressor oil 3.4.5 Pretest the valve operation sequence 3.4.6 Adjust programmable controllers 3.4.7 Calibrate the sensors 3.4.8 Check the contact valves 3.4.9 Check relay, circuit-breaker and fuse operation	
3.5 Check the operation of all components and related systems	3.5.1 Check oil levels 3.5.2 Check crankcase heater operation 3.5.3 Check the operation of the mechanical room's air exhaust system 3.5.4 Check the operation of protective systems (CO_2 and ammonia)	
3.6 Fill out the check sheet		
3.7 Check motor direction of rotation	3.7.1 Remove the compressor belt, if applicable 3.7.2 Start the motor for a short moment 3.7.3 Invert the phases, if applicable	
3.8 Write a report on work done	3.8.1 Calculate work time 3.8.2 Note the equipment used	

TASK 4 TURN ON AND ADJUST THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Operations	Sub-Operations	Clarifications
4.1 Consult user, startup and installation manuals		
4.2 Prepare startup	4.2.1 Establish the startup sequence, if applicable 4.2.2 Notify the persons present 4.2.3 Coordinate with control room personnel	

TASK 4	TURN ON AND ADJUST THE REFRIGERATION OR AIR CONDITIONING SYSTEM			
Operations		**Sub-Operations**		**Clarifications**
4.3	Start the system	4.3.1 4.3.2 4.3.3 4.3.4 4.3.5 4.3.6	Turn the equipment on Measure operating pressure Add refrigerant, if applicable Add oil, if applicable Detect operating problems Bring necessary correctives	
4.4	Make final adjustments to the system	4.4.1 4.4.2 4.4.3 4.4.4 4.4.5 4.4.6 4.4.7 4.4.8 4.4.9 4.4.10 4.4.11	Check the operation of units Detect obstructions Check alarms Adjust condensers Balance, level or correct the refrigeration gas load Correct the oil level Adjust water intake valves Adjust expansion valves Adjust the temperature Adjust defrost sequences Calibrate the sensors	The extent of adjustments depends on the size and use of systems and on whether systems are preassembled or not.
4.5	Perform leak tests at set points	4.5.1 4.5.2	Perform leak tests Repair leaks	
4.6	Inform the customer about system operation and maintenance	4.6.1. 4.6.2	Inform the customer about: • reactivating alarms • adjusting the temperature (air conditioning only) • the application of certain cleaning procedures Raise awareness of the importance of maintenance for the good operation of the system	
4.7	Clean the premises before leaving the construction site			
4.8	Write a report on work done	4.8.1 4.8.2 4.8.3 4.8.4	Calculate work time Note the equipment used Note recommendations on maintenance operations Fill out the register of refrigeration gases used	

TASK 5 DO PREVENTIVE MAINTENANCE ON THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Operations		Sub-Operations		Clarifications
5.1	Inspect the system	5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6	Browse the service contract and installation plan Browse the specifications, if applicable Locate on site the system's components and accessories Record system equipment Obtain data Collate the information	Specifications are consulted when there is a major problem.
5.2	Establish system maintenance points and frequency	5.2.1 5.2.2 5.2.3	List the units to be maintained Establish the number and frequency of visits List the necessary equipment: • oil • filters • belts • etc.	
5.3	Allocate areas of responsibility	5.3.1 5.3.2	Group maintenance work Send the information to the trades concerned	
5.4	Check system maintenance or repairs done by other trades			
5.5	Shut down the system, if applicable	5.5.1 5.5.2 5.5.3	Recover the refrigerant Shut service valves Cut power	
5.6	Perform maintenance operations	5.6.1 5.6.2 5.6.3 5.6.4 5.6.5 5.6.6 5.6.7	Change the oil Replace filters Replace belts Tighten mechanical and electrical connections Check pressures Check the operation of controls Check the wear and tear of mechanical components	
5.7	Turn the system on, if applicable	5.7.1 5.7.2 5.7.3	Turn the power back on Open service valves Create a demand for refrigeration or air conditioning	

TASK 5 DO PREVENTIVE MAINTENANCE ON THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Operations	Sub-Operations	Clarifications
5.8 Make recommendations for refurbishing the system	5.8.1 Suggest corrections 5.8.2 Estimate costs 5.8.3 Set up a meeting with the customer	
5.9 Write a service report	5.9.1 Calculate work time 5.9.2 Note the equipment used 5.9.3 Note recommendations on maintenance operations 5.9.4 Fill out the register of refrigerant used	

TASK 6 TROUBLESHOOT THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Operations	Sub-Operations	Clarifications
6.1 Make a diagnosis	6.1.1 Analyse system features 6.1.2 Obtain model and serial number information 6.1.3 Measure the pressures 6.1.4 Check the condition of equipment 6.1.5 Detect apparent breakages 6.1.6 Establish the causes of the problem 6.1.7 Establish the solution: • repairs • refurbishment • modification	
6.2 Plan the work	6.2.1 List the necessary equipment 6.2.2 Set up a meeting with the customer	
6.3 Shut down the system	6.3.1 Pump down the refrigerant 6.3.2 Shut service valves 6.3.3 Apply the lockout procedure 6.3.4 Recover the refrigerant, if necessary	
6.4 Remove and dismantle defective components or accessories	6.4.1 Remove system components 6.4.2 Disassemble units, if applicable 6.4.3 Check the wear and tear of parts 6.4.4 Make a final diagnosis 6.4.5 Order spare parts	Units to be disassembled are generally large, because it is often more economical to replace a defective internal component than the entire unit.

TASK 6	TROUBLESHOOT THE REFRIGERATION OR AIR CONDITIONING SYSTEM			
Operations		**Sub-Operations**		**Clarifications**
6.5	Replace defective or worn parts or units	6.5.1	Replace: • solenoids • expansion valves • ball bearings • bushings • etc.	
		6.5.2	Reassemble unit components	
		6.5.3	Install system components	
6.6	Make conversions or improvements to the system	6.6.1	Coordinate with other trades	
		6.6.2	Make a system conversion: • make an oil change • replace the refrigerant • replace filters • etc.	
		6.6.3	Make improvements to the system: • add valves • add condensers • add compressors • etc.	
		6.6.4	Modify piping connections	
6.7	Turn the system on	6.7.1	Apply the refrigerant charging procedure	
		6.7.2	Apply the lockout procedure	
6.8	Check and adjust components and accessories, as well as the system	6.8.1	Take operational readings	
		6.8.2	Measure the data	
		6.8.3	Perform leak tests	
		6.8.4	Make necessary adjustments	
6.9	Write a service report	6.9.1	Calculate work time	
		6.9.2	Note the equipment used	
		6.9.3	Note recommendations on maintenance operations	
		6.9.4	Fill out the register of refrigerant used	

2.3 ACHIEVEMENT CONDITIONS AND PERFORMANCE CRITERIA

2.3.1 Achievement Conditions

Data on achievement conditions were collected for the refrigeration mechanic trade as a whole. The data pertain to aspects such as work areas, level of collaboration, work instructions, reference documents consulted, material resources used, and health and safety hazards.

In Annex 1 is a list of tools and equipment used for each task.

