

Vocational Training Program

5815

# Refrigeration

Training Sector

7

Buildings  
and Public Works

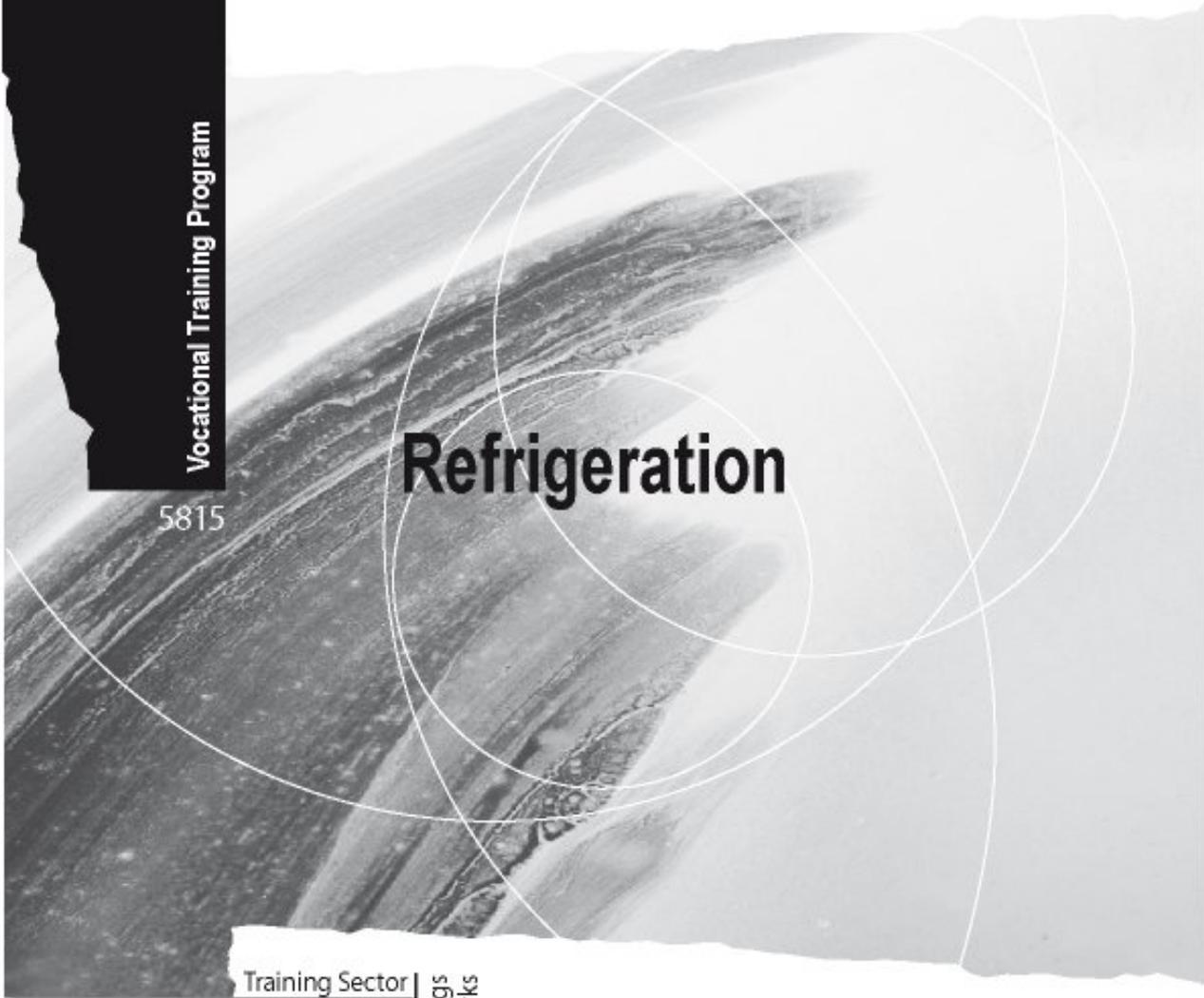
Québec 





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# Refrigeration

Training Sector

7

Buildings  
and Public Works

Formation professionnelle et technique  
et formation continue

Direction générale de la formation  
professionnelle et technique

# Development Team

## Coordination

*Manon Chiasson*

Coordinator, Sectorial training  
Direction générale de la formation professionnelle et  
technique  
Ministère de l'Éducation, du Loisir et du Sport

## Design and Development

*Line Desmarais*

Program development consultant  
Commission scolaire des Hautes-Rivières

*Hubert Dumont*

Teacher  
Commission scolaire de Laval

*Jean Rheault*

Teacher  
Commission scolaire des Bois-Francis

## English Version

Direction de la production en langue anglaise  
Secteur des services à la communauté anglophone  
Ministère de l'Éducation, du Loisir et du Sport

## Technical Editing:

*Éric Faguy*

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## Representatives Employed in Education

---

*Michel Auger*  
Commission scolaire Marie-Victorin

*Jimmy Campagna*  
Commission scolaire du Sault-Saint-Louis

*Daniel Drolet*  
Commission scolaire de la Capitale

*Armand Dumais*  
CSR Lapointe

*Éric Faguy*  
Commission scolaire Marguerite-Bourgeoys

*Francine Ferland*  
Commission scolaire de la Capitale

*Rémi Genest*  
Commission scolaire Marie-Victorin

*Didier Gaudron*  
Commission scolaire de la Capitale

*Martin Gauthier*  
Commission scolaire de la Région-de-Sherbrooke

*Michel Goulet*  
Commission scolaire De La Jonquière

*Roger Lacasse*  
Commission scolaire Les Écores

*André Leclair*  
Commission scolaire Chambly

*Michel Létourneau*  
Commission scolaire du Sault-Saint-Louis

*Daniel Marsolais*  
Commission scolaire de Laval

*Gilles Masson*  
Commission scolaire du Sault-Saint-Louis

*André Métivier*  
Commission scolaire de la Région-de-Sherbrooke

*John Olson*  
Commission scolaire du Sault-Saint-Louis (adult sector)

*Jean-Guy Paquette*  
CECQ

*Gilles Mannighan*  
Commission scolaire Marie-Victorin

*Jean Perron*  
Commission scolaire De La Jonquière

*René Pizzo*  
Commission scolaire de la Région-de-Sherbrooke

*Mario Roy*  
Commission scolaire de la Région-de-Sherbrooke

*Michel Savard*  
Commission scolaire des Bois-Francis

*Sylvain Tremblay*  
Commission scolaire De La Jonquière

*Michel Vigneault*  
Commission scolaire Marguerite-Bourgeoys

## Representatives Employed in the Field

---

*Jules Bergeron*  
Section 3, FTQ Construction, Montréal

*Sam Bergeron*  
Corporation des maîtres entrepreneurs en réfrigération  
du Québec (CMRQ)

*Marcel Bineau*  
Corporation des maîtres entrepreneurs en réfrigération  
du Québec (CMRQ)

*Daniel Cossette*  
Section 3, FTQ Construction, Montréal

*Normand Dupras*  
Corporation des maîtres entrepreneurs en réfrigération  
du Québec (CMRQ)

*Jean-Paul Dusseault*  
Corporation des maîtres mécaniciens en tuyauterie  
du Québec (CMMTQ)

*Pierre Gagnon*  
Corporation des maîtres entrepreneurs en réfrigération  
du Québec (CMRQ)

*José Martinez*  
FTQ

*Jean-Pierre Mimeault*  
Section 3, FTQ Construction, Montréal

*Mario Olivier*  
Corporation des maîtres mécaniciens en tuyauterie  
du Québec (CMMTQ)

*André Pélissier*  
Corporation des maîtres entrepreneurs en réfrigération  
du Québec (CMRQ)

*Marcel Riberdy*  
Section 3, FTQ Construction, Montréal

*Yves Rondeau*  
Commission de la construction du Québec (CCQ)

*Joseph Ruelland*  
AMECQ

*Pierre Sabetta*  
Section 3, FTQ Construction, Montréal

*Sylvain Sergerie*  
Corporation des maîtres entrepreneurs en réfrigération  
du Québec (CMRQ)

*Robert Synott*  
Section 3, FTQ Construction, Montréal

*Jean-Guy Trudeau*  
Corporation des maîtres entrepreneurs en réfrigération  
du Québec (CMRQ)

*Fernand Vallière*  
CFQ, Sherbrooke

*Alain Vary*  
Corporation des maîtres entrepreneurs en réfrigération  
du Québec (CMRQ)

*Bernard Viau*  
Corporation des maîtres entrepreneurs en réfrigération  
du Québec (CMRQ)

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# Introduction to the Program

In vocational training, a program of study presents the competencies required to practise a given trade or occupation at entry level on the job market. The training provided allows students to acquire a degree of versatility that will be useful in their career or personal development.

A program is a coherent set of competencies to be developed. It outlines the knowledge and broad orientations to be favoured during training. The competencies correspond to the tasks of the trade or occupation or to activities related to work, vocational or personal life, depending on the case. Learning is acquired in a specific achievement context and targets the ability to act, succeed and evolve.

According to the *Education Act*, “every program shall include compulsory objectives and contents and may include optional objectives and contents that shall be enriched or adapted according to the needs of students who receive the services.”<sup>1</sup> For behavioural competencies, the compulsory components include the statement of the competency, the elements of the competency, the achievement context and the performance criteria; for situational competencies, they include the corresponding components.

For information purposes, programs also provide a grid of competencies, educational aims, a summary of competency-related knowledge and know-how, and guidelines. They also specify the suggested duration of each competency. All optional components of a program may be enriched or adapted according to the needs of the students, the environment and the workplace.

## Program Components

### Program Goals

Program goals consist of the expected outcome at the end of training as well as a general description of a given trade or occupation. They also include the four general goals of vocational training.

### Educational Aims

Educational aims are broad orientations to be favoured during training in order to help students acquire intellectual or motor skills, work habits or attitudes. Educational aims usually address important aspects of personal and career development that have not been explicitly included in the program goals or competencies. They serve to orient appropriate teaching strategies to contextualize students' learning, in keeping with the dimensions underlying the practice of a trade or occupation. They help guide educational institutions in implementing the program.

### Competency<sup>2</sup>

A competency is the ability to act, succeed and evolve in order to adequately perform tasks or activities related to one's career or personal life, based on an organized body of knowledge and skills from a variety of fields, perceptions, attitudes, etc.

A competency in vocational training can be defined in terms of a behaviour or a situation, and includes specific practical guidelines and requirements for learning.

#### 1. Behavioural Competency

A behavioural competency describes the actions and the results expected of the student. It consists of the following features:

1. See section 461 of the Education Act (R.S.Q., c. 1-33.3) <[www.mels.gouv.qc.ca/lancement/LIP/index.htm](http://www.mels.gouv.qc.ca/lancement/LIP/index.htm)>.
2. For more information about competencies in vocational training, see Québec, Ministère de l'Éducation, du Loisir et du Sport, Reference Framework for Planning Learning and Evaluation Activities: Vocational Training (Québec: gouvernement du Québec, 2005) 8-12, available at <[www.inforoutefpt.org/documents/cadrereference/](http://www.inforoutefpt.org/documents/cadrereference/)>.

- The *statement of the competency* is the result of the job analysis, the orientations and general goals of vocational training and other determinants.
- The *elements of the competency* correspond to essential details that are necessary in order to understand the competency and are expressed in terms of specific behaviours. They refer to the major steps involved in performing a task or to the main components of the competency.
- The *achievement context* corresponds to the situation in which the competency is exercised at entry-level on the job market. The achievement context attempts to recreate an actual work situation but does not describe a learning or evaluation situation.
- The *performance criteria* define the requirements to be respected. They may refer to elements of the competency or to the competency as a whole. When associated with a specific element, performance criteria are used to judge whether a competency has been acquired. When associated with the competency as a whole, the criteria describe the requirements for performing a task or activity and provide information on the expected level of performance or the overall quality of a product or service.

## 2. Situational Competency

A situational competency describes the situation in which students are placed to acquire learning, and allows for actions and results to vary from one student to another. It consists of the following features:

- The *statement of the competency* is the result of the job analysis, the orientations and general goals of vocational training and other determinants.
- The *elements of the competency* outline the essential aspects of the competency and ensure a better understanding of the competency with respect to the expected outcome. The elements of the competency are fundamental to the implementation of the learning situation.
- The *learning context* provides a broad outline of the learning situation designed to help the students develop the required competency. It is normally divided into three key phases of learning: information, participation and synthesis.
- The *instructional guidelines* provide reference points and means for teachers to ensure that learning takes place and that the context in which it occurs is always the same. These guidelines may include general principles or specific procedures.
- The *participation criteria* describe requirements that the students must meet when participating in learning activities. They focus on how the students take part in the activities rather than on the results obtained. Participation criteria are normally provided for each phase of the learning situation.

### Competency-Related Knowledge and Know-How

Competency-related knowledge and know-how together with related guidelines are provided for information purposes. Competency-related knowledge and know-how define the essential and meaningful learning that students must acquire in order to apply and continue to develop the competency. They are in keeping with the job market and are accompanied by guidelines that provide information about the field of application, level of complexity and learning content. They generally encompass learning associated with knowledge, skills, strategies, attitudes, perceptions, etc.

### Duration

The total duration of the program is compulsory and must be observed. It consists of teaching time, which includes time for the evaluation of learning and for enrichment or remedial activities, depending on the students' needs. The duration indicated for a given competency refers to the amount of time needed to develop the competency.

The amount of teaching time corresponds to the amount of time allotted to training, which is established during program development as the average amount of time needed to acquire a competency and evaluate learning. This duration is helpful in organizing training.

### **Credit**

A credit is a unit used for expressing the quantitative value of each competency. One credit corresponds to 15 hours of training.

## **Aspects of Program Implementation**

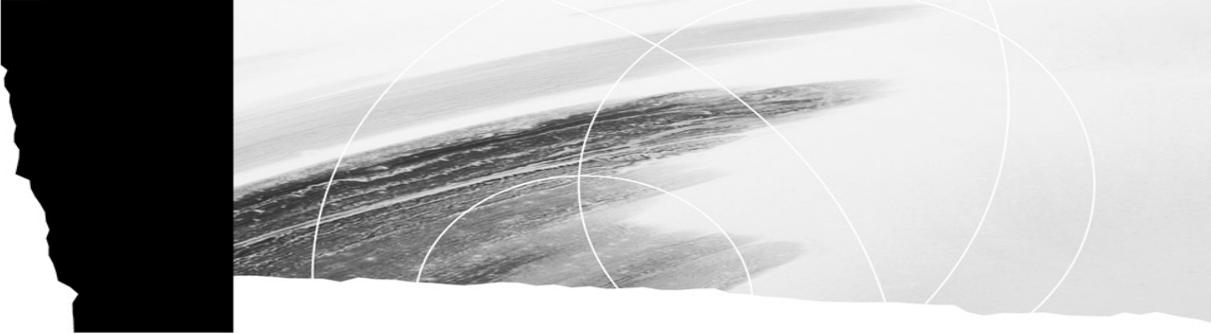
### **Program-Based Approach**

The program-based approach is founded on a comprehensive view of a program of study and its components (e.g. goals, educational aims, competencies). It requires concerted action among all players involved, from the initial stages of program design and development, to program implementation and evaluation. It consists in ensuring that all of the actions and activities proposed are based on the same aims and take into account the same orientations. For students, the program-based approach makes training more meaningful as it presents learning as a coherent whole.

### **Competency-Based Approach**

In vocational training, the competency-based approach is based on a teaching philosophy that is designed to help students mobilize their own individual sets of resources in order to act, succeed and evolve in different contexts, according to established performance levels with all the required knowledge and know-how (e.g. skills, strategies, attitudes, perceptions). The competency-based approach is carried out in situations that reflect vocational and personal life.