Table 2.3 Achievement Conditions

TASK 1 INSTALL REFRIGERATION OR AIR CONDITIONING COMPONENTS

Workplaces On the construction site. Indoors and outdoors.
Level of collaboration Alone or in a team. Under the foreman's supervision.
Instructions and references Based on plans and specifications. Based on manuals for system units.
Equipment installed Evaporator, condenser, compressor, air conditioner (one-piece or not), cold room components, heat exchanger (including unit heater), refrigerated counter, chiller, cryogenic tunnel, tank, etc.
Health and safety hazards In a context involving hazards: • of electrocution; • of falls; • of cuts; • of chilblains; • of eye injuries; • related to working in enclosed spaces; • related to heavy loads.

TASK 2 CONNECT REFRIGERATION OR AIR CONDITIONING COMPONENTS

Workplaces

On the construction site.
Indoors and outdoors.

Level of collaboration

Alone or in a team.
Under the foreman's supervision.

Instructions and references

Based on plans and specifications.
Based on system control manuals.

Equipment installed

Tubing of various gauges, lengths and thicknesses.[9]

Computer modules, motorized dampers, actuator, temperature controls, pressure controls, pressure switches, humidistat, Freon detector, gas detector, low pressure control, phase protector, relays, sequencer, timer, contactor, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of falls;
- of burns;
- of cuts;
- of intoxication;
- of eye injuries;
- related to work in enclosed spaces.

9. Read on this subject the Professional Subcommittee's comment in Annex 3.

TASK 3 CHECK THE REFRIGERATION OR AIR CONDITIONING SYSTEM WHEN STOPPED

Workplaces

On the construction site.
Indoors and outdoors.

Level of collaboration

In a team.
Under the foreman's and project leader's supervision.

Instructions and references

Based on plans and specifications.
Based on unit manuals and system control manuals.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of falls;
- of chilblains;
- of eye injuries;
- related to work in enclosed spaces.

TASK 4 TURN ON AND ADJUST THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Workplaces

On the construction site.
Indoors and outdoors.

Level of collaboration

Alone or in a team.
Under the foreman's and project leader's supervision.

Instructions and references

Based on plans and specifications.
Based on unit manuals and system control manuals.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of falls;
- of cuts;
- of chilblains;
- of intoxication.

TASK 5 DO PREVENTIVE MAINTENANCE ON THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Workplaces

On the construction site.
Indoors and outdoors.

Level of collaboration

Alone or in a team.
Under the supervision of the company owner.
In collaboration with the dispatcher or representative.

Instructions and references

Based on unit manuals, system control manuals, the service contract, plans, specifications and maintenance procedures.

Health and safety hazards

In a context involving hazards:

- of burns from cold or heat;
- of electrocution;
- of asphyxia;
- related to pressurized gas;
- related to working in heights;
- related to noise;
- related to enclosed spaces.

TASK 6 TROUBLESHOOT THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Workplaces

On the construction site.
Indoors and outdoors.

Level of collaboration

Alone or in a team.
Under the supervision of the company owner.
In collaboration with the dispatcher or representative.

Instructions and references

Based on unit manuals, system control manuals and bid documents.

Health and safety hazards

In a context involving hazards:

- of burns from cold or heat;
- of electrocution;
- of cuts and fractures;
- of intoxication;
- related to heavy loads;
- related to working in heights.

2.3.2 Performance Criteria

Performance criteria were gathered for each task. They are used for assessing whether the tasks were performed satisfactorily. The criteria pertain to aspects such as the quantity and quality of work done, the observance of a work procedure, the attitudes adopted, etc.

To draw the list of criteria related to each task, the participants worked in teams. The teams' results were then collected and presented in full session.

Table 2.4 Performance Criteria

TASK 1 INSTALL REFRIGERATION OR AIR CONDITIONING COMPONENTS	
Performance Criteria	
Level installed components	Observance of the National Building Code of Canada and the Quebec Building Code
Correct spacing of components for maintenance purposes	Observance of earthquake resistance standards
Compliant spacing of components	Meeting deadlines
Full visual inspection of components	Observance of occupational health and safety rules
Observance of plans and specifications	
TASK 2 CONNECT REFRIGERATION OR AIR CONDITIONING COMPONENTS	
Performance Criteria	
Appropriate use of measuring instruments	Free of leaks
Correctly determining the location for piping and accessories	Observance of plans and specifications
Correct execution of vacuum tests	Observance of the National Building Code of Canada and the Quebec Building Code
Correct identification of units, components and piping	Meeting deadlines
Full visual inspection of components	Observance of occupational health and safety rules

TASK 3	CHECK THE REFRIGERATION OR AIR CONDITIONING SYSTEM WHEN STOPPED
Performance Criteria	
Appropriate use of measuring instruments	Precise voltage adjustment
Carefully checking the location of tubing and accessories	Precise pressure adjustment
Checking the operation of safety devices meticulously	Precise adjustment of the flow rate
Checking connections meticulously	Observance of occupational health and safety rules
TASK 4	**TURN ON AND ADJUST THE REFRIGERATION OR AIR CONDITIONING SYSTEM**
Performance Criteria	
Appropriate use of measuring instruments	Precise adjustment of the temperature
Correct execution of performance tests	Precise adjustment of sensors
Accurate diagnosis of an operating problem	Correct determination of the startup sequence
Precise voltage adjustment	Free of leak
Precise pressure adjustment	Observance of lockout procedures
Precise adjustment of the flow rate	Observance of occupational health and safety rules
Precise adjustment of electrical current	
TASK 5	**DO PREVENTIVE MAINTENANCE ON THE REFRIGERATION OR AIR CONDITIONING SYSTEM**
Performance Criteria	
Appropriate use of measuring instruments	Readable service report
Correct execution of performance tests	Observance of recommended maintenance work
Accurate diagnosis of an operating problem	Observance of maintenance procedures
Correct interpretation of unit operating data	Observance of lockout procedures
Precise settings	Observance of occupational health and safety rules
Clean and aesthetic work	

TASK 6 TROUBLESHOOT THE REFRIGERATION OR AIR CONDITIONING SYSTEM	
Performance Criteria	
Appropriate use of measuring instruments	Clean and aesthetic work
Complete record of equipment in place	Accurate diagnosis of the operating problem
Complete record of operating data	Correctly repairing, converting or improving systems
Correctly determining the location for piping and accessories	Observance of the National Building Code of Canada and the Quebec Building Code
Precise settings	Observance of lockout procedures
Compliant execution of performance tests	Observance of occupational health and safety rules

2.4 FUNCTIONS

Functions:

- are a set of interrelated tasks;
- may be defined by work results or by a procedure;
- are natural and concrete sets.

The experts in the refrigeration mechanic trade identified two functions. The work involves:

- a function that consists of putting in place refrigeration and air conditioning systems and that includes the tasks “Install refrigeration or air conditioning components” (task 1) and “Connect refrigeration or air conditioning components” (task 2);

- a function that consists of starting up refrigeration and air conditioning systems and that includes the tasks “Check the refrigeration or air conditioning system when stopped” (task 3) and “Turn on and adjust the refrigeration or air conditioning system” (task 4).