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5815

**Refrigeration**

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Year of approval: 2007

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<b>Certification:</b>	Diploma of Vocational Studies
<b>Number of credits:</b>	120 credits
<b>Number of competencies:</b>	27 competencies
<b>Total duration:</b>	1 800 hours

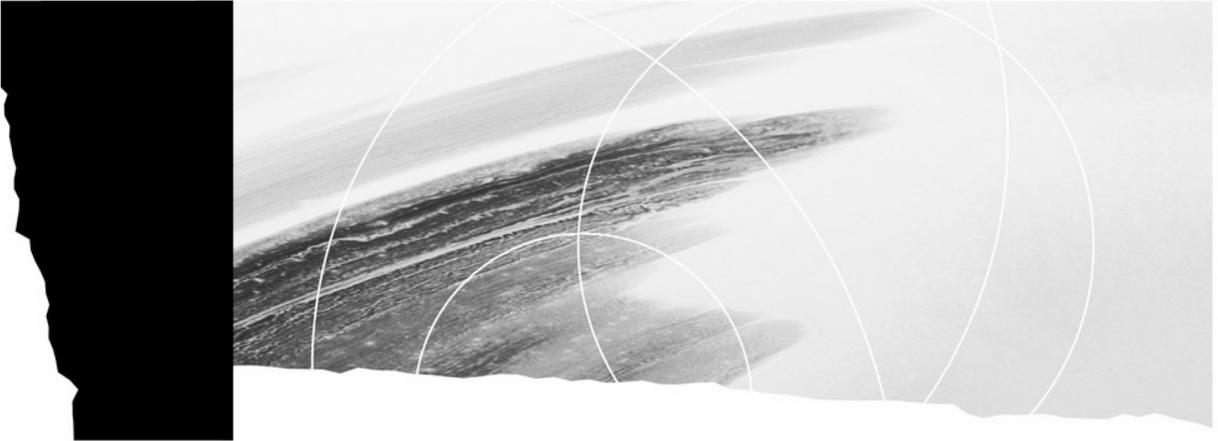
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To be eligible for admission to the *Refrigeration* program, candidates must meet one of the following requirements:

- Persons holding a Secondary School Diploma or its recognized equivalent are not subject to any additional admission requirements.
- OR
- Persons who are at least 16 years of age on September 30 of the year in which their training is to begin must meet the following admission requirement: to have earned Secondary IV credits in language of instruction, second language and mathematics, or to have been granted recognition of equivalent learning.
- OR
- Persons who are at least 18 years of age must have the following functional prerequisites: the successful completion of the general development test and of the language of instruction examination SPR 3, 4, 5, 6 and the mathematics courses MTH 3002-2, or the recognized equivalents.
- OR
- For students having obtained Secondary III credits in language of instruction, second language and mathematics in programs established by the Minister, general education is required in conjunction with vocational training in order to obtain the following credits, if applicable: Secondary IV language of instruction, second language and mathematics in programs established by the Minister.

The duration of the program is 1 800 hours, which includes 690 hours spent on the specific competencies required to practise the trade or occupation and 1 110 hours on general, work-related competencies. The program of study is divided into 27 competencies which vary in length from 15 to 120 hours. The total hours allocated to the program include time devoted to teaching, evaluation of learning and enrichment or remedial activities.

<b>Competency</b>	<b>Code</b>	<b>Number</b>	<b>Hours</b>	<b>Credits</b>
The Trade and the Training Process	937682	1	30	2
Health and Safety on Construction Sites	754992	2	30	2
Refrigeration Cycle	937695	3	75	5
Welding Processes	937703	4	45	3
Basic Maintenance Mechanics	937716	5	90	6
Expansion Valves	937723	6	45	3
Basic Electricity	937736	7	90	6
Use and Recovery of Refrigerants	937744	8	60	4
Basic Refrigeration Operations	937754	9	60	4
Motor Circuits	937768	10	120	8
Reciprocating Compressors	937772	11	30	2
Plans and Specifications	937782	12	30	2
Refrigeration Piping	937793	13	45	3
Fluidic Circuit Regulators	937803	14	45	3
Refrigeration System Installation	937818	15	120	8
Air Conditioning System Installation	937828	16	120	8
Compressors	937833	17	45	3
Refrigeration System Operation	937845	18	75	5
Monobloc Air Conditioning System Operation	937855	19	75	5
Split Air Conditioning System Operation	937867	20	105	7
Digital Control	937876	21	90	6
Air Treatment Processes	937886	22	90	6
Energy Analysis of a System	937894	23	60	4
Liquid Chiller Operation	937905	24	75	5
Central Air Conditioning System Operation	937918	25	120	8
Construction Industry Organizations	754991	26	15	1
Job Search Techniques	937921	27	15	1



# **Part I**

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**Program Goals**

**Educational Aims**

**Statements of the Competencies**

**Grid of Competencies**

**Harmonization**



## Program Goals

The *Refrigeration* program prepares students to practise the trade of refrigeration specialist.

Refrigeration specialists install, maintain, repair and inspect residential central air conditioning systems, commercial and industrial refrigeration and air conditioning systems, and combined heating, ventilation and refrigeration systems. They work for refrigeration and air conditioning companies, food wholesalers and engineering firms, in a variety of industrial environments, and in retail companies that sell and maintain these systems.

They also oversee, maintain and troubleshoot air conditioning units, refrigeration systems, heat pumps, etc. Knowledge of automatic controls, electronics and remote supervision are some of the qualifications required of refrigeration specialists.

The program goals of the *Refrigeration* program are based on the general goals of vocational training. These goals are:

- To help students develop effectiveness in the practice of a trade or occupation, that is:
  - to teach students to perform roles, functions, tasks and activities associated with the trade or occupation upon entry into the job market
  - to prepare students to progress satisfactorily on the job (which implies having the technical and technological knowledge and skills in such areas as communication, problem solving, decision making, ethics, health and safety)
- To help students integrate into the work force, that is:
  - to familiarize students with the job market in general and the context surrounding the trade or occupation they have chosen
  - to familiarize students with their rights and responsibilities as workers
- To foster students' personal development and acquisition of occupational knowledge, skills, perceptions and attitudes, that is:
  - to help students develop their autonomy and ability to learn, and acquire effective work methods
  - to help students understand the principles underlying the techniques and the technology used in the trade or occupation
  - to help students develop self-expression, creativity, initiative and entrepreneurial spirit
  - to help students adopt the attitudes required to successfully practise the trade or occupation, and instill in them a sense of responsibility and a concern for excellence
- To promote job mobility, that is:
  - to help students develop positive attitudes toward change
  - to help students develop the means to manage their careers by familiarizing them with entrepreneurship

## Educational Aims

The aim of the *Refrigeration* program is to help students develop attitudes and behaviours that are deemed essential to the practice of the trade or occupation:

- To adopt behaviours ensuring occupational health and safety.
- To adopt behaviours that foster information exchange and teamwork.
- To show constant concern for the environment.

# Statements of the Competencies

## List of Competencies

- Determine their suitability for the trade and the training process.
- Ensure health, safety and physical well-being on construction sites.
- Analyze the compression refrigeration cycle.
- Perform oxygen cutting, welding and brazing operations.
- Perform basic maintenance mechanics operations.
- Install an expansion valve.
- Perform basic electrical operations.
- Perform tasks related to the use and recovery of refrigerants.
- Perform basic refrigeration operations.
- Verify the operation of a motor circuit and its control devices.
- Verify the operation of a reciprocating compressor.
- Interpret plans and specifications.
- Install refrigeration piping.
- Install a fluidic circuit regulator.
- Install and commission a refrigeration system.
- Install and commission an air conditioning system.
- Rectify compressor malfunctions.
- Ensure the operation of a refrigeration system.
- Ensure the operation of a packaged air conditioning system.
- Ensure the operation of a split air conditioning system.
- Solve problems inherent in digital control.
- Analyze air treatment processes.
- Do an energy analysis of a refrigeration or air conditioning system.
- Ensure the operation of a liquid chiller.
- Ensure the operation of a central air conditioning system.
- Be familiar with construction industry organizations.
- Use job search techniques.

## Grid of Competencies

The grid of competencies shows the relationship between general competencies, which correspond to work-related activities, and specific competencies, which are required to practise the particular trade or occupation, as well as the major steps in the work process.

The general competencies appear on the horizontal axis and the specific competencies, on the vertical axis. The symbol (○) indicates a correlation between a general and a specific competency. The symbol (△) indicates a correlation between a specific competency and a step in the work process. Shaded symbols indicate that these relationships have been taken into account in the acquisition of specific competencies. The logic used in constructing the grid influences the course sequence. Generally speaking, this sequence follows a logical progression in terms of the complexity of the learning involved and the development of the students' autonomy. The vertical axis presents the specific competencies in the order in which they should be acquired and serves as a point of departure for determining how all of the competencies will be taught.

**GRID OF COMPETENCIES**

REFRIGERATION		GENERAL COMPETENCIES																				WORK PROCESS					
		Competency number	Type of competency	Duration (in hours)	Determine their suitability for the trade and the training process	Ensure health, safety and physical well-being on construction sites	Analyse the compression refrigeration cycle	Perform oxygen cutting, welding and soldering operations	Perform basic maintenance mechanics operations	Install an expansion valve	Perform basic electrical operations	Perform tasks related to the use and recovery of refrigerants	Perform basic refrigeration operations	Verify the operation of a motor circuit and its control devices	Verify the operation of a reciprocal compressor	Interpret drawings and specifications	Install refrigeration piping	Install a fluidic circuit regulator	Rectify compressor malfunctions	Solve problems inherent in digital control	Analyse air treatment processes	Do an energy analysis of a refrigeration or air conditioning system	Be familiar with construction industry organizations	Use job search techniques	Find out what needs to be done	Do the work	Check the quality of the work
Competency number	Type of competency	Duration (in hours)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	17	21	22	23	26	27					
Type of competency			S	S	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	S	C				
Duration (in hours)			30	30	75	45	90	45	90	60	60	120	30	30	45	45	45	90	90	60	15	15					
Install and commission a refrigeration system	15	C	120	●	●	●	●	●	●	●	●	●	●	●	●	○					○		○	▲	▲	▲	△
Install and commission an air conditioning system	16	C	120	●	●	●	●	●	●	●	●	●	●	●	●	●					○		○	▲	▲	▲	△
Ensure the operation of a refrigeration system	18	C	75	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○		○	▲	▲	▲	△	
Ensure the operation of a monobloc air conditioning system	19	C	75	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○		○	▲	▲	▲	△	
Ensure the operation of a multi-section air conditioning system	20	C	105	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○		○	▲	▲	▲	△	
Ensure the operation of a liquid cooler	24	C	75	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		○	▲	▲	▲	▲
Ensure the operation of a central air conditioning system	25	C	120	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		○	▲	▲	▲	▲

## Harmonization

The Ministère de l'Éducation, du Loisir et du Sport harmonizes its vocational and technical programs by establishing similarities and continuity between secondary- and college-level programs within a particular sector or between sectors in order to avoid overlap in program offerings, to recognize prior learning and to optimize the students' progress.

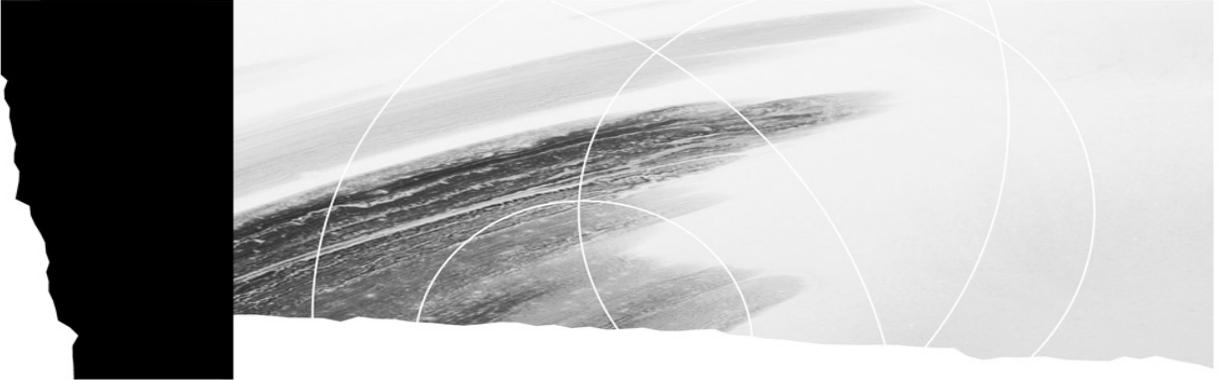
Harmonization establishes consistency between training programs and is especially important in ensuring that the tasks of a trade or occupation are clearly identified and described. Harmonization makes it possible to identify tasks requiring competencies that are common to more than one program. Even if there are no common competencies, training programs are still harmonized.

Harmonization is said to be “inter-level” when it focuses on training programs at different levels, “intra-level” when it focuses on programs within the same educational level, and “inter-sector” when carried out between programs in various sectors.

An important aspect of harmonization is that it allows the common features of competencies to be identified and updated as needed. Common competencies are those that are shared by more than one program; once acquired in one program, they can be recognized as having been acquired in another. Competencies with exactly the same statement and elements are said to be identical. Common competencies that are not identical but have enough similarities to be of equal value are said to be equivalent.

Harmonization of the Refrigeration program has resulted in identifying competencies that are shared with other programs. Detailed information on the harmonization of this program and its results is presented in the document entitled *Tableaux d'harmonisation du programme Refrigeration*.





## **Part II**

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### **Program Competencies**



Competency 1      Duration 30      Hours Credits 2

### ***Situational Objective***

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#### **Statement of the Competency**

Determine their suitability for the trade and the training process.

#### **Elements of the Competency**

- Be familiar with the nature of the trade.
- Understand the training program.
- Confirm their career choice.

#### **Learning Context**

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##### **Information Phase**

- Learning about the training project: program of study, training process, means of evaluation and certification of studies.
- Learning about the job market in refrigeration: work environments (types of companies and products), job prospects, remuneration, potential for advancement and transfer, and hiring criteria.
- Learning about the nature and requirements of the job (tasks, working conditions and workers' rights and responsibilities).

##### **Participation Phase**

- Discussing the skills, aptitudes and knowledge required to practise the trade.
- Discussing the relevance of the program to the work environment of a refrigeration specialist.

##### **Synthesis Phase**

- Assessing their career choice by comparing the different aspects and requirements of the trade with their own preferences, aptitudes and interests.
- Presenting the result of their assessment in a report.

#### **Instructional Guidelines**

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- Create a climate that is conducive to personal growth and to the students' integration into the job market.
- Encourage the students to engage in discussions and to express themselves.
- Motivate the students to take part in the suggested activities.
- Help the students acquire an accurate and objective perception of the trade.
- Provide the students with the means of assessing their career choice honestly and objectively.
- Organize a meeting with specialists in the trade.
- Organize field trips to buildings equipped with refrigeration or air conditioning systems (service rooms).
- Make available all pertinent documentation: information about the trade, program of study, guides, etc.
- Make available a questionnaire-type document intended to help students take notes.

## Participation Criteria

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### Information Phase

- Gather information on most of the topics to be covered.
- Express their views on the trade during a group discussion, relating these views to the information they have gathered.

### Participation Phase

- Give their opinions on some of the requirements that they will have to meet in order to practise the trade.
- Express their views on the training program during a group discussion.

### Synthesis Phase

- Write a report that sums up their preferences, aptitudes and interests and explains how they arrived at their career choice, making explicit connections.

## Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

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The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each phase of the learning context.

### Information Phase

- |  |   |
|--|---|
| • Be receptive to information about the trade and the training program.        | Conditions promoting receptiveness: favourable climate, interest, concentration, and physical and mental well-being   |
| • Make an effort to share their perception of the trade with their classmates. | Advantages of sharing their point of view and listening to others   |
| • Choose a work method.  | Work method: determination of the goal, available sources of information and important points to consider, and recording of important information   |
| • Choose a note-taking method.   | Note-taking method: summary, table, synthesis   |
| • Recognize the main rules governing group discussion.                         | Rules of group discussion: participation, respect of others' right to speak, observance of the topic, attentiveness to others and acceptance of diverging points of view  |
| • Locate the relevant information.   | Information about the job market in refrigeration, the structure of the industry and types of companies, its economic importance, job prospects in the different regions and remuneration<br>Information about the nature and requirements of the job, the main tasks, hiring criteria, working conditions, workers' rights and responsibilities, the importance of personal appearance and the importance of effective communication with colleagues and clients |

<ul style="list-style-type: none"> <li>• Find out about the learning context.</li> </ul>	<p>Layout of facilities, personnel, tasks, equipment and materials used Available equipment and materials Rules</p>
<ul style="list-style-type: none"> <li>• Present the information gathered and discuss their perception of the trade during a group discussion.</li> </ul>	<p>Different workplaces; necessary skills and behaviours; advantages, disadvantages and requirements of the trade</p>
<b>Participation Phase</b>	
<ul style="list-style-type: none"> <li>• Identify the skills, aptitudes, attitudes and knowledge required to practise the trade.</li> </ul>	<p>Distinction between “skills,” “aptitudes,” “attitudes” and “knowledge” Search for the skills, aptitudes, attitudes and knowledge required to practise the trade Physical requirements Employers’ perception of women working in the field of refrigeration</p>
<ul style="list-style-type: none"> <li>• Recognize the attitudes to adopt with colleagues.</li> </ul>	<p>Language used on construction sites Positive effects of collaboration and mutual respect Teamwork and smooth progress</p>
<ul style="list-style-type: none"> <li>• Describe the nature, function and content of the program of study.</li> </ul>	<p>Program objectives Connections between the modules Program development procedure</p>
<ul style="list-style-type: none"> <li>• Discuss the relevance of the program of study with respect to the actual working conditions of refrigeration specialists.</li> </ul>	<p>Connections between the different competencies in the program and the practice of the trade</p>
<b>Synthesis Phase</b>	
<ul style="list-style-type: none"> <li>• Distinguish between “preferences,” “aptitudes” and “interests.”</li> </ul>	<p>Definition of terms</p>
<ul style="list-style-type: none"> <li>• Working individually, analyze their preferences, aptitudes and interests with respect to the requirements of the trade.</li> </ul>	<p>Identification of their qualities and experiential learning Recognition of the types of problems likely to arise Ability to anticipate means of overcoming these problems</p>
<ul style="list-style-type: none"> <li>• State their preferences and aptitudes for the trade and assess their career choice.</li> </ul>	<p>Identification of their qualities and experiential learning Recognition of the types of problems likely to arise Ability to anticipate means of overcoming these problems</p>



Competency 2          Duration 30          hours          Credits 2

## ***Situational Objective***

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### **Statement of the Competency**

Ensure health, safety and physical well-being on construction sites.

### **Elements of the Competency**

- Adopt a responsible attitude regarding dangers to personal health and safety.
- Be aware of the importance of complying with occupational health and safety standards and regulations.
- Recognize dangerous situations or unsafe behaviour and applicable preventive measures.

### **Learning Context**

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#### **Information Phase**

- Learning about the risks inherent in construction sites.
- Learning about the health and safety standards and regulations on construction sites.
- Learning about emergency measures.
- Reflecting on the importance of developing occupational health and safety skills.

#### **Participation Phase**

- Experiencing situations in which it is necessary to prevent risks and eliminate hazards associated with the environment, facilities, equipment, machinery, tools, materials, energy sources, etc.
- Participating in activities that allow students to recognize risks associated with transporting loads and working in constricted postures.
- Participating in activities that allow students to recognize safety signs and symbols (e.g. hazardous products, roadwork, transportation of hazardous materials).
- Comparing different high-risk behaviours observed on a construction site and identifying the basic principles underlying safe behaviour.

#### **Synthesis Phase**

- Producing a report containing:
  - a summary of their newly acquired knowledge and skills
  - an evaluation of their attitude toward occupational health and safety
  - objectives and means of improving their behaviour

### Instructional Guidelines

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- Provide the required sources of information.
- Invite, as needed, resource persons specialized in certain areas of occupational health and safety to speak to the class.
- Make effective use of audiovisual materials.
- Make extensive use of learning situations that are representative of conditions on construction sites.
- Ensure that students avoid dangerous behaviours during simulation exercises.
- Encourage all students to participate in discussions.
- Guide the students' evaluation process by providing them with appropriate tools (e.g. questionnaire) to help them analyze their experience and set objectives.

### Participation Criteria

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#### Information Phase

- Consult available sources of information.
- Describe the advantages of complying with health and safety standards and regulations.

#### Participation Phase

- Participate responsibly in the suggested activities.
- State the principles underlying safe behaviour.
- List the risks inherent in construction sites and the applicable preventive measures.

#### Synthesis Phase

- Produce a report containing:
  - a summary of their newly acquired knowledge and skills
  - an evaluation of their attitude toward occupational health and safety
  - objectives and means of protecting their health, safety and physical well-being, as well as that of others, on a construction site

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

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The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to the learning context.

#### Information Phase

- Be receptive to information on health and safety on construction sites.
- Recognize the most common dangers to health, safety and physical well-being on construction sites.
- Recognize the sources of information relating to health and safety on construction sites and find information in these sources.

Roles and responsibilities in matters relating to health and safety on construction sites  
Regulatory framework governing occupational health and safety

- Identify the advantages of complying with health and safety standards and regulations.

Prevention of illness and accidents  
Importance of wearing personal protective equipment

#### Participation Phase

- Associate the risks inherent in construction sites and the trade with applicable preventive measures.

Risks inherent in the constructive site itself and in the practice of the trade  
Preventive measures to apply according to the risks involved  
Workplace Hazardous Materials Information System (WHMIS)



Competency 3      Duration 75 Hours Credits 5

***Behavioural Objective***

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**Statement of the Competency**

Analyze the compression refrigeration cycle.

**Achievement Context**

- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- To repair an HVAC/R system

**Elements of the Competency****Performance Criteria**

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1. Locate a system's components, accessories and refrigerant lines.

- Accurate location of components, accessories and refrigerant lines
- Determination of the direction of refrigerant flow
- Accurate interpretation of symbols

2. Assess the effect of heat on a system.

- Accurate determination of means of heat transfer
- Correct identification of information about the temperature and condition of the refrigerant
- Accurate information

3. Assess the effect of pressure on a system.

- Correct identification of information about pressure
- Accurate assessment

4. Interpret a system's operating information.

- Accurate location of superheating and subcooling phenomena
- Consideration of physical changes to the refrigerant
- Consideration of the system's operating conditions
- Appropriate use of Mollier diagram
- Accurate interpretation of information

*For the competency as a whole:*

- Appropriate use of terminology
- Correct use of mathematical formulas
- Correct use of measuring instruments
- Observance of occupational health and safety and environmental protection legislation and regulations

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Locate a system's components, accessories and refrigerant lines.

- Distinguish between the different types of components in a system.

Compressor, condenser, expansion valve, evaporator, lines (vacuum, discharge, fluid, condensate), accessories (receiver, filter drier and sight glass)  
Characteristics, function and operation of components
- Draw a diagram of a compression refrigeration cycle.

Graphic representation of a system: symbols for components, lines and accessories  
Direction of refrigerant flow on the diagram  
Characteristics of the refrigerant at the input and output of the components: phases and states
- Make connections between the diagram of a compression refrigeration cycle and a system in operation.

Correspondence between the diagram and the system with respect to the components, accessories, inputs, outputs, phases, states and direction of refrigerant flow in the circuit

#### 2. Assess the effect of heat on a system.

- Analyze the impact of heat on refrigerant fluids.

Composition: atoms and molecules  
Internal and external energy: potential and kinetic  
Energy and heat sources: thermal, electrical and chemical  
Energy transformation  
Effects of heat on matter  
Quantity of energy depending on the phase  
Composition of refrigerants: atoms, molecules, CFCs, HFCs
- Distinguish between the different types of heat transfer.

Conduction, convection and radiation  
Transmission of heat to the evaporator and condenser
- Convert temperatures from one scale to another.

Heat amperage, measurement scales, degrees and measuring instruments  
Temperature scales: Celsius, Fahrenheit, Kelvin and Rankine
- Do calculations related to heat transfers.

Units for measuring heat: BTUs, watts, joules  
Types of heat: sensible, specific and latent

## 3. Assess the effect of pressure on a system.

- Distinguish between the different types of pressure.

Sources of pressure

Pressures exerted by solids, liquids and gases

Types of pressure: atmospheric, manometric, absolute and barometric

Scales and instruments for measuring pressure: psi, inches HG, bar, manometer and barometer

- Calculate the pressure exerted by different substances.

Calculation of the volume of receivers

Calculation of the mass of refrigerant in a receiver

Calculation of the pressure exerted by a solid, a liquid (liquid column) and steam

Calculation of absolute, manometric, atmospheric and barometric pressure and the relationship between barometric and manometric pressure

- Do calculations related to laws involving gases.

Calculation of volume, temperature and pressure related to Charles', Boyle's and Gay-Lussac's laws

- Analyze the impact of pressure on refrigerants.

Impact of pressure on the saturation temperature of liquids and steam and the saturation temperature in the condenser and evaporator

Charts of temperature/pressure ratios

Pressure vs. saturation temperature during evaporation and condensation

## 4. Interpret a system's operating information.

- Recognize the physical changes refrigerants undergo in the compressor.

Reduction in volume vs. increase in pressure:

Boyle's law

Increase in temperature vs. transfer of mechanical energy to heat energy

Influence of compression on condensation

- Recognize the physical changes refrigerants undergo in the condenser.

Sensible heat rejection: attemperation

Latent heat rejection: condensation

Sensible heat rejection: subcooling

Speed of heat transmission vs. temperature difference (TD at the condenser)

- Recognize the physical changes refrigerants undergo during expansion.

Pressure loss

Decrease in saturation temperature

Flash gas, transfer of sensible heat to latent heat

Importance of subcooling

- Recognize the physical changes refrigerants undergo in the evaporator.

Absorption of latent heat: evaporation

Absorption of sensible heat: superheating

Speed of heat transmission vs. temperature difference (TD at the evaporator)

- Identify a system's operational data.  
Pressure and temperature readings  
State of refrigerant at input and output of components
- Plot a system's operating conditions on a Mollier diagram.  
Use of Mollier diagram  
Operating conditions and possible variations

Competency 4      Duration 45      Hours Credits 3

### ***Behavioural Objective***

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#### **Statement of the Competency**

Perform oxygen cutting, welding and brazing operations.

#### **Achievement Context**

- Using data sheets
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- To install, modify or repair an HVAC/R system

#### **Elements of the Competency**

#### **Performance Criteria**

1. Set up an oxyacetylene welding station.

- Observance of assembly and disassembly sequences
- Proper verification of safety devices
- Appropriate adjustment of welding station
- Functional commissioning of welding station

2. Weld pieces of steel using the oxyacetylene process.

- Appropriate positioning and securing of workpieces
- Satisfactory welding techniques
- Quality welds

3. Brazing metals using the oxyacetylene process.

- Satisfactory preparation of metal
- Satisfactory brazing techniques
- Quality brazing

4. Cut ferrous metals using the oxyacetylene process.

- Satisfactory oxyacetylene cutting techniques
- Quality cuts

5. Weld pieces of steel using the electric arc process.

- Appropriate positioning and securing of workpieces
- Satisfactory welding techniques
- Quality welds

*For the competency as a whole:*

- Observance of methods for maintaining tools and equipment
- Appropriate selection of tools
- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Proper use of tools and equipment
- Observance of occupational limitations

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Set up an oxyacetylene welding station.

- Recognize the risks inherent in using and handling gases.
  - Composition and characteristics of gases: acetylene and oxygen
  - Data sheets
  - Acetylene and oxygen cylinders: contents, pressure and fusible safety plugs
  - Pressurized gases: hazards (explosion, burns, fire), handling and storage
- Assemble an oxyacetylene welding station.
  - Components of an oxyacetylene welding station
  - Characteristics, function, use and maintenance
  - Assembly sequence
  - Assembly tools
  - Safety measures
  - Detection of defective threaded joints
  - Detection of defective components
  - Leak test
- Adjust an oxyacetylene welding station.
  - Size of welding tip vs. pressure
  - Pressure and flame adjustments
  - Adjustment techniques: pressure regulating valves; reducing, neutral and oxidizing torches
- Shut down an oxyacetylene welding station.
  - Temporary and long-term shutdown procedures
- Disassemble an oxyacetylene welding station.
  - Disassembly sequence

#### 2. Weld pieces of steel using the oxyacetylene process.

- Distinguish between the different types of ferrous metals.
  - Black steel, galvanized steel, stainless steel, hot-rolled steel and cold-rolled steel
  - Shapes: flat, angle, tube (round, square, rectangular)
- Select a welding tip and a filler metal.
  - Size of welding tip vs. thickness of metal
- Distinguish between the different stages in the oxyacetylene welding process.
  - Butt welding, overlap, T welding, flat welding and welding mild steel
  - Work techniques: positioning and securing of workpiece, use of torch, weld pool and application of filler metal

#### 3. Braze metals using the oxyacetylene process.

- Distinguish between the different types of nonferrous metals.
  - Aluminum, copper, brass

- Select a flux, a welding tip and a filler metal. Data sheets
  - Distinguish between the different stages in the oxyacetylene brazing process.
    - Types of brazing: silver and bronze
    - Importance of preparing the work and adjusting the station
    - Selection of filler metal depending on the metals and their application
    - Use of tube cutter and measuring tape
    - Brazing equipment: operation, use and safety measures
    - Brazing techniques: cleaning, application of fluxing medium, adjustment of flame, heating, application of filler metal and verification
4. Cut ferrous metals using the oxyacetylene process.
- Analyze the impact of oxygen on oxidation. Principle of oxygen oxidization
  - Select a welding tip.
    - Size of welding tip vs. thickness of metal (quantity of heat produced)
    - Cutting torch: characteristics, operation and use
  - Recognize the oxyacetylene cutting process.
    - Importance of preparing the work and adjusting the station
    - Flat- and position-cutting of steel plates, angle iron and square tubing
    - Techniques for cleaning cuts
5. Weld pieces of steel using the electric arc process.
- Use an electric arc welding station.
    - Construction and operating characteristics
    - Components: cables, ground and electrode holder
    - Methods of use and maintenance methods
    - Assembly sequence
    - Reminder of electrical hazards
  - Select an electrode.
    - Types of electrodes, composition, size, application, coating, preservation and selection criteria
    - Data sheet
  - Distinguish between the different stages in the electric arc welding process.
    - Importance of preparing the work and adjusting the station
    - Work techniques: securing of workpieces to be welded, tacking, electrode, position of electrode (angles) and speed
    - Quality of welds: holes, undercut, shortage or surplus of metal, machine too hot or too cold, insufficient or excess penetration
    - Techniques for cleaning welds



Competency 5      Duration 90      Hours Credits 6

***Behavioural Objective***

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**Statement of the Competency**

Perform basic maintenance mechanics operations.

**Achievement Context**

- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- To install, modify or repair an HVAC/R system

**Elements of the Competency****Performance Criteria**

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1. Prepare, modify and assemble pieces of metal.

- Appropriate measuring, marking out and positioning of workpieces
- Proper performance of welding operations
- Observance of indicated dimensions
- Quality assembly

2. Prepare, modify and assemble pieces of sheet metal.

- Appropriate measuring, marking out and positioning of workpieces
- Proper performance of welding operations
- Observance of indicated dimensions
- Quality assembly

3. Prepare, modify and assemble copper piping.

- Appropriate measuring, marking out and positioning of workpieces
- Proper performance of brazing operations
- Observance of indicated dimensions
- Leaktight assembly
- Safe use of pressurized gases

4. Maintain tools.

- Observance of maintenance methods
- Clean, functional tools

*For the competency as a whole:*

- Appropriate selection of tools
- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of occupational limitations

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Prepare, modify and assemble pieces of metal.