The tasks “Do preventive maintenance on the refrigeration or air conditioning system » (task 5) and “Troubleshoot the refrigeration or air conditioning system” (task 6) are different and cannot be grouped by affinities.

3. QUANTITATIVE DATA ON TASKS

3.1 OCCURRENCE

Occurrence data concern the percentage of refrigeration mechanics[10] who perform a task in the same work environment. The data presented in the tables below are the experts' average results. However, they account for the tasks performed not only by the experts attending the workshop, but also of all refrigeration mechanics working in the companies represented.

Table 3.1 Task Occurrence

Task		Occurrence
1	Install refrigeration or air conditioning components	69.1%
2	Connect refrigeration or air conditioning components	75.6%
3	Check the refrigeration or air conditioning system when stopped	85.0%
4	Turn on and adjust the refrigeration or air conditioning system	92.8%
5	Do preventive maintenance on the refrigeration or air conditioning system	95.6%
6	Troubleshoot the refrigeration or air conditioning system	85.0%

3.2 WORK TIME

Work time, also expressed in percentages, represents the time allocated to each task by each expert, on an **annual** basis.

10. The data exclude apprentices.

Table 3.2 Work Time Allocated to Tasks

Task		Work Time
1	Install refrigeration or air conditioning components	11.9%
2	Connect refrigeration or air conditioning components	13.5%
3	Check the refrigeration or air conditioning system when stopped	9.0%
4	Turn on and adjust the refrigeration or air conditioning system	9.4%
5	Do preventive maintenance on the refrigeration or air conditioning system	23.1%
6	Troubleshoot the refrigeration or air conditioning system	33.1%

3.3 IMPORTANCE AND DIFFICULTY OF TASKS

The **importance** of a task is estimated according to the more or less harmful consequences of performing a task poorly or not at all. The importance is assessed according to the following scale:

1. Not important: Poor execution of the task has no consequences on the quality of the result, the costs, health and safety, etc.

2. Not very important: Poor execution of the task could entail minimal costs, lead to an unsatisfactory result, risk minor injuries or accidents, etc.

3. Important: Poor execution of the task could lead to substantial additional costs, injuries, accidents, etc.

4. Very important: Poor execution of the task could have major consequences in terms of costs, safety, etc.

A task's **difficulty** is assessed according to the following scale:

1. Very easy: The task involves little risk of error; it requires no notable mental or physical effort. Performing the task is less difficult than average.

2. Easy: The task involves a few risks of error; it requires minimal mental or physical effort.

3. Difficult: The task involves many risks of error; it requires a significant mental or physical effort. Performing the task is more difficult than average.

4. Very difficult: The task involves a high risk of error; it requires a major mental or physical effort. The task is among the most difficult in the trade.

The data presented in the table below are the average results for the refrigeration mechanics who participated in the workshop.

Table 3.3 Importance and Difficulty of Tasks

Task	Importance	Difficulty
1 Install refrigeration or air conditioning components	3.9	2.7
2 Connect refrigeration or air conditioning components	4.0	3.0
3 Check the refrigeration or air conditioning system when stopped	3.9	2.6
4 Turn on and adjust the refrigeration or air conditioning system	4.0	3.4
5 Do preventive maintenance on the refrigeration or air conditioning system	3.7	2.4
6 Troubleshoot the refrigeration or air conditioning system	4.0	3.5

4. KNOWLEDGE, SKILLS AND ATTITUDES

The occupational analysis enabled us to specify some of the knowledge, skills and attitudes necessary for performing the tasks. Those qualities are transferable, i.e., applicable to a variety of tasks and situations.

The following pages present the knowledge, skills and attitudes that, according to the participants, are considered essential for performing the tasks of the refrigeration mechanic.

4.1 KNOWLEDGE

Properties of gases and refrigerant fluids

Knowledge of various types of refrigerant gases is essential for safe handling of various types and sizes of mechanical refrigeration systems. This knowledge pertains particularly to:

- applications of various types of gases;
- specific operating pressures and temperatures of gases;
- compatible oils to be used in compressors;
- oil acidity tests.

This knowledge applies mainly to tasks 3, 4, 5 and 6 (“Check the refrigeration or air conditioning system when stopped,” “Turn on and adjust the refrigeration or air conditioning system,” “Do preventive maintenance on the refrigeration or air conditioning system,” “Troubleshoot the refrigeration or air conditioning system”).

Finally, knowledge of the Mechanical Refrigeration Code (CSA B52) is an asset for the refrigeration mechanic.

Physics

The concepts of heat, temperature, flow rate, pressure, volume and enthalpy are essential to the operation of refrigeration and air conditioning systems; understanding them is important for the refrigeration mechanic's work, particularly regarding tasks 4, 5 and 6 ("Turn on and adjust the refrigeration or air conditioning system," "Do preventive maintenance on the refrigeration or air conditioning system," "Troubleshoot the refrigeration or air conditioning system").

The ability to estimate a unit's or component's centre of gravity is also useful for lifting loads.

Electricity

Knowledge of voltage, amperage, resistance, types of current (alternating and direct as well as single-phase and three-phase) and of Ohm's law is essential. It enables refrigeration mechanics to use measuring instruments (such as a multimeter, megohmmetre or ammeter), understand the data collected by those instruments, interpret wiring diagrams, and choose wire gauges. Electrical knowledge is also used to:

- connect accessories and controls (operation 2.4);
- turn the system on (operation 2.9);
- check and preset controls (operation 3.4);
- check the operation of all components and related systems (operation 3.5);
- check motor direction of rotation (operation 3.7);
- start the system (operation 4.3);
- make final adjustments to the system (operation 4.4);
- shut down or start up the system (operations 5.5, 5.7, 6.3 and 6.7);
- make a diagnosis (operation 6.1).

Electronics

Knowledge of electronics is also necessary for practicing the trade, since the refrigeration mechanic must perform tests on electronic components and replace several of them, such as potentiometers and capacitors. In addition, with the arrival new technologies, he must be able to calibrate various sensors. This knowledge of electronics is also essential for system instrumentation and control, particularly for tasks 4, 5 and 6 (“Turn on and adjust the refrigeration or air conditioning system,” “Do preventive maintenance on the refrigeration or air conditioning system,” “Troubleshoot the refrigeration or air conditioning system”).

Computer use

Refrigeration and air conditioning systems can be controlled by computer hardware within the systems or by portable computers. Computers are also used to:

- tour the premises and collect data (operations 1.2, 2.2 and 3.2);
- adjust system settings (operations 3.4 and 4.4);
- shut down or turn on the system (operations 5.5 and 5.7);
- troubleshoot the refrigeration or air conditioning system (task 6).

In some cases, computers are used for writing information about work done and for ordering equipment.

Instrumentation and control

Knowledge of instrumentation and control is essential for practicing the trade, since refrigeration and air conditioning processes consist of sensors, programmable controllers, regulators (including many of the PID[11] type), variable speed drives, timers, programmable thermostats, pressure gauges and pressure regulators, among other things.

Instrumentation and control concepts are useful in all tasks of the trade, particularly to:

- enter set points;
- configure startups;

11. PID: Proportional, integral and derivative.

- adjust system settings, including multi-zone settings;
- start or stop systems.

Welding

Refrigeration mechanics must be able to weld using brazing, oxy-acetylene and electric arc processes (mainly for tack welding).

Mechanics

Refrigeration mechanics must have mechanical knowledge, particularly to:

- disassemble and reassemble certain units (such as compressors);
- repair clutch components;
- solve unit vibration problems;
- align belts and pulleys.

Mathematics

The trade requires an ability to perform the four basic operations, particularly to convert units of measurement and calculate quantities of gas.

Refrigeration mechanics must also have acquired a basic knowledge both of geometry to calculate angles and slopes, and of algebra to solve Ohm's law equations.

Chemistry

A basic knowledge of chemistry is useful for understanding the molecular composition of gases and refrigerant fluids as well as oil pH.

4.2 SKILLS

Skills are types of know-how. They are divided into three categories: cognitive, motor and perceptual.

4.2.1 Cognitive Skills

Problem-solving

This skill is necessary in all tasks of the trade, but task 6, “Troubleshoot the refrigeration or air conditioning system,” is the one that most often requires refrigeration mechanics to have this cognitive skill.

The participants pointed out that troubleshooting operational problems caused by inadequate design or installation requires a high level of problem-solving skills.

Planning activities

The ability to plan the work is essential for installing system components (task 1) and troubleshooting system operation problems (task 6), but is also necessary for starting up and stopping systems (operations 5.5, 5.7, 6.3 and 6.7) and for doing maintenance work.

Decision-making

This skill is particularly useful during emergency repairs or when a system stoppage may cause the owner substantial losses. In those situations, refrigeration mechanics must quickly establish work priorities, advise people and suggest effective solutions.

4.2.2 Motor Skills

The trade of refrigeration mechanic requires the ability to lift loads of up to 25 kg. Beyond this weight, it is specified that refrigeration mechanics must apply occupational health and safety rules, use required equipment or request assistance.

Moreover, good limb coordination is necessary for working in enclosed spaces or in the dark, and for transporting equipment.

It is also mentioned that manual dexterity is required for working outdoors in cold weather.

4.2.3 Perceptual Skills

Vision

This skill is used for interpreting colour codes on electric cables.

In addition, good peripheral vision is useful in preventing work accidents.

Smell

This skill is used for detecting overheating, gas leaks, defective transformers and altered oil compositions.[12]

Touch

Touch is useful for perceiving suctions, temperatures, obstructions and pressures. This skill is also used for handling and fastening hidden components.

4.3 ATTITUDES

Attitudes are ways of acting, reacting and relating with others or with one's environment. They involve personal skills. The main attitudes that refrigeration mechanics need are the following.

Personal attitudes

Patience, the ability to stay calm, and an alert and attentive mind demonstrate attitudes that are appreciated in refrigeration mechanics.

Interpersonal attitudes

These attitudes are necessary for working in a team and in relations with supervisors and customers.

12. Read in Annex 3 the Professional Subcommittee's point on this subject.

They are essential in tasks related to preventive maintenance and to troubleshooting operating problems, because those tasks are often performed in the presence of customers.

Professional ethics

Refrigeration mechanics may hold keys or access codes to enter buildings and do maintenance or troubleshooting work. At times, they must work in buildings where safety is important (banks and police stations, for example). It goes without saying that honesty and confidentiality are essential in those situations.

Preventive attitudes and behaviours in matters of health and safety

These attitudes and behaviours are demonstrated by:

- wearing personal protection and safety equipment;
- vigilance and caution;
- observance of rules, particularly for working in enclosed spaces;
- following lockout procedures.

5. TRAINING SUGGESTIONS

The refrigeration mechanics attending the occupational analysis workshop made suggestions on initial training and the training of journeymen.

With regard to initial training, the participants made the following suggestions:

- The ministère de l'Éducation du Loisir et du Sport should raise the requirements for admission to the program.
- Training should include more field work.
- The School boards' teaching materials should be more up-to-date.
- The ministère de l'Éducation, du Loisir et du Sport should introduce in the program of study a training period in the workplace.
- The school boards should organize more tours of construction sites.
- Students should be trained in the skillful use of basic tools.

As for the training of journeymen, the participants made the following suggestions:

- Apprentices should be better supervised by journeymen.
- Training should be improved by giving apprentices tasks suited to their level and by avoiding repetitive tasks.
- The CCQ should offer retraining courses on the new refrigerant gases, new technologies, instrumentation and control, the environment, and safety equipment.
- The retraining courses should be offered during working hours and be remunerated.
- The CSST should establish or specify certain standards or recommendations for unit installation and access.

Annexes

Annex 1

TOOLS AND EQUIPMENT

For each task of the refrigeration mechanic trade, and on the basis of a list submitted to them[13], the participants determined the tools and equipment they use: hand tools, portable and stationary power tools, brazing and soldering tools, recovery and recycling equipment, charging tools and equipment, diagnostic and measuring equipment, access equipment, rigging, hoisting and lifting equipment, and personal protective equipment and safety equipment.

It should be noted that refrigeration mechanics regularly drive service vehicles to perform their tasks.

Table A.1 Tools and Equipment

TASK 1 INSTALL REFRIGERATION OR AIR CONDITIONING COMPONENTS	
Hand Tools	
- Reamer	- Pry bar
- Tin snips	- Hammer
- Hex keys	- Levels (laser, bubble, precision, line, transit)
- Chalk line	- Crowbar
- Utility knife	- Caulking gun
- Socket sets	- Hack saw
- Orifice drill set	- Screwdrivers
- Flashlight	- Nut drivers
Portable and Stationary Power Tools	
- Hole saw kit	- Impact gun
- Trouble light	- Two-way radio
- Drills (electric, cordless, hammer)	- Saws (jig, reciprocating, band)
Brazing and Soldering Tools	
- Brazing rod	- Torch kit
- Silver solder	- Air fuel equipment
- Soft solder	- Oxy-fuel equipment
- Soldering iron/gun	- Cloth (sand, emery, sandpaper)

13. This list is based on the 2008 Canadian Red Seal occupational analysis *Refrigeration and Air Conditioning Mechanic.*

TASK 1 INSTALL REFRIGERATION OR AIR CONDITIONING COMPONENTS	
Recovery and Recycling Equipment	
- Recovery and recycling unit	- Filter/drier
- Recovery and storage cylinder	- Pressure/temperature chart
- Hazardous waste container	- Liquid pump
Charging Tools and Equipment	
- Charging scales	- Refrigerant and oil pump
- Charging cylinder	- Vacuum pump
- Charging manifold	- Refrigerant hoses
Diagnostic and Measuring Equipment	
- Belt tension indicator	- Caliper
- Alignment tools	- Measuring tape
Access Equipment	
- Scaffolding/staging	- Personnel lift
- Ladders (step, extension)	
Rigging, Hoisting and Lifting Equipment	
- Material lift	- Chain hoist
- Eyebolts	- Shackles
- Chains and cables	- Chain fall
- Hand cart	- Block and tackle
- Forklifts	- Spreader bars
- Rope	- Dollies
- Jacks (hydraulic, mechanical)	- Winch
- Slings	- Come-along
Personal Protective Equipment (PPE) and Safety Equipment	
- Safety boots	- Safety glasses
- Rubber boots	- Welding goggles
- Hard hat	- Mask (dust, particle, filter)
- Fire blanket	- Lock-out kit
- Safety face shield	- Barricades/pylons
- Fall arrest equipment (safety harness, etc.)	- Warning signs
- Electrical live test safety equipment	- Hearing protection (ear plugs, muffs)
- Fire extinguisher	- Respirator
- Gloves (rubber, insulated, leather)	- Flagging
- Welding gloves	- Rubber aprons and coveralls
- Safety goggles	- Rain and winter clothing