- Use measuring instruments and tools for working with metal. Rulers, squares (90° and 45°), micrometer, vernier, centre punches, dividers, hammers, tin snips, hacksaws, metal drills, hand drill, drill press, threading tools, tapping tools, types of threads, vices and cutting oils  
Characteristics, use and maintenance of measuring instruments
- Measure and mark out pieces of metal.
- Cut, file and bend pieces of metal. Angle iron, square iron, flat iron, Cantruss
- Tap and thread pieces of metal. Types of nuts and bolts  
Imperial and metric measurements
- Extract broken bolts.
- Anchor pipe supports. Types of anchors  
Types of concrete drills

#### 2. Prepare, modify and assemble pieces of sheet metal.

- Distinguish between the different types of sheet metal. Black steel, galvanized steel, stainless steel, aluminum and copper  
Characteristics and function
- Measure, cut and bend pieces of sheet metal.
- Assemble pieces of sheet metal. Riveting

#### 3. Prepare, modify and assemble copper piping.

- Distinguish between the different types of piping. Copper, steel (black, galvanized and stainless), aluminum, brass and plastic (ABS, PVC)  
Characteristics (diameter and thickness) and function
- Use tools for working with copper. Reamer, router, bender, bending spring and swaging punch  
Characteristics, use and maintenance of tools

<ul style="list-style-type: none"> <li>• Distinguish between the different types of connectors.</li> </ul>	<p>Connectors: elbows, Ts, fittings, bushing couplings, welded, threaded (conical and cylindrical), male and female            Combined connectors: welded and threaded            Characteristics (diameter and thickness) and function</p>
<ul style="list-style-type: none"> <li>• Prepare copper piping for modification or assembly.</li> </ul>	<p>Measuring, cutting, reaming and dimpling techniques</p>
<ul style="list-style-type: none"> <li>• Make mechanical joints.</li> </ul>	<p>Techniques for making and crimping joints and checking for leaks</p>
<ul style="list-style-type: none"> <li>• Bend copper piping.</li> </ul>	<p>Bending techniques            Calculation of offset</p>
<ul style="list-style-type: none"> <li>• Check a copper piping assembly.</li> </ul>	<p>Leak test: nitrogen pressurization, minimum pressure, maximum safety pressure and use of soap</p>
4. Maintain tools.	
<ul style="list-style-type: none"> <li>• Recognize the importance of having clean, functional tools.</li> </ul>	
<ul style="list-style-type: none"> <li>• Clean, sharpen and grease tools.</li> </ul>	<p>Techniques for sharpening chisels, scribes and metal drills</p>



Competency 6      Duration 45      Hours Credits 3

***Behavioural Objective***

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**Statement of the Competency**

Install an expansion valve.

**Achievement Context**

- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- To install, modify, repair or commission an HVAC/R system

**Elements of the Competency**

---

1. Select an expansion valve.

- Consideration of the system's operating conditions
- Appropriate selection
- Effective use of manufacturers' catalogues

2. Install and connect an expansion valve.

- Observance of installation method
- Quality installation
- Quality connection
- Observance of manufacturer's specifications

3. Adjust an expansion valve.

- Observance of adjustment method
- Proper use of measuring instruments
- Accurate adjustment

*For the competency as a whole:*

- Observance of methods for maintaining tools and equipment
- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Select an expansion valve.

- Distinguish between the different types of expansion valves.

Manual expansion valve or needle valve, capillary tube, calibrated orifice, automatic expansion valve, thermostatic expansion valve, electronic expansion valve

Characteristics, operation and connection

- Recognize the criteria for selecting an expansion valve.

Types of systems, refrigeration capacity, pressure loss, operating parameters of the system and types of connections

Power system load

#### 2. Install and connect an expansion valve.

- Install a capillary tube.

Installation method: cutting, brazing and positioning  
Safety measures

- Install thermostatic expansion valves.

Positioning and location of expansion valve, bulb and external equalizer

#### 3. Adjust an expansion valve.

- Determine the superheating value at the evaporator.

Positioning and installation of measuring instruments on the system

Methods of calculating superheating

Superheating value depending on the application (air conditioning, refrigeration) and operating temperature

Adjustment technique

Competency 7      Duration 90      Hours Credits 6

***Behavioural Objective***

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**Statement of the Competency**

Perform basic electrical operations.

**Achievement Context**

- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- To install, modify, repair or commission an HVAC/R system

**Elements of the Competency**

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1. Inspect an electrical circuit.
2. Draw a circuit diagram.
3. Connect electrical circuit components.

**Performance Criteria**

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- Consideration of the circuit's operating conditions
- Appropriate selection of measuring instruments
- Proper use of measuring instruments
- Accurate calculations and readings
- Accurate identification of components
- Use of appropriate symbols
- Logical operation of circuit
- Clear diagram
- Proper lockout procedure
- Appropriate selection of tools
- Proper use of tools
- Observance of diagram
- Quality connections
- Observance of the appropriate checkpoints

*For the competency as a whole:*

- Compliance with legislation applicable to electrical installations
- Observance of methods for maintaining tools and equipment
- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of occupational limitations

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Inspect an electrical circuit.

- Use specialized terminology. Amperage (ampere), resistance (ohm), voltage (volt) and power (watt)  
*Canadian Electrical Code*
- Recognize electrical symbols. Switches, wiring, motor, heating element, light, fuse, breaker
- Distinguish between the different methods of producing electricity. Chemical, magnetic, thermal, piezoelectric and photoelectric  
Structure of matter  
Movement of electrons, positive charge, negative charge and direction of electrical current  
Principle of electromagnetism
- Distinguish between the different types of current. Alternating current: frequency, peak value, root mean square (RMS) and instantaneous value  
Direct current: voltage, current, polarity and use
- Calculate the operating parameters of an electrical circuit based on Ohm's law. Resistance, amperage, voltage, active power, conductance  
AC or DC circuit with resistive loads
- Interpret procedures for safely accessing hazardous areas of a machine for purposes of inspection, adjustment, the removal of blockages, maintenance, training or repair. *Regulation respecting occupational health and safety*  
Importance and compulsory nature of procedures  
Procedure for accessing hazardous areas of a machine in operation
- Distinguish between the different electrical measuring instruments. Voltmeter, ohmmeter, wattmeter, ammeter (tong-type or serial) and multimeter  
Categories, characteristics, function, use, maintenance and safety measures
- Use electrical measuring instruments. Verification of voltage using a voltmeter  
Determination of state of controls (open or closed) using a voltmeter or ohmmeter  
Hazards associated with a live circuit, safety measures, technique for safely taking readings  
Verification of the amperage of a load using an ammeter

## 2. Draw a circuit diagram.

- Distinguish between the different types of diagrams.
  - Schematic, one-line diagram, block diagram, connection diagram
  - Operating sequence
  - Arrangement of components, indication of connections, symbols
- Distinguish between the different types of electrical circuits.
  - Series, parallel and series-parallel circuits
  - Characteristics
- Distinguish between the different types of switches.
  - SPST (single-pole single-throw), SPDT (single-pole double-throw) and DPDT (double-pole double-throw)
  - Characteristics and function
- Distinguish between the different types of insulators and conductors.
  - Factors determining resistance
  - Application of insulators in electrical circuits
  - Solid or stranded cable
- Distinguish between the different types of electrical boxes.
  - Octagonal, square, for fixtures, for masonry
  - Electrical entry, anchoring, maximum number of conductors, cover plate, location and NEMA classification
- Distinguish between the different types of electrical circuit protection.
  - Fuses: type, function, rating and interrupting capacity
  - Breakers: type, function, operation and rating
  - Parameters of an electrical circuit: application, use, voltage and amperage
  - Grounding
- Distinguish between the different types of circuit breakers.
  - Maximum voltage, output voltage and number of blades
  - Characteristics and function

## 3. Connect electrical circuit components.

- Lock and unlock switches.
- Connect components using copper wire.
  - Use of crimpers and wire strippers
  - Types of joints and fasteners: insulating caps, terminals, connectors and screws
  - Components indicated in specifications
  - Operating parameters of the circuit: voltage and amperage
  - Solid or stranded cable
  - Canadian Electrical Code*
  - Installation and connecting techniques
  - Checkpoints



Competency 8      Duration 60      Hours Credits 4

***Behavioural Objective***

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**Statement of the Competency**

Perform tasks related to the use and recovery of refrigerants.

**Achievement Context**

- Using data sheets
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- Working on HVAC/R systems

**Elements of the Competency****Performance Criteria**

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1. Interpret regulations respecting refrigerants.

- Accurate location of provisions respecting the use and recovery of refrigerants
- Accurate interpretation of provisions respecting the use and recovery of refrigerants

2. Check a refrigeration circuit for leaks.

- Attentive verification of areas likely to leak
- Accurate identification of type of refrigerant
- Observance of leak detection techniques

3. Recover the refrigerant from a refrigeration circuit.

- Appropriate selection of recovery method
- Proper installation of equipment
- Proper use of equipment
- Proper disposal of contaminated refrigerants

4. Charge a refrigeration circuit.

- Appropriate selection of type of refrigerant
- Observance of charging techniques
- Proper charging
- Proper execution of performance tests

5. Keep a refrigerant log.

- Timely and regular updating
- Accurate, complete log in conformity with regulations

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of methods for maintaining tools and equipment
- Appropriate selection of tools

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Interpret regulations respecting refrigerants.

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of refrigerants.</li> </ul>   | <p>Azeotropes (CFCs, HCFCs, HFCs), quasi-azeotropes (HCFCs), zeotropes (HCFCs) and ammonia<br/>Composition, density, specific volume, enthalpy, latent heat, dew point, bubble point and temperature slip<br/>Refrigerant colour code</p>  |
| <ul style="list-style-type: none"> <li>• Distinguish between the different oils used in refrigeration systems.</li> </ul>  | <p>Mineral oils and synthetic oils: characteristics, function and effects on system components, handling and safety measures</p>   |
| <ul style="list-style-type: none"> <li>• Recognize the consequences of refrigerant emissions in the atmosphere.</li> </ul>                                       | <p>Destruction of the ozone layer, greenhouse effect, air pollution and toxicity<br/>Effects of different refrigerants on the ozone layer<br/>ODS, ODP and PRP</p>   |
| <ul style="list-style-type: none"> <li>• Recognize the obligations of refrigeration specialists with respect to the use and recovery of refrigerants.</li> </ul> | <p>Regulations applicable by refrigeration specialists<br/>Obligations with respect to repairing leaks; recharging systems; handling, recovering and storing refrigerants; and disposing of contaminated or recovered refrigerants<br/>Stages in the phasing out of CFCs and HCFCs</p> |

#### 2. Check a refrigeration circuit for leaks.

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• Recognize sources of leaks.</li> </ul>                                   | <p>Welded and mechanical joints<br/>Effects on the operation of the system: temperature difference in the exchangers, reduction of operating pressure and line temperature</p>  |
| <ul style="list-style-type: none"> <li>• Detect leaks.</li> </ul>   | <p>Visual inspection: cleanliness of system, traces of oil, sight glass<br/>Use of materials and equipment: soap, halide torch, electronic detector and pressurization equipment (nitrogen and test tank)<br/>Pressurization techniques</p> |
| <ul style="list-style-type: none"> <li>• Distinguish between the different methods of repairing leaks.</li> </ul> | <p>Welded joint method<br/>Mechanical joint method (nitrogen purge and recovery)<br/>Piping method</p>  |

## 3. Recover the refrigerant from a refrigeration circuit.

- Recognize the sources of refrigerant contamination. Air, water, acids, particles and mixture  
Verification of quality of refrigerants: temperature/pressure ratio and sight glass
- Distinguish between the different methods of recovering refrigerants. Vapour recovery  
Liquid recovery  
Push and pull recovery  
Function, sequence of operations, safety measures, connection of equipment and detection (pressure and temperature)
- Distinguish between the different types of recovery equipment. Characteristics, function, operation and operating limits
- Use tools and equipment to recover refrigerants. Cylinders, electronic balance, conventional balance, test tank

## 4. Charge a refrigeration circuit.

- Perform a pressure test. Pressurization and leak detection techniques
- Evacuate a circuit. Evacuating techniques: vacuum pump  
Alternate dilution
- Determine the type and amount of refrigerant required. Types of refrigerants: name plates on components (compressor, condenser, expansion valve)  
Calculation of amount of refrigerant: volume of receiver and density of refrigerant
- Determine the type and amount of oil required. Oil/refrigerant compatibility
- Distinguish between the different charging methods. Charging equipment: refrigerant tank, balance, test tank  
Vapour injection  
Liquid injection  
Verification of process  
Charging and compatibility of system
- Distinguish between the different operations for replacing prohibited refrigerants. Types and quantity of refrigerant to be recovered  
Disassembly of system, replacement of refrigerant or modifications  
Compatibility with oils and efficiency  
Draining and replacement of oil in compressors and vessels  
Adjustments: pressure switches, regulators and expansion valves

## 5. Keep a refrigerant log.

- Recognize the usefulness of a refrigerant log.

*Regulation respecting halocarbons*

Compulsory content vs. optional content

Procedure for returning used or contaminated refrigerants

Conditions for recharging a system

Using recovered refrigerants

Non-CFC halocarbons

Leak test

Competency 9      Duration 60      Hours Credits 4

***Behavioural Objective***

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**Statement of the Competency**

Perform basic refrigeration operations.

**Achievement Context**

- Using sketches
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- To install, modify, repair or commission an HVAC/R system

**Elements of the Competency**

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**Performance Criteria**

- |   |  |
|---|--|
| 1. Plan the installation of fluidic circuit components. | <ul style="list-style-type: none"> <li>• Appropriate selection of components</li> <li>• Clear sketch of fluidic circuit</li> <li>• Determination of the appropriate tools</li> </ul>   |
| 2. Prepare a refrigeration system for start-up.         | <ul style="list-style-type: none"> <li>• Proper installation of test tank</li> <li>• Appropriate selection of type of refrigerant</li> <li>• Observance of evacuating, leak detection and circuit charging techniques</li> <li>• Proper charging of circuit</li> <li>• Consideration of operational data</li> </ul>  |
| 3. Replace a fluidic circuit accessory.                 | <ul style="list-style-type: none"> <li>• Observance of sequence of operations for removing and reinstalling the component</li> <li>• Proper use of tools and equipment</li> <li>• Proper execution of performance tests</li> <li>• Proper recovery and disposal of refrigerants</li> </ul> <p style="text-align: center;"><i>For the competency as a whole:</i></p> <ul style="list-style-type: none"> <li>• Observance of legislation and regulations pertaining to occupational health and safety and environmental protection</li> <li>• Observance of methods for maintaining tools and equipment</li> </ul> |

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Plan the installation of fluidic circuit components.