TASK 2 CONNECT REFRIGERATION OR AIR CONDITIONING COMPONENTS	
Hand Tools	
- Reamer - Fuse puller - Brushes (wire, paint, acid, tube) - Tin snips - Wrenches (pipe, open end, adjustable, valve, torque) - Hex keys - Chalk line - Bolt cutter - Tube cutter - Pipe cutters - Utility knife - Regulator (CO_2, nitrogen, oxygen, acetylene) - Punch cutters - Orifice drill set - Tap and die set	- Flashlight - Pry bar - Files - Hammer - Mirror - Levels - Flaring tools - Swaging tools - Bending tools and springs - Fin combs - Folding pliers - Cutters (side, wire) - Caulking gun - Hack saw - Drywall saw - Screwdrivers - Nut drivers
Portable and Stationary Power Tools	
- Hole saw kit - Trouble light - Grinder	- Drills (electric, cordless, hammer) - Two-way radio - Saws (jig, reciprocating, band)
Brazing and Soldering Tools	
- Brazing rod - Silver solder - Torch kit	- Oxy-fuel and welding equipment - Cloth (sand, emery, sandpaper)
Charging Tools and Equipment	
- Charging scales - Charging manifold - Refrigerant and oil pump	- Vacuum pump - Refrigerant hoses
Diagnostic and Measuring Equipment	
- Refrigerant scale (mechanical, electronic) - Leak detectors (electronic, ultrasonic, halide, soap tests, litmus test, sulphur test, ultraviolet)	- Micron gauge (mechanical, electronic) - Alignments tools - Measuring tape - Transducers (humidity, pressure, amps, current, voltage)

TASK 2 CONNECT REFRIGERATION OR AIR CONDITIONING COMPONENTS	
Access Equipment	
- Scaffolding/staging - Ladders (step, extension)	- Personnel lift
Rigging, Hoisting and Lifting Equipment	
- Chains and cables - Hand-cart	- Rope - Chain hoist
Personal Protective Equipment (PPE) and Safety Equipment	
- Safety boots - Hard hat - Fall arrest equipment (safety harness, etc.) - Fire extinguisher	- Welding gloves - Safety goggles - Safety glasses - Welding goggles - Rain and winter clothing
TASK 3 CHECK THE REFRIGERATION OR AIR CONDITIONING SYSTEM WHEN STOPPED	
Hand Tools	
- Fuse puller - Chisels - Wrenches (pipe, open end, adjustable, valve, torque) - Hex keys - Snap ring pliers - Utility knife - Valve extractor - Socket sets - Orifice drill set - Flashlight	- Labelling machine - Paint equipment - Mirror - Pliers - Wire strippers - Grease gun - Caulking gun - Straight edge - Screwdrivers - Nut drivers
Portable and Stationary Power Tools	
- Trouble light	- Two-way radio
Recovery and Recycling Equipment	
- Pressure/temperature chart	
Charging Tools and Equipment	
- Refrigerant and oil pump	

TASK 3 CHECK THE REFRIGERATION OR AIR CONDITIONING SYSTEM WHEN STOPPED

Diagnostic and Measuring Equipment

- Carbon monoxide analyzer/detector
- Capacitor tester
- Belt tension indicator
- Megger
- Multimeter (volt, amps, ohms, capacitance)
- Computer
- Litmus paper
- Phase meter (mechanical, electronic)
- Potentiometer
- Refractometer
- Caliper
- Measuring tape

Access Equipment

- Scaffolding/staging
- Ladders (step, extension)
- Personnel lift

Personal Protective Equipment (PPE) and Safety Equipment

- Safety boots
- Hard hat
- Fall arrest equipment (safety harness, etc.)
- Electrical live test safety equipment
- Gloves (rubber, insulated, leather)
- Safety goggles
- Safety glasses
- Lock-out kit
- Warning signs
- Hearing protection
- Respirator
- Rain and winter clothing

TASK 4 TURN ON AND ADJUST THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Hand Tools

- Fuse puller
- Wrenches (pipe, open end, adjustable, valve, torque)
- Hex keys
- Snap ring pliers
- Utility knife
- Regulator (CO_2, nitrogen, oxygen, acetylene)
- Valve core remover
- Socket sets
- Orifice drill set
- Flashlight
- Pry bar
- Files
- Labelling machine
- Flaring tools
- Swaging tools
- Bending tools and springs
- Fin combs
- Crowbar
- Snap pliers for elastic rings
- Pliers
- Wire strippers
- Folding pliers
- Cutters (side, wire)
- Grease gun
- Caulking gun
- Punches
- Hand sprayer

TASK 4 TURN ON AND ADJUST THE REFRIGERATION OR AIR CONDITIONING SYSTEM	
- Pipe threaders - Hammer - Paint equipment - Mirror - Knock-out kit - O-ring removal tool	- Straight edge - Hack saw - Drywall saw - Screwdrivers - Nut drivers
Portable and Stationary Power Tools	
- Vacuum cleaner - Air compressor and regulator - Hole saw kit - Trouble light	- Drills (electric, cordless, hammer) - Two-way radio - Saws (jig, reciprocating, band)
Brazing and Soldering Tools	
- Brazing rod - Silver solder - Soft solder - Soldering iron/gun	- Torch kit - Oxy-fuel and welding equipment - Cloth (sand, emery, sandpaper)
Recovery and Recycling Equipment	
- Recovery and recycling unit - Recovery and storage cylinder - Filter/drier	- Pressure/temperature chart - Liquid pump
Charging Tools and Equipment	
- Charging scales - Charging cylinder - Charging manifold	- Refrigerant and oil pump - Vacuum pump - Refrigerant hoses
Diagnostic and Measuring Equipment	
- Combustion analyzer - Carbon monoxide analyzer/detector - Air quality analyzer - Air volume test equipment - Infrared thermography camera and display unit - Refrigerant scale (mechanical, electronic) - Calculator	- Feeler gauges - Manometers (differential, U-tube, incline, electronic) - Compound gauge - Megger - Micrometer - Micron gauge (mechanical, electronic) - Multimeter (volts, amps, ohms, capacitance)

TASK 4 TURN ON AND ADJUST THE REFRIGERATION OR AIR CONDITIONING SYSTEM	
- Feeler gauge - Capacitor tester - Dial indicator - Thermocouple tester - Flowmeter - Decibel meter - Leak detectors (electronic, ultrasonic, halide, soap tests, litmus test, sulphur test, ultraviolet) - Electronic pressure/temperature chart - Flame safeguard tester - Data loggers - Vibration analysis equipment - Hydrometer - Hygrometer - Belt tension indicator - Pneumatic calibration kit - Computer	- Alignment tools - Phase meter (mechanical, electronic) - Potentiometer - Ruler sling psychrometer - Refractometers - Caliper - Measuring tape - Tachometer - Smoke tester - Thermometers (infrared, electronic, mechanical) - Transducers (humidity, pressure, amps, current, voltage) - Oil test kit - Water analysis kit - Pilot tube - Vacuum gauge
Access Equipment	
- Ladders (step, extension)	
Personal Protective Equipment (PPE) and Safety Equipment	
- Safety boots - Rubber boots - Hard hat - Fall arrest equipment (safety harness, etc.) - Fire extinguisher - Gloves (rubber, insulated, leather) - Safety goggles - Safety glasses	- Welding goggles - Mask (dust, particle, filter) - Lock-out kit - Warning signs - Hearing protection (ear plugs, muffs) - Respirator - Rain and winter clothing

TASK 5	DO PREVENTIVE MAINTENANCE ON THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Hand Tools

- Fuse puller
- Brushes (wire, paint, acid, tube)
- Fish tape
- Tin snips
- Wrenches (pipe, open end, adjustable, valve, torque)
- Hex keys
- Snap ring pliers
- Chalk line
- Utility knife
- Regulator (CO_2, nitrogen, oxygen, acetylene)
- Funnel
- Valve core remover
- Pullers
- Screw extractors
- Scrapers
- Socket sets
- Orifice drill set
- Tap and die set
- Flashlight
- Pry bar
- Files
- Labelling machine
- Hammer
- Mirror
- Fin combs
- Crowbar
- Snap pliers for elastic rings
- Pliers
- Wire strippers
- Folding pliers
- Cutters (side, wire)
- Grease gun
- Caulking gun
- Punches
- Hand sprayer
- Straight edge
- Hack saw
- Drywall saw
- Screwdrivers
- Nut drivers

Portable and Stationary Power Tools

- Vacuum cleaner
- Drill index
- Air compressor and regulator
- Trouble light
- Power washer
- Grinder
- Drills (electric, cordless, hammer)
- Circulating pump
- Transfer pump
- Two-way radio
- Saws (jig, reciprocating, band)

Brazing and Soldering Tools

- Brazing rod
- Torch kit
- Air fuel equipment
- Oxy-fuel equipment
- Cloth (sand, emery, sandpaper)

Recovery and Recycling Equipment

- Hazardous waste container
- Filter/drier
- Pressure/temperature chart
- Liquid pump

TASK 5	DO PREVENTIVE MAINTENANCE ON THE REFRIGERATION OR AIR CONDITIONING SYSTEM

Charging Tools and Equipment

- Refrigerant and oil pump
- Vacuum pump
- Refrigerant hoses

Diagnostic and Measuring Equipment

- Carbon monoxide analyzer/detector
- Air quality tester
- Air volume test equipment
- Feeler gauge
- Capacitor tester
- Dial indicator
- Thermocouple tester
- Flowmeter
- Air flow meter hood
- Leak detectors (electronic, ultrasonic, halide, soap tests, litmus test, sulphur test, ultraviolet)
- Electronic pressure/temperature chart
- Flame safeguard tester
- Data loggers
- Megger
- Hydrometer
- Hygrometer
- UV light
- Magnahelic gauge
- Manometers (U-tube, incline, electronic)
- Micron gauge (mechanical, electronic)
- Multimeter (volts, amps, ohms, capacitance)
- Dye penetrant kit
- Eddy current tester
- Foucault current analyser
- Pneumatic calibration kit
- Computer
- Alignment tools
- Clamp-on ammeter
- Phase meter
- Potentiometer
- Sling psychrometer
- Refractometers
- Caliper
- Measuring tape
- Smoke tester
- Thermometers (infrared, electronic, mechanical)
- Oil test kit
- Water analysis kit
- Pilot tube

Access Equipment

- Ladders (step, extension)
- Personnel lift

Rigging, Hoisting and Lifting Equipment

- Hand-cart
- Rope

Personal Protective Equipment (PPE) and Safety Equipment

- Safety boots
- Rubber boots
- Hard hat
- Fall arrest equipment (safety harness, etc.)
- Electrical live test safety equipment
- Gloves (rubber, insulated, leather)
- Safety goggles
- Safety glasses
- Mask (dust, particle, filter)
- Lock-out kit
- Barricades/pylons
- Hearing protection (ear plugs, muffs)
- Respirator
- Rain and winter clothing

TASK 6 TROUBLESHOOT THE REFRIGERATION OR AIR CONDITIONING SYSTEM	
Hand Tools	
- Reamer - Fuse puller - Brushes (wire, paint, acid, tube) - Chisels - Fish tape - Tin snips - Wrenches (pipe, open end, adjustable, valve, torque) - Hex keys - Snap ring pliers - Bolt cutter - Tube cutter - Pipe cutters - Utility knife - Regulator (CO2, nitrogen, oxygen, acetylene) - Funnel - Squares - Valve core remover - Pullers - Screw extractors - Pipe dies - Scrapers - Socket sets - Orifice drill set - Tap and die set - Flashlight - Pry bar - Files	- Labelling machine - Pipe threaders - Hammer - Paint equipment - Mirror - Knock-out kit - Levels (laser, bubble, precision, line, transit) - O-ring removal tool - Flaring tools - Swaging tools - Bending tools and springs - Fin combs - Crowbar - Snap pliers for elastic rings - Pliers - Wire strippers - Folding pliers - Cutters (side, wire) - Grease gun - Caulking gun - Punches - Hand sprayer - Straight edge - Hack saw - Drywall saw - Screwdrivers - Nut drivers
Portable and Stationary Power Tools	
- Vacuum cleaner - Drill index - Air compressor and regulator - Powder-actuated tools - Hole saw kit - Trouble light - Power washer	- Grinder - Drills (electric, cordless, hammer) - Circulating pump - Transfer pump - Two-way radio - Saws (jig, reciprocating, band) - Router

TASK 6 TROUBLESHOOT THE REFRIGERATION OR AIR CONDITIONING SYSTEM	
Brazing and Soldering Tools	
- Brazing rod - Silver solder - Soft solder - Soldering iron/gun	- Torch kit - Air fuel equipment - Oxy-fuel equipment - Cloth: sand, emery, sandpaper
Recovery and Recycling Equipment	
- Recovery and recycle unit - Recovery and storage cylinder - Filter/drier	- Pressure/temperature chart - Liquid pump
Charging Tools and Equipment	
- Charging scales - Charging cylinder - Charging manifold	- Refrigerant and oil pump - Vacuum pump - Refrigerant hoses
Diagnostic and Measuring Equipment	
- Carbon monoxide analyzer/detector - Air quality tester - Air volume test equipment - Refrigerant scale (mechanical, electronic) - Calculator - Feeler gauge - Capacitor tester - Dial indicator - Thermocouple tester - Flowmeter - Air flow meter hood - Leak detectors (electronic, ultrasonic, halide, soap tests, litmus test, sulphur test, ultraviolet) - Electronic pressure/temperature chart - Flame safeguard tester - Hydrometer - Hygrometer - Belt tension indicator - UV light - Manometers (differential, U-tube, incline, electronic) - Compound gauge	- Megger - Micrometer - Micron gauge (mechanical, electronic) - Multimeter (volts, amps, ohms, capacitance) - Dye penetrant kit - Pneumatic calibration kit - Computer - Alignment tools - Phase meter (mechanical, electronic) - Potentiometer - Sling psychrometer - Refractometer - Caliper - Measuring tape - Stethoscope - Tachometer - Smoke tester - Thermometers (infrared, electronic, mechanical) - Transducers (humidity, pressure, amps, current, voltage) - Oil test kit - Pilot tube - Vacuum gauge