- Distinguish between the different types of evaporators.
  - Dry expansion evaporator (plain tubes, finned tubes): characteristics, function and operation
  - Heat transfer methods, direction of fluid circulation, operating TD, delta temperature of the medium and superheating
  - Appearance of frost: causes, inconveniences and consequences
  
- Determine the capacity of an evaporator.
  - Capacity criteria: exchange surface, operating TD and air flow and velocity
  - Calculation of operating TD
  
- Distinguish between the different types of condensers.
  - Air condenser, water condenser: methods of heat transfer, direction of fluid circulation, operating TD, delta temperature of the medium, stages (desuperheating, condensation and subcooling), capacity control system, fan speed deactivation and control
  
- Determine the capacity of an air condenser.
  - Capacity criteria: exchange surface, operating TD and air flow and velocity
  - Method for determining the operating TD depending on the application
  - Calculation of the operating TD
  
- Distinguish between the different fluidic circuit accessories.
  - Vibration dampeners
  - Function and use
  
- Make a sketch of a fluidic circuit.
  - Freehand technique
  - Orthogonal projection
  - Fluidic and mechanical symbols
  - Isometric sketch (on isometric paper)
  - Oblique sketch (on graph paper)
  - Scales: reduced, actual-size and enlarged
  - Importance of standardized lines: visible and hidden contour lines, centre lines, dimension lines, extension lines, section centre lines, direction lines, short or long broken lines, phantom lines, hatching and leader lines
  - T-square, 30°-60° square and triangular scale
  - Function and operation
  - Diagram: piping (liquid, suction and discharge), indication of direction of flow, indication of measurements (length of lines, distances between components and positioning of pipe supports)

<ul style="list-style-type: none"><li>• Make a list of the materials needed.</li></ul>	Components and accessories: types, number, brand names, models and capacity Equipment and tools
2. Prepare a refrigeration system for start-up.	
<ul style="list-style-type: none"><li>• Do a performance test.</li></ul>	Electrical, fluidic and mechanical verification methods Sequences of operations
<ul style="list-style-type: none"><li>• Evacuate and charge a refrigeration system.</li></ul>	Evacuation and recharging techniques Verification of refrigerant: pressure, temperatures, amperage at compressor, subcooling, superheating and line temperature Charging of system Measures to avoid circuit contamination
<ul style="list-style-type: none"><li>• Identify the operational data for a refrigeration system.</li></ul>	Saturation pressures and temperature at the condenser and evaporator Superheating at the evaporator outlet, the compressor inlet, the compressor outlet and the condenser inlet Temperature difference at the evaporator and condenser TD at the evaporator and condenser
3. Replace a fluidic circuit accessory.	
<ul style="list-style-type: none"><li>• Remove and reinstall a fluidic circuit accessory.</li></ul>	Techniques for removing and reinstalling each component Leak test



Competency 10      Duration 120      Hours Credits 8

***Behavioural Objective***

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**Statement of the Competency**

Verify the operation of a motor circuit and its control devices.

**Achievement Context**

- Using circuit diagrams
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working on HVAC/R systems

**Elements of the Competency****Performance Criteria**

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1. Identify the operational data for a single-phase motor circuit.

- Appropriate selection of measuring instruments
- Proper use of measuring instruments
- Satisfactory measuring techniques
- Obvious concern for the integrity of the system and its components

2. Analyze the operational data for a single-phase motor circuit.

- Accurate interpretation of drawings
- Proper use of reference data
- Correct data analysis

3. Identify the operational data for a three-phase motor circuit.

- Appropriate selection of measuring instruments
- Proper use of measuring instruments
- Satisfactory measuring techniques
- Obvious concern for the integrity of the system and its components

4. Analyze the operational data for a three-phase motor circuit.

- Accurate interpretation of drawings
- Proper use of reference data
- Correct data analysis

*For the competency as a whole:*

- Observance of laws and regulations respecting electrical installations
- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of occupational limitations

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Identify the operational data for a single-phase motor circuit.

- Distinguish between the different types of single-phase motors.

Split-phase: construction and operation of squirrel-cage rotors, run and start windings, starting (temporary or permanent split phase, with or without run or start capacitor, asynchronous speed, slip and stall speed)  
High efficiency motors (HEM) (advantages, uses and energy cost)  
Shaded-pole: construction, function and operation, cost, starting torque, running performance and effective outputs  
Information on the name plate
- Distinguish between the different types of loads.

Inductive load and capacitive load  
Voltage-current curves: phase angle, phase vectors and out-of-phase waves  
Characteristics of RCL circuits (series, parallel and series-parallel)  
Vectorial addition (inductive and capacitive)
- Distinguish between the different types of capacitors.

Run or start and run and start motor torque  
Construction, classifications, function, operation and connection  
Grouping: series and parallel  
Capacitance meter: operation and use
- Distinguish between the different types of thermistors.

Positive temperature coefficient (PTC) or negative temperature coefficient (NTC)  
Characteristics, function and operation
- Distinguish between the different types of single-phase motor-compressors.

Without a start capacitor (RSIR), with a start capacitor (CSIR), with a run capacitor (PSC) and with a CSCR motor (capacitator start capacitator run motor)  
Characteristics, function, performance, starting and running torque, power factor  
Interpretation of information on the name plate
- Distinguish between the different single-phase motor-compressor starting system components.

Start windings  
Current relays (amperage), potential relays (voltage), thermistor relays (PTC) and thermal overload protection (internal and external)  
Use, function, operation, connection diagram, position, advantages and verification techniques

- Distinguish between the different types of operational data for single-phase electric motor circuits.

Motor: voltage, amperage, velocity, winding resistance, insulation resistance, up time vs. down time and winding temperature  
 Identification of terminals (CSR) of sealed or hermetic compressors  
 Technique for starting a motor-compressor with a test lead  
 Megohmmeter: function, operation, application and use  
 Technique for verifying the insulation of windings with a megohmmeter  
 Manufacturers' specifications  
 Name plate

## 2. Analyze the operational data for a single-phase motor circuit.

- Distinguish between the different types of transformers.

Single-phase transformer, three-phase transformer and single-phase autotransformer  
 Characteristics, function, operation  
 Cooling method for dry control transformers  
 Operating limits  
 Connection and verification technique  
 Power: in VA or kVA  
 Transformer protection  
 Interpretation of information on the name plate

- Distinguish between the different types of pressure controls.

Low-pressure control  
 High-pressure control  
 Dual pressure control (low and high pressure)  
 Differential pressure control (also known as oil pressure control, oil failure control or oil failure switch)  
 Characteristics, function, operation, connection, installation and verification  
 Types of adjustments: control or protection  
 Adjustment techniques

- Distinguish between the different types of thermostatic controls.

Thermostat: room, product to be cooled, coil, evaporator fan delay and defrost termination  
 Characteristics, function, operation, adjustment, connection, installation and verification

- Distinguish between the different types of automatic defrost timers.

Electromechanical timer  
 Digital control timer  
 Natural and electrical defrost  
 Characteristics, function, operation, adjustment and connection

<ul style="list-style-type: none"> <li>Distinguish between the different types of magnetic starters.</li> </ul>	Contactors: coil, number of contacts, types of contacts and capacity of contacts Auxiliary contact: plug-in or instant contact, timed or conventional Thermal protection at the starter Characteristics, function, operation and verification
<ul style="list-style-type: none"> <li>Distinguish between the different types of magnetic relays.</li> </ul>	Characteristics, function, operation and verification
<ul style="list-style-type: none"> <li>Distinguish between the different types of solenoid valves.</li> </ul>	Coil, armature and electric plunger Characteristics, function, operation and verification Use with a pump-down system
<ul style="list-style-type: none"> <li>Draw a diagram of a single-phase electrical circuit.</li> </ul>	Operating conditions: voltage (power circuit and control circuit) and amperage (fuses) Operating sequence Components of an electrical circuit: main isolating switch, transformer, fuses, contactors, thermal protection, pressure switches, thermostats, defrost timers and single-phase motors Electrical symbols
<ul style="list-style-type: none"> <li>Draw a connection diagram of a single-phase electrical circuit.</li> </ul>	Control sequence Arrangement of components, connection points of different components, wiring configuration, economic aspect, insulating caps and junction boxes
<ul style="list-style-type: none"> <li>Recognize the symptoms of poorly functioning control circuits with single-phase electric motors.</li> </ul>	Possible situations: high or low operating voltage High or low operating amperage, condition of mechanical components and wear High operating temperature Short cycles Intermittent problems
3. Identify the operational data for a three-phase motor circuit.	
<ul style="list-style-type: none"> <li>Distinguish between the different types of three-phase electric motors.</li> </ul>	Squirrel cage induction motor: connections (star or delta), full-voltage starting motor, motor with part winding starting and motor with reduced voltage starting (star/delta) Determination of rotation speed of motors Rotating magnetic field: principle, source and advantages Interpretation of information on the manufacturer's name plate
<ul style="list-style-type: none"> <li>Calculate the operating parameters of a three-phase alternating current circuit.</li> </ul>	Characteristics of star and delta assemblies: line voltage and amperage, phase voltage and amperage, and dissipated and output power Calculations on a resistance circuit

- Distinguish between the different components of a three-phase motor starting circuit.
  - Magnetic starters
  - AC variable-speed drives for asynchronous motors: specifications for inlet and outlet power supply, torque, efficiency and protection
  - Protection systems for three-phase motors: overload protection (external, internal) integrated into the starter (permanent and adjustable)
  - Phase loss, inversion or imbalance detectors
  - Function, operation and adjustment
- Distinguish between the different types of operational data for three-phase electric motor circuits.
  - Motors: voltage, amperage, velocity, winding resistance, insulation resistance, up time vs. down time and winding temperature
  - Verification of winding insulation using a megohmmeter
  - Condition of contacts: relays, contactors, pressure switches and thermostats
  - Verification of windings: relays, contactors and solenoids
  - Manufacturers' specifications
  - Name plate

#### 4. Analyze the operational data for a three-phase motor circuit.

- Draw a diagram of a three-phase electrical circuit.
  - Operating conditions: voltage (power circuit, control circuit), amperage (fuses) and phase balancing
  - Operating sequence
  - Components of an electrical circuit: main isolating switch, transformer, fuses, contactors, thermal protection, pressure switches, thermostats, defrost timers and three-phase motors
  - Electrical symbols
- Draw a connection diagram of a three-phase electrical circuit.
  - Arrangement of components, connection points of the different components, wiring configuration, economic aspect, insulating caps and junction boxes
- Recognize the symptoms of poorly functioning control circuits with three-phase electric motors.
  - Possible situations: high or low operating voltage
  - High or low operating amperage
  - Condition of mechanical components
  - High operating temperature: ambient temperature, cleanliness, ventilation and phase imbalance (formulas and calculation)
  - Short cycles
  - Intermittent problems



Competency 11      Duration 30      Hours Credits 2

***Behavioural Objective***

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**Statement of the Competency**

Verify the operation of a reciprocating compressor.

**Achievement Context**

- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- To repair or commission an HVAC/R system

**Elements of the Competency**

1. Analyze the operational data for a reciprocating compressor.
2. Disassemble a reciprocating compressor.
3. Reassemble a reciprocating compressor.

**Performance Criteria**

- Accurate identification of operational data
- Consideration of manufacturer’s specifications
- Proper performance of disassembly operations
- Obvious concern for the cleanliness of the work area
- Relevant and systematic verifications
- Proper performance of reassembly operations
- Functional compressor

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Appropriate selection of tools and equipment
- Observance of methods for maintaining tools and equipment

**Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

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The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

1. Analyze the operational data for a reciprocating compressor.

- Distinguish between the different types of reciprocating compressors.

Open, hermetic and sealed  
 Characteristics, function and operation  
 Types of open compressor drives: direct or belt drive

<ul style="list-style-type: none"> <li>• Distinguish between the different components of a reciprocating compressor.</li> </ul>	<p>Immovable components, movable components and fastening devices                      Characteristics (materials: copper, brass, steel, aluminum and composite), function and operation                      Resistance of components</p>
<ul style="list-style-type: none"> <li>• Recognize the operating stages of a reciprocating compressor.</li> </ul>	<p>Decompression, vacuum, compression and discharge cycles, and clearance pocket</p>
<ul style="list-style-type: none"> <li>• Recognize the operating conditions of a reciprocating compressor.</li> </ul>	<p>Splash lubrication methods                      Force-feed lubrication methods: pump, screen, filter and path and function of oil                      Operating conditions that affect capacity                      Possible causes of malfunctions</p>
<ul style="list-style-type: none"> <li>• Evaluate the refrigerating capacity of a reciprocating compressor.</li> </ul>	<p>Measurement of construction parameters: pistons, number, diameter and stroke                      Rotation speed                      Calculations of volume displacement, compression rate and hourly gas volume displacement (cubic feet per hour)                      Percentage efficiency                      Reference to manufacturers' specifications</p>
<p>2. Disassemble a reciprocating compressor.</p>	
<ul style="list-style-type: none"> <li>• Recognize the steps involved in the disassembly of a reciprocating compressor.</li> </ul>	<p>Steps: identification of parts and their original position                      Specialized tools: wrenches, sockets, ratchet wrench, torque wrench, vernier and micrometer                      Quantity of oil removed and oil acid test                      Safety measures</p>
<ul style="list-style-type: none"> <li>• Detect malfunctions in reciprocating compressor parts.</li> </ul>	<p>Mechanical parts                      Abnormal wear, rust, grooves and distortion</p>
<ul style="list-style-type: none"> <li>• Select replacement parts for a reciprocating compressor.</li> </ul>	<p>Manufacturers' documentation: exploded view, specifications and part numbers</p>
<p>3. Reassemble a reciprocating compressor.</p>	
<ul style="list-style-type: none"> <li>• Recognize the steps involved in the reassembly of a reciprocating compressor.</li> </ul>	<p>Steps: identification of original position of parts, production of seals, cleaning of parts (types of solvents), installation of trim, tightening sequence and torque, verifications (clearances, rotation and seal) and oil filling (type and amount of oil, oil pump)                      Safety measures</p>

Competency 12      Duration 30      Hours Credits 2

***Behavioural Objective*****Statement of the Competency**

Interpret plans and specifications.

**Achievement Context**

- To install, modify, repair or commission an HVAC/R system

**Elements of the Competency****Performance Criteria**

1. Locate elements on a plan.

- Accurate interpretation of symbols and lines
- Accurate interpretation of title block and legends
- Accurate location of elements

2. Locate a system and its components on a plan.

- Accurate interpretation of symbols and lines
- Accurate interpretation of title block and legends
- Accurate location of HVAC/R system and its components

3. Analyze specifications.

- Proper use of index and sections
- Detailed analysis of specifications pertaining to the HVAC/R system

*For the competency as a whole:*

- Obvious concern for detail
- Systematic work method

**Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

1. Locate elements on a drawing.

- Distinguish between the different types of plans.

Architectural plan, structural drawing, mechanical drawing (plumbing, ventilation, refrigeration and air conditioning), electrical drawing (lighting, motors, other loads and outlets) and monitoring plans (electrical, pneumatic and digital)

- Recognize conventional lines and shapes used in drafting.

Types of lines, views, sections and dimensioning  
Geometric shapes

- Interpret a title block.

Information  
Scales: importance of visualizing proportions

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Distinguish between the different conventional symbols used in structural and architectural drawings.</li> </ul> | <p>Symbols denoting materials: concrete, brick, wood, steel and other metals, insulation and coverings</p> <p>Symbols for architectural elements: doors, windows and partitions</p>  |
| <ul style="list-style-type: none"> <li>• Distinguish between the different conventional symbols used in plumbing.</li> </ul>                              | <p>Drainage, vents, water supply and circulation of chilled and heating water</p> <p>Ducts: types, shapes and location</p> <p>Components: pump, heating and cooling coil, tank, sink, toilet, bathtub, urinal and shower</p> |
| <ul style="list-style-type: none"> <li>• Distinguish between the different conventional symbols used in ventilation.</li> </ul>                           | <p>Air distribution system, network of supply and return ducts and evacuation system</p> <p>Ducts: types, shapes and location</p> <p>Components: fan, damper, limit switch box, grille, air diffuser and exterior hood</p>   |
| <ul style="list-style-type: none"> <li>• Distinguish between the different conventional symbols used in refrigeration and air conditioning.</li> </ul>    | <p>Piping</p> <p>Components: compressor and compressor unit, condenser, evaporator, exchanger, water tower, motor, expansion valve, regulator, accessories, valves, manometer and thermometer</p>                            |
| <ul style="list-style-type: none"> <li>• Distinguish between the different conventional symbols used in electricity.</li> </ul>                           | <p>Service panel, conduit, wiring, outlet, switch, junction box and lighting</p>   |
| <ul style="list-style-type: none"> <li>• Distinguish between the different conventional symbols used in monitoring plans.</li> </ul>                      | <p>Electrical, pneumatic and digital monitoring</p> <p>Components: wiring, relays, contactor, sensor, servo-actuator and distribution network</p>  |
2. Locate a system and its components on a drawing.
- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• Recognize the location of a system on a drawing.</li> </ul>          | <p>Connections between drawing and building</p> |
| <ul style="list-style-type: none"> <li>• Recognize the location of system components on a drawing.</li> </ul> | <p>Connections between drawing and building</p> |
3. Analyze specifications.
- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• Distinguish between the different sections of specifications.</li> </ul> | <p>Usefulness of specifications for refrigeration specialists</p> <p>Sections: list of drawings, table of contents, general conditions of fixed-price contract and additional general conditions, general requirements, finished products, equipment, mechanics, electricity, timing of auditing procedures and installation schedule</p> |
|---|---|

Competency 13      Duration 45      Hours Credits 3

***Behavioural Objective***

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**Statement of the Competency**

Install refrigeration piping.