TASK 6 TROUBLESHOOT THE REFRIGERATION OR AIR CONDITIONING SYSTEM	
Access Equipment	
- Scaffolding/staging - Ladders (step, extension)	- Personnel lift
Rigging, Hoisting and Lifting Equipment	
- Material lift - Eyebolts - Chains and cables - Hand-cart - Forklifts - Rope - Jacks (hydraulic, mechanical) - Slings	- Chain hoist - Shackles - Chain fall - Block and tackle - Spreader bars - Dollies - Winch - Come-along
Personal Protective Equipment (PPE) and Safety Equipment	
- Safety boots - Rubber boots - Hard hat - Fire blanket - Safety face shield - Fall arrest equipment (safety harness, etc.) - Electrical live test safety equipment - Fire extinguisher - Gloves (rubber, insulated, leather) - Welding gloves - Safety goggles	- Safety glasses - Welding goggles - Mask (dust, particle, filter) - Lock-out kit - Barricades/pylons - Warning signs - Hearing protection (ear plugs, muffs) - Respirator - Flagging - Rubber aprons and coveralls - Rain and winter clothing

Annex 2

GRIDS OF OCCUPATIONAL HEALTH AND SAFETY ELEMENTS

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Table A.2 Description of Hazards in the Refrigeration Mechanic Trade

No.	Hazards	Effects on Health and Safety	Means of Prevention
1	**Chemical Hazards** • Welding fumes and other welding products (flux, acid, etc.) • Other products (lubricant, adhesives, etc.) • Refrigerant gas leak • Asbestos in materials (walls, thermal insulation, etc.)	• Effects of welding fumes[14]: **Acute effects**: irritation of the eyes and respiratory tracts, pulmonary edema, asphyxia, brazier's disease **Chronic effects:** rhinitis, expectorations, eye pain, coughing, chest pain, headache, bronchitis, pneumonia, pneumoconiosis, sensitivity to pneumonia, professional asthma, lesion or irritation of the skin or mucous membranes, irritative and allergic dermatosis (References No. 1, 2, 3, 4, 5) • pulmonary and eye irritation • respiratory distress • irritation and corrosion of tissues • cardiac rhythm troubles • asphyxia • other possible effects specified on the material safety data sheets of products used. (References No. 6, 7, 8) • Asbestosis, cancer (consult asbestos information on the following website: http://www.reptox.csst.qc.ca)	• Catch smoke at the source and ensure adequate ventilation. • Wear a respirator as necessary (observe exposure values and protective factors, and choose the respirator according to the Occupational Health and Safety Regulation, sec. 45). • Wear appropriate gloves. • Wear splash goggles as necessary. • Took training in safely handling products (WHMIS). • Consult the material safety data sheet and label of each product used (refrigerant gas, welding product, lubricants, adhesives, caulking, etc.). (References No. 9, 10) For work in enclosed spaces, first ensure that, in accordance with regulations (Occupational Health and Safety Regulation, section XXVI): • inherent dangers have been assessed by a qualified person; • the work method is safe and includes proven rescue measures; • the personnel assigned has received adequate training in the work method, rescue measures and personal protective equipment.

14. The effects of welding fumes depend on a multitude of factors, such as the composition of metals welded and the welding equipment, the method used, and the welding parameters. Other effects may be observed depending on the composition of the welding material – metal or flux.

No.	Hazards	Effects on Health and Safety	Means of Prevention
			That safe work method includes, notably: • the presence of a supervisor trained in that role and equipped with a communications system keeping him in permanent contact with the worker without ever entering the enclosed space. He must implement rescue measures in case of emergency; • ventilation of the enclosed space before and throughout the work, by means ensuring a continuous supply of fresh air; • measuring the concentration of contaminants before and throughout the work (by using, among other things, a multigas detector attached to the worker or whose probe is near the worker in the enclosed space. The detector must remain in operation throughout the work); • wearing appropriate personal protective equipment (coveralls, gloves, boots, hard hat, etc.) and respiratory protection as necessary; • emergency recovery devices (fall arrest harness, lifeline, winch, as needed). (References No. 11, 12) • knowing how to recognize materials likely to contain asbestos. An expert is required for confirmation. The work must comply with section 3.23 of the Safety Code for the construction industry (confinement, PPE, etc.).

No.	Hazards	Effects on Health and Safety	Means of Prevention
2	**Physical Hazards** • Hot surface • Cold liquid or very cold surface • Noise • Hot ambient temperature • Very cold ambient temperature • Sudden release of pressurized gas • Unit turned on	• Local skin burns • Chilblains • Hearing loss • Dehydration • Heatstroke • Hypothermia • Local chilblains • Electrification • Electrocution (References No. 13, 14)	• Wear appropriate gloves, use tools adequately, plan the work, took the required training. • Choose less-noisy tools and wear PPE if the source cannot be controlled. • Adapt heatstroke prevention means to the level of risk. (Reference No. 15). • Wear adequate clothing. • Limit exposure time (pauses in a heated area if necessary) or use backup heating. • Limit the workload to avoid excessive sweating. • Cover metal handles and bars with thermal insulation. • Choose machines and tools designed for use without the worker removing his gloves or mittens. • Use backup heating and screens preventing or limiting wind exposure. • Use handling equipment reducing the workload and sweating. • Put a lockout procedure in place. • Have required training in the lockout procedure in application.
3	**Biological Hazards** • Bioaerosols airborne or in ventilation ducts	• Rhinitis, • Flu symptoms • Infection, pneumonia or asthma • Skin irritation • Allergy	• Plan the work: prepare the premises, decontaminate beforehand. (References No. 17, 18)

No.	Hazards	Effects on Health and Safety	Means of Prevention
4	**Ergonomic Hazards** • Repetitive movements, repetitively picking objects up • Elbows and wrists without support • Repetitive use of tools (mechanical pressure) • Restrictive postures • Load handling • Working in a dark or poorly lit area	• Muscular fatigue • Upper limb musculoskeletal disorders (tendinitis, epicondylitis, bursitis, etc.) • Backache • Eye fatigue • Headache	• Choose light tools and of appropriate anthropometric size. • Maintain tools in good condition. • Use adequate handling equipment and have the required training (Reference No. 19). • Use adequate backup lighting.
5	**Safety Hazards**[15] • Dangerous tool shapes • Mechanical pressure • Moving parts • Fire • Working at heights • Working in a cluttered area • Working in an area of difficult access or narrow	• Cuts, contusion, crushing, hand lesions • Calluses on the palms • Crushing, upper limb lesions • Severe burns • Fall from a height • Contusion • Fracture	• Have received training and information on rules for safely handling tools. • Store unused tools and correctly arrange tools used. • Maintain tools: sharpening, honing, etc. • Choose adequate tools. • Protect yourself from moving parts and perform a lockout. See also, in the "Means of Prevention" column of the "Chemical Hazards" section, the information on work in enclosed spaces and on welding safety. • Use a harness, arrange the premises (guardrails), use ladders and stepladders safely (Reference No. 20). • Wear PPE (hardhat, closed shoes, notably), plan the construction site layout to avoid clutter. • Plan the work.
6	**Psychosocial Hazards** • Tight deadline, emergency • Sustained attention	• Stress • Fatigue • Loss of concentration	• Plan and organize the work. • Took the required training and receive the required support.