**Achievement Context**

- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- To install or modify an HVAC/R system

**Elements of the Competency**

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**Performance Criteria**

1. Determine the diameter of the piping.

- Consideration of operating conditions
- Consideration of system capacity
- Appropriate selection of pipe diameters

2. Plan the installation of the piping.

- Appropriate selection of tools and equipment
- Correct determination of location of piping and accessories
- Observance of specifications

3. Secure piping elements.

- Observance of plans
- Quality of work

4. Connect the piping.

- Observance of configuration
- Quality of connections

5. Insulate the piping.

- No glue residue
- Compression-free insulation
- Quality of insulation

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of work process
- Observance of methods for maintaining tools and equipment
- Observance of occupational limitations

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Determine the diameter of the piping.

- Distinguish between the different types of piping used in refrigeration. K, L, M: characteristics and use
- Distinguish between the different piping arrangements. Vibration and expansion: expansion loop, slopes, expansion joints and slant loop  
Oil flow and drive in the system: slope, traps and double riser  
Configuration of the piping in a multiple evaporator or multiple compressor system
- Recognize the effects of refrigerant flow rate. Density and volume depending on the state of the refrigerant (liquid or vapour)  
Diameter vs. flow rate  
Effects of refrigerant flow rate  
Minimum and maximum rates
- Distinguish between the different criteria for selecting a piping diameter. Calculations of equivalent lengths  
Capacity of system  
Tolerances: pressure drop and decreased flow rate  
Manufacturers' specifications

#### 2. Plan the installation of the piping.

- Make a list of the tools and materials needed. Pipes, connections, anchors, supports and brazing  
Power and hand tools
- Determine the sequence of operations. Importance of a logical sequence of operations  
Importance of saving time, travel and handling

#### 3. Secure piping elements.

- Distinguish between the different types of pipe supports. Horizontal and vertical supports, trapeze hangers, adjustable and nonadjustable models
- Distinguish between the different ways of securing and adjusting piping. Adjustment of level, slope or difference in level  
Distances required between supports and the floor or ceiling, depending on the accessories, in order to change direction: *Building Code*  
Drilling techniques for different surfaces (partitions, walls and floors)  
Use of tools

## 4. Connect the piping.

- Prepare the piping for connection.

Preparation for brazing

Technique for making offsets: 45°

Technique for making traps out of 90° elbows

Technique for making an expansion loop

Technique for brazing piping up to 2 1/8 inches in diameter

- Secure the accessories.

Types of components: filter drier and sight glass

- Install the piping.

Technique for anchoring supports

Distance required between supports, depending on the accessories, in order to change direction

Technique for crimping supports on piping (torque and integrity of the piping)

Slope

Appearance and cost

Concern for the integrity of materials and the environment when brazing

- Check a system for leaks.

Potential leak sites

Techniques for detecting leaks

Importance of a leaktight circuit

## 5. Insulate the piping.

- Distinguish between the different types of insulation.

Semi-rigid elastomer insulating sleeve, insulating tape and insulating sheet

Characteristics: thermal break, diameter, thickness of walls, elasticity, maximum and minimum operating temperatures, available lengths and resistance to UV rays

- Determine the diameter of the insulation.

Diameter of pipe, temperature of fluid, ambient temperature

- Distinguish between the different ways of installing insulation.

Cutting, joining and gluing



Competency 14      Duration 45      Hours Credits 3

***Behavioural Objective***

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**Statement of the Competency**

Install a fluidic circuit regulator.

**Achievement Context**

- Using plans and specifications
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- To install, modify, repair or commission a system
- Working on HVAC/R systems

**Elements of the Competency**

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**Performance Criteria**

1. Choose a fluidic circuit regulator.

- Consideration of the system's operating conditions
- Consideration of the system's configuration
- Appropriate selection
- Effective use of manufacturers' catalogues

2. Secure and connect a fluidic circuit regulator.

- Observance of installation methods
- Regulator properly secured
- Regulator properly connected
- Observance of manufacturer's specifications

3. Adjust a fluidic circuit regulator.

- Observance of specifications
- Observance of adjustment methods
- Proper use of measuring instruments
- Accurate adjustment
- Functional regulator

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of work process
- Observance of methods for maintaining tools and equipment

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Choose a fluidic circuit regulator.

- Distinguish between the different types of fluidic circuit regulators.
  - Outlet and inlet pressure regulators
  - Evaporating pressure, condensing pressure, crankcase pressure and hot gas bypass regulators (models and identification)
  - Characteristics, function and operation
- Recognize the criteria for selecting a fluidic circuit regulator.
  - Incidence of a system's operating parameters and configuration
  - Criteria related to the system's capacity and operating conditions
  - Manufacturers' specifications

#### 2. Secure and connect a fluidic circuit regulator.

- Draw a diagram of a refrigeration system with regulators.
  - Symbols: regulator and components
  - Lines drawn between regulators
  - Indication of direction of flow
- Distinguish between the different ways of installing regulators.
  - Location, position, access, types of connections, safety measures, brazing techniques and electrical connections

#### 3. Adjust a fluidic circuit regulator.

- Distinguish between the different parameters and ways of adjusting a fluidic circuit regulator.
  - Operating pressures
  - Adjustment methods
  - Consequences of a poorly adjusted fluidic circuit regulator or of the absence of regulators
- Determine the operating pressures of a system with an evaporating pressure regulator.
  - Evaporating pressure/temperature ratio
  - Evaporating temperature/TD/type of refrigerated product ratio
  - Influence of evaporating pressure on the operating TD, the accumulation of frost on the evaporator and the defrost adjustments
  - Adjustment range and selection
- Determine the operating pressures of a system with a condensing pressure regulator.
  - Condensing pressure/temperature ratio
  - Influence of condensing pressure on the capacity of the system and the operating TD
  - Adjustment range and selection
- Determine the operating pressures of a system with a crankcase pressure regulator.
  - Pressure/operating conditions of compressor ratio
  - Influence of low pressure on amperage
  - Adjustment range and selection

- Determine the operating pressures of a system with a hot gas bypass regulator.

Evaporating pressure/temperature ratio  
Influence of the evaporating pressure on frost in the evaporator  
Risks inherent in frost in the evaporator  
Adjustment range and selection

- Read the operating temperatures and pressures on a fluidic circuit regulator.

Connection points for measuring instruments  
Verification of manufacturers' specifications



Competency 15      Duration 120      Hours Credits 8

### ***Behavioural Objective***

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#### **Statement of the Competency**

Install and commission a refrigeration system.

#### **Achievement Context**

- Using drawings and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague

#### **Elements of the Competency**

#### **Performance Criteria**

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- |   |  |
|---|--|
| 1. Plan the installation of a refrigeration system.     | <ul style="list-style-type: none"> <li>• Accurate interpretation of drawings and specifications</li> <li>• Appropriate choice of components</li> <li>• Appropriate choice of tools and equipment</li> <li>• Accurate and complete purchase order</li> </ul>  |
| 2. Install refrigeration system components.             | <ul style="list-style-type: none"> <li>• Proper use of tools</li> <li>• Careful handling of equipment</li> <li>• Observance of installation methods</li> <li>• Solid installation</li> </ul>   |
| 3. Install refrigeration system piping and accessories. | <ul style="list-style-type: none"> <li>• Proper use of tools</li> <li>• Careful handling of equipment</li> <li>• Observance of installation method</li> <li>• Solid installation</li> </ul>  |
| 4. Commission a refrigeration system.                   | <ul style="list-style-type: none"> <li>• Adequate preparation of system</li> <li>• Precise and correct adjustments</li> <li>• Absence of contaminants</li> <li>• Observance of checkpoints and verification techniques</li> <li>• Consideration of operating conditions</li> <li>• Adequate operation of system</li> </ul> |

*For the competency as a whole:*

- Observance of procedures for accessing hazardous areas of a machine
- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Obvious concern for the cleanliness of the work area
- Observance of occupational limitations

### **Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Plan the installation of a refrigeration system.

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of cold rooms.</li> </ul>                         | Characteristics, function and operation<br>Type of insulation, thicknesses, type of product stored (short- and long-term), temperature (above or below 0°C (32°F), humidity and controlled atmosphere  |
| <ul style="list-style-type: none"> <li>• Distinguish between the different ways of cooling cold rooms.</li> </ul>                  | Direct expansion method: types of evaporators, speed and operating TD<br>Indirect expansion method: glycol plate exchanger   |
| <ul style="list-style-type: none"> <li>• Determine the capacity of a cold room.</li> </ul>   | Use of quick selection tables  |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of refrigerated cases and cabinets.</li> </ul>    | Characteristics, function and operation<br>Refrigeration capacity, number and arrangement of evaporators, air distribution, types of products refrigerated, operating temperature and humidity<br>Arrangements: single installation, multiple direct expansion installations and multiple indirect expansion installations |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of ice-making machines.</li> </ul>                | Characteristics, function and operation  |
| <ul style="list-style-type: none"> <li>• Distinguish between the different methods of defrosting refrigeration systems.</li> </ul> | Natural and electrical defrosting: frequency and duration<br>Hot gas defrosting: operation, use, frequency and duration  |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of heat reclaimers.</li> </ul>                    | Desuperheaters: tube in tube, plate, and shell and tube<br>Finned-tube air heater<br>Characteristics, function, operation and connection   |

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Distinguish between the different fluidic circuit accessories.</li> </ul> | <p>Hand valves, electromagnetic valves (positive action, power operated, three-way), safety relief valves, suction accumulators, heat exchangers (liquid/suction), mufflers, oil separators and check valves</p> <ul style="list-style-type: none"> <li>• Characteristics, function, operation and types of connections</li> </ul> |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of condensing units.</li> </ul>   | <p>With sealed or hermetic compressors<br/>With air- or water-cooled condensers and liquid receiver</p>  |
| <ul style="list-style-type: none"> <li>• Select an evaporator.</li> </ul>  | <p>Selection criteria: application, operating temperature, relative humidity, types of products, location, capacity, defrost methods (natural, electric and hot gas)<br/>Manufacturers' catalogues</p>   |
| <ul style="list-style-type: none"> <li>• Determine the location of an evaporator.</li> </ul>                       | <p>Parameters to consider: clearance, dimensions, air circulation, ambient temperature and solidity of the area</p>  |
| <ul style="list-style-type: none"> <li>• Select a condensing unit.</li> </ul>                                      | <p>Operating temperature, capacity, type of refrigerant, voltage, compressor, condenser (air- or water-cooled) and liquid receiver<br/>Location: inside and outside<br/>Manufacturers' catalogues</p>  |
| <ul style="list-style-type: none"> <li>• Select a remote air-cooled condenser.</li> </ul>                          | <p>Application, available location, operating temperature, heat load, number of fans, quantity and capacity of circuits<br/>Manufacturers' catalogues</p>  |
| <ul style="list-style-type: none"> <li>• Determine the location of an air-cooled condenser.</li> </ul>             | <p>Parameters to consider: clearance, dimensions, air circulation, ambient temperature and solidity of the area</p>  |
| <ul style="list-style-type: none"> <li>• Determine the diameters of the piping.</li> </ul>                         |  |
| <ul style="list-style-type: none"> <li>• Make an installation sketch for a refrigeration system.</li> </ul>        | <p>Isometric sketch: components, accessories and piping (indication of direction of flow, indication of measurements, length of lines, distance between components and positioning of piping supports)<br/>Choice, scale and dimensioning</p>  |
| <ul style="list-style-type: none"> <li>• Prepare a purchase order.</li> </ul>                                      | <p>Piping: type, quantity, length, diameter, connections, anchors and supports<br/>Accessories: quantity, capacity and models<br/>Components: quantity, capacity and models</p>  |

## 2. Install refrigeration system components.

- Distinguish between the different ways of installing components
- Distinguish between the different ways of installing prefabricated cold rooms.
- Distinguish between the different ways of installing refrigerated cases and cabinets.

Evaporator, expansion valve, condenser, condensing unit, compressor unit: location and position  
Anchors and supports, installation and positioning technique

Assembly techniques: insulating boards (floor, wall and ceiling), baseboards, subfloor joints, doors and sealer

Installation and connection of a single case  
Installation and connection of multiple cases

## 3. Install refrigeration system piping and accessories.

- Install piping supports.
- Secure the fluidic circuit accessories.

Determination of location of piping supports  
Distances required between supports, depending on the accessories, in order to change direction  
Techniques for making piping supports  
Cross webs: quantity, diameter, composition of materials to be drilled, protection, thermal break and slope  
Thermal insulation of supports  
Insulation protection

Location, access, position, types of connections and safety measures (handling, crimping and brazing)

## 4. Commission a refrigeration system.

- Make a circuit diagram for the system.
- Check the system's electrical connections.
- Check the system for leaks.
- Evacuate the system.
- Charge the system.
- Adjust the controls and regulators.

Schematic, block diagram, one-line diagram and connection diagram  
Power circuit and control circuit

Pressurization and leak detection techniques

Evacuation techniques

Charging techniques

Preliminary adjustments of electromechanical or electronic controls: pressure switches, thermostats and defrost timers (number, duration and start)  
Preliminary adjustments of fluid regulators: evaporating pressure, condensing pressure, hot gas bypass, water flow and expansion valve  
Final adjustments: consistency between adjustments, relationships between adjustments and expected vs. actual results

- Check the operating conditions of the fluidic circuit.  
Operating conditions: saturation pressures and temperature at the condenser and evaporator  
Superheat at the evaporator outlet, the compressor inlet, the compressor outlet and the condenser inlet  
Delta temperature at the evaporator and condenser  
TD at the evaporator and condenser  
Ambient temperature and relative humidity of the refrigerated chamber
- Check the operating conditions of the electrical circuit.  
Procedure for checking voltage and amperage (FLA, RLA)



Competency 16      Duration 120      Hours Credits 8

***Behavioural Objective***

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**Statement of the Competency**

Install and commission an air conditioning system.