15. Without being a hazard directly related to practicing the trade, driving a vehicle may be considered hazardous. Many driving accidents occur during work. For more information on this subject, consult the following articles: "Pour prévenir les accidents de la route reliés au travail" and "Une politique de sécurité routière: un exemple!," *Objectif Prévention*, vol. 32, No. 3, p. 12-17.

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The following list does not constitute an exhaustive review of the literature; these references are mentioned by way of indication.

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Table A.3 Hazards Related to the Tasks and Operations of the Refrigeration Mechanic Trade

Legend

0	The risk is nil.
+	The risk is low.
++	The risk is average.
+++	The risk is high.

Risk levels are noted according to exposure to hazards, not according to the gravity of effects on personal health and safety.

No.	Operations and Sub-Operations	Chemical Hazards	Physical Hazards	Biological Hazards	Ergonomic Hazards	Safety Hazards	Psychosocial Hazards
TASK 1	**Install refrigeration or air conditioning components**						
1.1	Interpret system plans and specifications	0	0	0	+	+	+
1.2	Tour the premises and collect data	0	+	+	+	++	0
1.3	Plan the work and organize the construction site	0	0	0	+	++	++
1.4	Determine a component installation sequence	0	0	0	0	0	+
1.5	Maintain coordination with other trades during installation	0	0	0	0	+	+
1.6	Check the condition of bases and supports	0	+	+	+	+	+
1.7	Prepare bases and supports	++	+	+	++	+	0
1.8	Ensure that components are accessible for maintenance and repairs	0	0	0	0	+	+
1.9	Install system units	+	++	+	+++	++	0
1.10	Write a report on work done	0	0	0	+	0	+
TASK 2	**Connect refrigeration or air conditioning components**						
2.1	Interpret system plans and specifications	0	0	0	+	0	++
2.2	Tour the premises and collect data	0	+	+	+	++	+
2.3	Locate, install and connect tubes	++	++	+	++	++	+
2.4	Connect accessories and controls	+	+	0	++	++	+

No.	Operations and Sub-Operations	Chemical Hazards	Physical Hazards	Biological Hazards	Ergonomic Hazards	Safety Hazards	Psychosocial Hazards
2.5	Leak test piping	+	+	0	+	++	+
2.6	Repair leaks, if applicable	++	+	0	+	++	+
2.7	Notify system inspectors, if applicable	0	0	0	+	0	+
2.8	Purge and dehydrate the system	+	++	0	+	++	0
2.9	Turn the system on	0	++	0	+	+	0
2.10	Preload the system	++	+	0	+	+	0
2.11	Align the direct or belt drive motor(s) and compressor(s)	0	+	0	+	++	0
2.12	Identify units, components and tubes	0	+	0	+	+	+
2.13	Write a report on work done	0	0	0	+	0	+
TASK 3	**Check the refrigeration or air conditioning system when stopped**						
3.1	Interpret system plans and specifications	0	0	0	+	0	+
3.2	Tour the premises and collect data	0	+	+	+	++	+
3.3	Check and tighten electrical connections	0	+++	0	++	++	+
3.4	Check and preset controls	0	++	0	++	+	+
3.5	Check the operation of all components and related systems	+	+	0	+	+	+
3.6	Fill out the check sheet	0	0	0	+	0	+
3.7	Check motor direction of rotation	0	+	0	+	++	+
3.8	Write a report on work done	0	0	0	+	0	+
TASK 4	**Turn on and adjust the refrigeration or air conditioning system**						
4.1	Consult user, startup and installation manuals	0	0	0	+	0	++
4.2	Prepare startup	0	+	0	0	0	+
4.3	Start the system	+++	+++	0	++	++	+
4.4	Make final adjustments to the system	+	++	0	++	+	+
4.5	Perform leak tests at set points	++	+	0	++	+	+
4.6	Inform the customer about system operation and maintenance	0	0	0	0	0	+
4.7	Clean the premises before leaving the construction site	+	+	+	++	++	0
4.8	Write a report on work done	0	0	0	+	0	+

No.	Operations and Sub-Operations	Chemical Hazards	Physical Hazards	Biological Hazards	Ergonomic Hazards	Safety Hazards	Psychosocial Hazards
TASK 5	**Do preventive maintenance on the refrigeration or air conditioning system**						
5.1	Inspect the system	0	+	+	+	+	+
5.2	Establish system maintenance points and frequency	0	0	0	+	0	0
5.3	Allocate areas of responsibility	0	0	0	0	0	+
5.4	Check system maintenance or repairs done by other trades	0	+	0	+	+	+
5.5	Shut down the system, if applicable	++	+++	0	+	+	0
5.6	Perform maintenance operations	+	++	0	++	++	+
5.7	Turn the system on, if applicable	0	++	0	+	+	0
5.8	Make recommendations for refurbishing the system	0	0	0	+	0	++
5.9	Write a service report	0	0	0	+	0	+
TASK 6	**Troubleshoot the refrigeration or air conditioning system**						
6.1	Make a diagnosis	+	+	+	+	+	++
6.2	Plan the work	0	0	0	0	0	+
6.3	Shut down the system	++	+++	0	+	+	0
6.4	Remove and dismantle defective components or accessories	+	+	+	+++	++	+
6.5	Replace defective or worn parts or units	+	+	0	++	++	+
6.6	Make conversions or improvements to the system	++	++	+	+++	++	++
6.7	Turn the system on	++	+++	0	+	+	+
6.8	Check and adjust components and accessories, as well as the system	+	+	0	++	++	+
6.9	Write a service report	0	0	0	+	0	+

Annex 3

APPROVAL OF THE PROFESSIONAL SUBCOMMITTEE

At the 68th meeting of the Refrigeration Mechanic Professional Subcommittee, held in Montreal on September 22, 2011, the members approved the present occupational analysis report, while making the following clarifications:

- Page 27, Achievement Conditions, Task 2, Equipment installed:

  In addition to tubing of various gauges, lengths and thicknesses, refrigeration mechanics use Armaflex elastomer insulation to connect refrigeration or air conditioning components.

- Page 42, Perceptual Skills, Smell:

  Refrigeration mechanics cannot rely solely on smell to detect gas leaks, because most of the latter are odourless. In fact, only ammonia, natural gas and propane have a perceptible odour.