**Achievement Context**

- Using plans and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- Working on a low-capacitance monobloc or multi-section system

**Elements of the Competency****Performance Criteria**

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- |   |   |
|---|---|
| 1. Plan the installation of an air conditioning system.                       | <ul style="list-style-type: none"> <li>• Accurate interpretation of plans and specifications</li> <li>• Appropriate selection of components</li> <li>• Appropriate selection of tools and equipment</li> <li>• Accurate and complete purchase order</li> </ul>  |
| 2. Install air conditioning system components.                                | <ul style="list-style-type: none"> <li>• Proper use of tools</li> <li>• Careful handling of equipment</li> <li>• Observance of installation methods</li> <li>• Solid installation</li> </ul>  |
| 3. Install piping and accessories for a ducted split-air conditioning system. | <ul style="list-style-type: none"> <li>• Proper use of tools</li> <li>• Careful handling of equipment</li> <li>• Observance of installation methods</li> <li>• Solid installation</li> </ul>  |
| 4. Connect air conditioning system control circuit components.                | <ul style="list-style-type: none"> <li>• Proper use of tools</li> <li>• Careful handling of equipment</li> <li>• Quality connections</li> </ul>   |
| 5. Commission an air conditioning system.                                     | <ul style="list-style-type: none"> <li>• Adequate preparation of system</li> <li>• Proper and precise adjustments</li> <li>• Absence of contaminants</li> <li>• Observance of checkpoints and verification techniques</li> <li>• Consideration of operating conditions</li> <li>• Adequate operation of system</li> </ul> |

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of procedures for accessing hazardous areas of a machine
- Obvious concern for the cleanliness of the work area
- Observance of occupational limitations

### **Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Plan the installation of an air conditioning system.

- Distinguish between the different types of packaged air conditioners and heat pumps. Units: window, sleeve, suspended, floor, wall, console, ceiling (flush mounted or conventional), exterior (on a slab, on supports and on the roof)  
Characteristics, function and operation
- Distinguish between the different components of a zone system. Pre-programmed controller (AC unit), networking, wiring, thermostats and types of terminal boxes  
Characteristics, function and operation
- Distinguish between the different types of zone controls. System: variable volume, constant volume at the unit and variable volume in the room  
Characteristics, function and operation
- Distinguish between the different types of split air conditioners and heat pumps. Self-contained or otherwise  
Split system: single-zone or multi-zone  
Types: air-air, air-water and water-water  
Characteristics, function, operation and applications
- Distinguish between the different types of geothermal heat pumps. Packaged air conditioner, split system, closed or open circuit (water and land)  
Underground heat exchanger  
Heating media: ethanol, propylene glycol, potassium acetate and methanol  
Physical and chemical characteristics, use, thermal efficiency and risk of soil and water pollution  
Direct and indirect expansion systems  
Characteristics, operation, applications and advantages
- Distinguish between the different types of supplementary heating. Forced-air furnace: oil, propane, natural gas, wood and electricity  
Characteristics, function and operation

<ul style="list-style-type: none"> <li>• Distinguish between the different types of room thermostats.</li> </ul>	Line or low voltage, electronic (programmable or conventional), single- or multi-stage bulb Mechanism and sensor Contacts Bases and lights
<ul style="list-style-type: none"> <li>• Distinguish between the different types of humidifiers.</li> </ul>	Evaporative: characteristics, function and operation Selection, location, installation and connection techniques, start-up procedure Manufacturers' specifications
<ul style="list-style-type: none"> <li>• Determine the wiring required for a very low voltage electrical circuit (24 VAC).</li> </ul>	LVT cable: characteristics, function, applications, maximum voltage, maximum temperature, gauges and number of strands, length
<ul style="list-style-type: none"> <li>• Select a packaged air conditioner or heat pump.</li> </ul>	Capacity, application, available location, client's needs and heat load Selection table Servitudes Municipal by-laws Manufacturers' catalogues
<ul style="list-style-type: none"> <li>• Select a split air conditioner or heat pump.</li> </ul>	Capacity, application, available location, client's needs and heat load Selection table Servitudes Municipal by-laws Manufacturers' catalogues
<ul style="list-style-type: none"> <li>• Determine the diameters of the piping.</li> </ul>	Application of techniques for selecting piping based on the manufacturers' recommended method Manufacturers' specifications
<ul style="list-style-type: none"> <li>• Make a sketch for the installation of an air conditioning system.</li> </ul>	Isometric sketch: components, accessories and piping Selection, scale, dimensions
<ul style="list-style-type: none"> <li>• Determine the order of operations.</li> </ul>	Logical, chronological, economical, duration of work, time required for the different stages and timetable
<ul style="list-style-type: none"> <li>• Prepare a purchase order.</li> </ul>	Components and accessories Piping Very low voltage wiring
<p>2. Install air conditioning system components.</p>	
<ul style="list-style-type: none"> <li>• Distinguish between the different ways of installing thermostats.</li> </ul>	Location, anchoring, levelling, appearance Manufacturers' specifications

<ul style="list-style-type: none"> <li>• Distinguish between the different ways of installing packaged air conditioners and heat pumps.</li> </ul>	Location, position, clearance, anchors and supports, installation and positioning techniques, antitheft measures, slope and safety rules Provision for future removal Manufacturers' specifications
<ul style="list-style-type: none"> <li>• Distinguish between the different ways of installing geothermal heat pumps.</li> </ul>	Location (interior), position, clearance, anchors and supports, and installation and positioning techniques Manufacturers' specifications
<ul style="list-style-type: none"> <li>• Help install a roof unit.</li> </ul>	Cooperation with the different tradespeople involved Signaller: role, current hand signals and safe transportation of load
<ul style="list-style-type: none"> <li>• Distinguish between the different ways of installing split air conditioners and heat pumps.</li> </ul>	Self-contained or otherwise Location, position, clearance, anchors and supports, installation and positioning techniques, safety rules, techniques for control stacking and location of coil added to an existing system Manufacturers' specifications
<p>3. Install piping and accessories for a multi-section air conditioning system.</p>	
<ul style="list-style-type: none"> <li>• Secure the fluidic circuit accessories.</li> </ul>	Interior or exterior support Gutters for pipes, wiring and condensation evacuation drain Thermal insulation and adhesive insulating tape Methods for securing and adjusting piping Distances required between supports Techniques for drilling different surfaces Use of tools Location, position, connection methods and safety measures
<p>4. Connect air conditioning system control circuit components.</p>	
<ul style="list-style-type: none"> <li>• Interpret the electrical schematics of the system components.</li> </ul>	Manufacturers' schematics
<ul style="list-style-type: none"> <li>• Draw a circuit diagram of the system.</li> </ul>	Block and one-line diagrams of the installation (low and very low voltage) Connection diagram of the very low voltage circuit (24 VAC)
<ul style="list-style-type: none"> <li>• Install the very low voltage wiring (24 VAC).</li> </ul>	Retaining straps, electrical connections and junctions, mechanical protection, method for pulling and running wires (wall, ceiling, attic, window and door frames and baseboards)

## 5. Commission an air conditioning system.

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Check the system for leaks.</li> </ul>                               | <p>Application of pressurization and leak detection techniques</p>   |
| <ul style="list-style-type: none"> <li>• Evacuate the system.</li> </ul>                                      | <p>Application of evacuation techniques</p>  |
| <ul style="list-style-type: none"> <li>• Charge the system.</li> </ul>  | <p>Application of charging techniques<br/>Manufacturer's specifications</p>  |
| <ul style="list-style-type: none"> <li>• Make the necessary adjustments before start-up.</li> </ul>           | <p>Determination of operating parameters, low pressure, high pressure, operating temperatures: use of manufacturers' charging tables and graphs<br/>Defrost board: interval between defrost cycles (heat pump)<br/>Thermostats: control points (day, night and weekend), differential (adjustable or not), number of cycles per hour and decrease in temperature<br/>Application of techniques for adjusting electric and electronic controls<br/>Manufacturer's specifications and factory settings</p> |
| <ul style="list-style-type: none"> <li>• Check the operating conditions of the aeraulic circuit.</li> </ul>   | <p>Delta temperature at the evaporator and condenser<br/>Ambient temperature and relative humidity in the air conditioned area</p>   |
| <ul style="list-style-type: none"> <li>• Check the operating conditions of the fluidic circuit.</li> </ul>    | <p>Operating conditions<br/>Pressure: high and low<br/>Superheat at the inlets and outlets of the different components (heat pump depending on the season)<br/>Domestic supply water: temperature and flow (heat pump)<br/>TD at the evaporator and condenser</p>  |
| <ul style="list-style-type: none"> <li>• Check the operating conditions of the electrical circuit.</li> </ul> | <p>Procedure for checking voltage and amperage<br/>FLA or RLA and LRA for different motors</p>   |



Competency 17      Duration 45      Hours Credits 3

***Behavioural Objective***

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**Statement of the Competency**

Rectify compressor malfunctions.

**Achievement Context**

- Using plans and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- To install, modify, repair or commission an HVAC/R system

**Elements of the Competency**

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**Performance Criteria**

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1. Maintain a compressor.

- Observance of maintenance methods and frequencies
- Appropriate adjustment techniques
- Consideration of operational data

2. Detect compressor malfunctions.

- Proper analysis of the refrigeration cycle
- Consideration of operational data
- Observance of verification techniques
- Accurate diagnosis

3. Remove and re-install a compressor.

- Observance of removal techniques
- Observance of positioning and connection techniques
- Obvious concern for the integrity of the system
- Functional installation

4. Select a replacement compressor.

- Accurate interpretation of name plate
- Consideration of manufacturers' specifications
- Appropriate selection

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Proper use of tools and equipment
- Observance of methods for maintaining tools and equipment
- Use of a problem-solving process

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Maintain a compressor.

- Distinguish between the different types of compressors. Reciprocating, rotary, centrifugal, scroll and screw  
Characteristics, function and operation  
Types of housings: sealed, hermetic and open
- Distinguish between the different ways of lubricating compressors. Pumping, splash lubrication, oil filtration, oil discharge opening, oil pump (direction of rotation), leveller, multiple compressor and oil protection device
- Distinguish between the different types of compressor drives. Types of motors: gas, diesel and electric  
Drives: belt, direct and coupling joint  
Dimensions of pulleys vs. rotation speed, calculation of rotation speed and alignment of pulleys  
Techniques for aligning different types of drives: pulleys and belts, direct
- Distinguish between the different compressor cooling systems. Air-cooled, water-cooled, suction vapour and liquid injection  
Cooling of frames, heads, electrical windings and bearings  
Use depending on the type of compressor
- Distinguish between the different compressor capacity reduction devices. Load shedding at the cylinder  
Suction gas admission control  
Hot gas bypass  
Rotation speed control  
Goals, justifications, function, operation, adjustments, installation and selection
- Recognize the components of a compressor requiring maintenance. Maintenance methods (lubrication system, oil, and mechanical and electrical components)  
Verification methods (mechanical and electrical)  
Maintenance schedule

#### 2. Detect compressor malfunctions.

- Recognize the steps in a trouble-shooting process.
- Distinguish between the different types of malfunctions. Depending on the type of compressor: superheat, noise, vibration, premature wear, current surge, performance and deterioration (oil, seal and winding)

<ul style="list-style-type: none"> <li>• Make connections between symptoms and compressor operation.</li> </ul>	<p>Possible situations: the compressor is inoperable; the compressor works but pressure is insufficient; the compressor works for a brief period then shuts down; the compressor works intermittently; the compressor is noisy and the amperage is high</p>
3. Remove and re-install a compressor.	
<ul style="list-style-type: none"> <li>• Determine the necessary tools and materials.</li> </ul>	<p>Anchor, base and support Insulation Noise Vibrations (elimination) Electrical connections</p>
<ul style="list-style-type: none"> <li>• Recognize the steps involved in removing a compressor.</li> </ul>	<p>Recovery of refrigerant from receiver Recovery of refrigerant in a recovery cylinder Disassembly Importance of safe handling Importance of lockout procedure</p>
<ul style="list-style-type: none"> <li>• Recognize the steps involved in installing a compressor.</li> </ul>	<p>Importance of safe handling Securing of compressor, evacuation of pressure inside the compressor (shielding gas), connection of piping, leak tests, evacuation of noncondensable gases such as air and nitrogen, position of service and recharging valves before start-up Unlocking method</p>
<ul style="list-style-type: none"> <li>• Do performance tests on a compressor.</li> </ul>	<p>Electrical verifications: voltage, amperage (LRA, FLA or RLA) Mechanical verifications: pressures, operating temperature and lubrication Manufacturers' specifications</p>
4. Select a replacement compressor.	
<ul style="list-style-type: none"> <li>• Recognize the criteria for selecting a replacement compressor.</li> </ul>	<p>Use, capacity and operating conditions Type of installation: air conditioning, heat pump and refrigeration Temperature: high, medium, low and ultra-low Use: residential, commercial or industrial Location: exterior or interior Availability: ventilation Power supply: voltage and capacity available Technical documentation</p>



Competency 18      Duration 75      Hours Credits 5

***Behavioural Objective***

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**Statement of the Competency**

Ensure the operation of a refrigeration system.

**Achievement Context**

- Using plans and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- For preventive maintenance or on a service call

**Elements of the Competency****Performance Criteria**

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1. Maintain a refrigeration system.

- Accurate recognition of components requiring maintenance
- Observance of maintenance methods and schedule
- Proper use of tools and measuring instruments

2. Locate the source of a refrigeration system malfunction.

- Systematic search
- Observance of verification techniques
- Proper use of tools and measuring instruments
- Pertinent links between the malfunction and its causes

3. Take corrective action.

- Observance of steps in removing and re-installing components
- Relevant and appropriate corrective measure
- Proper use of tools

4. Start up a refrigeration system.

- Adequate preparation of system
- Appropriate and accurate adjustments
- Absence of contaminants
- Observance of checkpoints and verification techniques
- Consideration of operational data and atmospheric conditions
- Successful start-up

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of procedures for accessing hazardous areas of a machine
- Obvious concern for the cleanliness of the work area
- Observance of occupational limitations

### **Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Maintain a refrigeration system.

- Recognize components requiring maintenance.

Maintenance methods  
Verification methods  
Maintenance schedule

#### 2. Locate the source of a refrigeration system malfunction.

- Distinguish between the different factors that affect the operation of a refrigeration system.

Condensation medium, produce, rate of use, air stream, sunlight, lighting, ambient temperature and humidity

- Recognize the symptoms of a refrigeration system malfunction.

Possible situations: the system is inoperable; the system works, but does not cool produce; the system works but does not cool sufficiently; the system works for a brief period then shuts down; the system works intermittently

- Locate the subsystem responsible for the malfunction.

Refrigeration, regulation, control, defrost and ventilation subsystems  
Consultation of available technical information and analysis of the sequence of operations and operational data  
Connections made between symptoms, malfunctions and causes

- Check the components of the subsystem responsible for the malfunction.

List of components, sequence of operations, operating principle, list of abnormalities observed and links between the abnormalities and the components  
Establishment of checkpoints, types of verifications, verification techniques, elimination of useless verifications

## 3. Take corrective action.

- Determine the necessary corrective action. Choice of components, possible equivalence, availability and alternative solution  
Importance of working quickly
- Remove and reinstall a refrigeration system component. Fluidic circuit component  
Safety measures and manufacturer's specifications  
Importance of lockout procedure

## 4. Start up a refrigeration system.

- Check the atmospheric conditions in the refrigerated space. Temperature and humidity  
Performance test: voltage, amperage, temperatures, pressures, sequences of operations and manufacturer's specifications  
Use of pre-programmed controller
- Distinguish between the different shutdown and restart modes  
Depending on the type of refrigeration system: cold rooms, cases and cabinets (self-contained or compressor unit)  
Safety measures to take following a short shutdown  
Safety measures to take following a lengthy shutdown



Competency 19      Duration 75      Hours Credits 5

***Behavioural Objective***

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**Statement of the Competency**

Ensure the operation of a packaged air conditioning system.

**Achievement Context**

- Using plans and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- Working on an institutional, commercial or industrial system
- For preventive maintenance or on a service call

**Elements of the Competency****Performance Criteria**

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- |   |   |
|---|---|
| 1. Maintain a packaged air conditioning system.                         | <ul style="list-style-type: none"> <li>• Accurate recognition of components requiring maintenance</li> <li>• Observance of maintenance methods and schedule</li> <li>• Proper use of tools and measuring instruments</li> </ul>   |
| 2. Locate the source of a packaged air conditioning system malfunction. | <ul style="list-style-type: none"> <li>• Systematic search</li> <li>• Observance of verification techniques</li> <li>• Proper use of tools and measuring instruments</li> <li>• Pertinent links between the malfunction and its causes</li> </ul>   |
| 3. Take corrective action.  | <ul style="list-style-type: none"> <li>• Observance of steps in removing and re-installing components</li> <li>• Relevant and appropriate corrective measure</li> <li>• Proper use of tools</li> </ul>  |
| 4. Start up a packaged air conditioning system.                         | <ul style="list-style-type: none"> <li>• Adequate preparation of system</li> <li>• Appropriate and accurate adjustments</li> <li>• Absence of contaminants</li> <li>• Observance of checkpoints and verification techniques</li> <li>• Consideration of operating parameters and atmospheric conditions</li> <li>• Successful start-up</li> </ul> |

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of procedures for accessing hazardous areas of a machine
- Obvious concern for the cleanliness of the work area
- Observance of occupational limitations

### **Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Maintain a packaged air conditioning system.

- Recognize components requiring maintenance.
  - Maintenance methods
  - Verification methods
  - Maintenance schedule

#### 2. Locate the source of a packaged air conditioning system malfunction.

- Distinguish between the different factors that affect the operation of a packaged air conditioning system.
  - Condensation medium
  - Season, outdoor temperature, number of people and level of activity, sunlight, lighting, ambient temperature and humidity and control points
- Recognize the symptoms of a packaged air conditioning system malfunction.
  - Possible situations: the system is inoperable; the system works but does not sufficiently cool the ambient air; the system works but does not sufficiently heat the ambient air; the system sufficiently conditions the air in certain areas only; the system works for a brief period then shuts down; the system works intermittently
- Locate the subsystem responsible for the malfunction.
  - Consultation of available technical documentation and analysis of the sequence of operations
  - Connections made between symptoms, malfunctions and causes
  - Refrigeration, regulation, control, heating and ventilation subsystems
- Check the components of the subsystem responsible for the malfunction.
  - List of components, sequence of operations, operating principles, list of abnormalities observed and links between the abnormalities and the components
  - Establishment of checkpoints, types of verifications, elimination of useless verifications

## 3. Take corrective action.

- Determine the necessary corrective action.
- Remove and re-install a packaged air conditioning system component.

Choice of components, possible equivalence, availability of components and alternative solution  
Importance of working quickly

Removal process  
Re-installation process  
Importance of lockout procedure

## 4. Start up a packaged air conditioning system.

- Check the atmospheric conditions in the air conditioned space.
- Recognize shutdown and restart modes.

Function of the air conditioned space: commercial, industrial, institutional  
Comfort  
Performance test

Depending on the type of packaged air conditioning system  
Depending on the component  
Safety measures to take following a short shutdown  
Safety measures to take following a lengthy shutdown



Competency 20      Duration 105      Hours Credits 7

***Behavioural Objective***

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**Statement of the Competency**

Ensure the operation of a split air conditioning system.

**Achievement Context**

- Using plans and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- For preventive maintenance or on a service call

**Elements of the Competency****Performance Criteria**

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1. Maintain a split air conditioning system.

- Accurate recognition of components requiring maintenance
- Observance of maintenance methods and schedule
- Proper use of tools and measuring instruments

2. Locate the source of a split air conditioning system malfunction.

- Systematic search
- Observance of verification techniques
- Proper use of tools and measuring instruments
- Pertinent links between the malfunction and its causes

3. Take corrective action.

- Observance of steps in removing and re-installing components
- Relevant and appropriate corrective measure
- Proper use of tools

4. Start up a split air conditioning system.

- Adequate preparation of system
- Appropriate and accurate adjustments
- Absence of contaminants
- Observance of checkpoints and verification techniques
- Consideration of operational data and atmospheric conditions
- Successful start-up

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of procedures for accessing hazardous areas of a machine
- Obvious concern for the cleanliness of the work area
- Observance of occupational limitations

### **Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Maintain a split air conditioning system.

- Recognize components requiring maintenance.
 

	Maintenance methods
	Verification methods
	Maintenance schedule

#### 2. Locate the source of a split air conditioning system malfunction.

- Distinguish between the different factors that affect the operation of a split air conditioning system.
 

	Condensation medium
	Season, outdoor temperature, number of people and level of activity, sunlight, lighting, ambient temperature and humidity and control points
- Recognize the symptoms of a split air conditioning system malfunction.
 

	Possible situations: the system is inoperable; the system works but does not cool the ambient air; the system works but does not sufficiently cool the ambient air; the system works for a brief period then shuts down; the system works intermittently
--	--
- Locate the subsystem responsible for the malfunction.
 

	Consultation of available technical documentation and analysis of the sequence of operations
	Connections made between symptoms, malfunctions and causes
	Subsystem: refrigeration, regulation, control, heating or ventilation
- Check the components of the subsystem responsible for the malfunction.
 

	List of components, sequence of operations, operating principle, list of abnormalities observed and links between the abnormalities and the components
	Establishment of checkpoints, types of verifications and elimination of useless verifications

## 3. Take corrective action.

- Determine the necessary corrective action. Choice of components, possible equivalence, availability of components and alternative solution  
Importance of working quickly
- Remove and re-install a split air conditioning system component. Removal process  
Re-installation process  
Importance of lockout procedure

## 4. Start up a split air conditioning system.

- Verify the atmospheric conditions in the air conditioned space. Function of the air conditioned space: residential, commercial, institutional  
Comfort  
Performance test
- Recognize shutdown and restart modes. Depending on the type of split air conditioning system  
Depending on the component  
Safety measures to take following a short shutdown  
Safety measures to take following a lengthy shutdown



Competency 21      Duration 90      Hours Credits 6

***Behavioural Objective***

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**Statement of the Competency**

Solve problems inherent in digital control.

**Achievement Context**

- Using plans and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using specialized software
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- To repair an HVAC/R system

**Elements of the Competency****Performance Criteria**

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- |  |  |
|--|--|
| 1. Check the input and output signals of a digital controller. | <ul style="list-style-type: none"> <li>• Observance of verification techniques</li> <li>• Accurate interpretation of monitoring plans</li> <li>• Precise location of entry and exit points in the graphic interface</li> </ul>   |
| 2. Check the configuration of a digital controller.            | <ul style="list-style-type: none"> <li>• Accurate interpretation of monitoring diagram</li> <li>• Accurate interpretation of technical documentation</li> <li>• Accurate interpretation of program printout</li> <li>• Observance of verification techniques</li> <li>• Accurate readings</li> </ul> |
| 3. Locate the source of a digital controller malfunction.      | <ul style="list-style-type: none"> <li>• Correct analysis of operational data</li> <li>• Systematic search</li> <li>• Observance of verification techniques</li> <li>• Proper use of measuring instruments</li> <li>• Accurate diagnosis</li> </ul>  |
| 4. Replace components connected to a digital controller.       | <ul style="list-style-type: none"> <li>• Appropriate selection of replacement component</li> <li>• Proper use of tools and equipment</li> <li>• Quality connections</li> <li>• Obvious concern for the integrity of the system and its components</li> </ul>   |

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of methods for maintaining tools and equipment
- Use of a problem-solving process

### **Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Check the input and output signals of a digital controller.

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of digital controllers.</li> </ul>                                 | <p>Programmable or pre-programmed and stand-alone or slave<br/>Inputs, outputs, programs, internal variables, memory, buffer, networking, protocols (BACnet <i>Building Automation and Control Networks</i>), communications, Internet address, data transmission (RS232, RS485, IEEE)<br/>Central processing unit (CPU)<br/>Characteristics, function, operation and capacity</p> |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of digital controller inputs.</li> </ul>                           | <p>Digital or binary input, analog input, counters<br/>Characteristics, function and operation</p>   |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of digital controller outputs.</li> </ul>                          | <p>Digital or binary: relay or Triac, active or passive, AC or DC<br/>Analog: DC amperage or voltage<br/>Pulsed: AC or DC<br/>Characteristics, function and operation</p>  |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of interfaces connected to a digital controller input.</li> </ul>  | <p>Sensors, transducers, transmitters<br/>Interface input energy<br/>Interface output energy<br/>Function, operation and applications</p>  |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of interfaces connected to a digital controller output.</li> </ul> | <p>Servo-actuators, single-phase or three-phase solid-state relays, AC or DC relays, and electronic-pneumatic transducer<br/>Function, operation and applications</p>  |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of accessories connected to a digital controller.</li> </ul>       | <p>Accessories: communications, signal repetition or conversion, communication signal conversion (RS485 to RS232, RS232 to RS485), networked room thermostat, input and output cards<br/>Function, operation and applications</p>  |

## 2. Check the configuration of a digital controller.

- Use dedicated digital controller software.
  - Access procedures, task bar, windows, icons, notification zone, tools, dialog boxes, help menu (general, contextual)
  - Graphic mode: creation, navigation, content, icon and pushbutton
  - Terminal mode: navigation, content and display
  - User: name and password, authorizations
  - Function, operation, use and limitations
- Distinguish between the different types of configurations.
  - Hardware, software, networking, programming and parameterization
  - DIP switch adjustments
- Interpret a digital control diagram.
  - Control diagrams, circuit diagrams, panels, list of points, network architecture and connection details

## 3. Locate the source of a digital controller malfunction.

- Check the operation of a digital controller.
  - Regulation strategies in different modes: occupied, unoccupied, optimized start and alarm
  - Response of different components
- Locate the source of a malfunction.
  - Internal sources: adjustments, parameters, programs, internal fuses, manual output bypass buttons and DIP switches
  - External sources: equipment, wiring, hardware and components

## 4. Replace components connected to a digital controller.

- Determine the component to be replaced.
  - Choice of components, possible equivalence, availability of components and alternative solution
  - Importance of working quickly
  - Possibility of bypassing the digital controller
- Remove and re-install a component connected to a digital controller.
  - Removal and re-installation process and techniques for each component, safety measures and manufacturer's specifications
  - Importance of lockout procedure
- Do a performance test.
  - Electrical verifications: voltage, amperage
  - Verification of the controller: appropriate input signal
  - Verification of the component: response and appropriate input signal vs. output energy, response and appropriate output energy vs. input signal
  - Manufacturer's specifications



Competency 22      Duration 90      Hours Credits 6

***Behavioural Objective***

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**Statement of the Competency**

Analyze air treatment processes.

**Achievement Context**

- Using plans and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- To repair or commission an HVAC/R system

**Elements of the Competency****Performance Criteria**

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1. Check the ambient conditions in an air conditioned space.
2. Check the operating conditions of an air conditioning system.
3. Modify the operating parameters of a ventilation system.

- Comparison with reference comfort conditions
- Accurate readings
- Accurate readings
- Accurate location of components
- Accurate determination of air parameters
- Accurate plotting on the psychrometric chart
- Accurate determination of system capacity
- Accurate ventilation calculations
- Adequate air distribution
- Pertinent and functional modifications

*For the competency as a whole:*

- Observance of occupational health and safety legislation and regulations
- Adequate verification techniques
- Appropriate use of terminology
- Appropriate use of charts
- Proper use of measuring instruments

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

1. Check the ambient conditions in an air conditioned space.

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Use instruments for measuring air pressure, air speed, air flow and atmospheric conditions.</li> </ul> | Liquid manometer, aneroid manometer, Pitot tube and electronic manometer<br>Velometer ( <i>alnor</i> ), blade anemometer, hot-wire anemometer and electronic anemometer<br>Flowmeter (balometer) and electronic flowmeter<br>Psychrometer and hygrometer, etc.<br>Location of points of measurement<br>Characteristics, use, safety measures and maintenance |
| <ul style="list-style-type: none"> <li>• Recognize the comfort conditions in a given space.</li> </ul>  | Ambient temperature, average temperature of walls, cleanliness of air, radiation, sunlight, relative humidity and air movement<br>Factors related to personal comfort: location, clothing, age, state of health and type of activity   |
| <ul style="list-style-type: none"> <li>• Distinguish between the different parameters of ambient air.</li> </ul>                                | Composition, dry-bulb and wet-bulb temperature, specific and relative humidity, specific volume and density  |
| <ul style="list-style-type: none"> <li>• Analyze the atmospheric conditions measured, referring to a human comfort chart.</li> </ul>            | Use of a human comfort chart   |
| <ul style="list-style-type: none"> <li>• Distinguish between the different components of an air treatment system.</li> </ul>                    | Centrifugal or axial fans: methods of modifying flow<br>Ventilation ducts<br>Accessories<br>Air exchanger<br>Characteristics, function, operation, installation, position and location   |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of heating systems.</li> </ul>                                 | Hot water heating systems<br>Characteristics, function, operation, installation, position and location   |
| <ul style="list-style-type: none"> <li>• Distinguish between the different types of cooling systems.</li> </ul>                                 | Direct and indirect cooling systems<br>Characteristics, function, operation, installation, position, location, arrangements, components and accessories  |
| <ul style="list-style-type: none"> <li>• Distinguish between the processes for humidifying a building's air.</li> </ul>                         | Vaporization; air stream or water heating and sprinkler<br>Atomizer<br>Water vapour injected into the air<br>Latent heat from the humidification process<br>Sensible heat provided by the air  |

- Distinguish between the different types of humidifiers.

Use: commercial, industrial and institutional  
 Different types: steam boilers, atomizers, evaporative and ultrasonic humidifiers (construction characteristics, advantages and disadvantages)  
 Vaporization mechanism, water flow regulators, capacity, installation and location  
 Risks related to the production of contaminated aerosols

## 2. Check the operating conditions of an air conditioning system.

- Distinguish between different variables on a psychrometric chart.

Curves, lines and readings  
 Plotting techniques for a given atmospheric condition

- Plot a combined heating and humidifying process on a psychrometric chart.

Differences between dry-bulb and wet-bulb temperatures; specific and relative humidity; specific volume and density; and sensible, latent and total enthalpy

- Plot a cooling process on a psychrometric chart.

Plotting of process on chart  
 Differences between dry-bulb and wet-bulb temperatures; specific and relative humidity; specific volume and density; and sensible, latent and total enthalpy

- Plot a combined cooling and dehumidifying process on a psychrometric chart.

Plotting of process on chart  
 Differences between dry-bulb and wet-bulb temperatures; specific and relative humidity; specific volume and density; and sensible, latent and total enthalpy

- Plot a mixing process on a psychrometric chart.

Importance of exchanging air in a building  
 Air exchange rate  
 Determination of conditions of recirculated and exterior air  
 Method of determining the percentage of fresh air  
 Method of determining the temperature of the mix  
 Plotting of mixing process on chart  
 Use of measuring instruments  
 Conditions before and after the process: dry-bulb temperature and wet-bulb temperature; specific and relative humidity; specific volume and density; and sensible, latent and total enthalpy

- Plot a combined heating and humidifying process on a psychrometric chart.

Plotting of process on chart  
 Differences between dry-bulb and wet-bulb temperatures; specific and relative humidity; specific volume and density; and sensible, latent and total enthalpy

<ul style="list-style-type: none"> <li>Plot a mixed cooling and dehumidifying process on a psychrometric chart.</li> </ul>	Comparison of differences between dry-bulb and wet-bulb temperatures Specific and relative humidity; specific volume and density; and sensible, latent and total enthalpy
<ul style="list-style-type: none"> <li>Determine the capacity of an air conditioning system in heating mode.</li> </ul>	Impact of air conditions on the operation of the system: inlet and outlet temperature vs. flow and heating capacity Method of calculating the heating capacity of a system based on the difference in conditions before and after the process, and air flow Application of mathematical formulas
<ul style="list-style-type: none"> <li>Determine the sensible and latent capacity of an air conditioning system.</li> </ul>	Impact of conditions on the operation of the system (SHR, air inlet and outlet conditions) Calculation of the sensible cooling capacity of a system based on the difference in conditions before and after the process, and air flow Application of mathematical formulas
<ul style="list-style-type: none"> <li>Determine the capacity of a humidifier.</li> </ul>	Calculation of the capacity of a humidifier based on the difference in conditions before and after the process, and air flow Application of mathematical formulas
<b>3. Modify the operating parameters of a ventilation system.</b>	
<ul style="list-style-type: none"> <li>Distinguish between the different types of ventilation systems.</li> </ul>	Ventilation system: natural, extraction (negative), pressurization (positive), combined and with recirculation (total or partial) Characteristics, function and operation
<ul style="list-style-type: none"> <li>Distinguish between the different operating parameters of a ventilation system.</li> </ul>	Basic concepts: static pressure, velocity pressure, total pressure, flow and surface Air pressure in the ducts Parameters related to the loss of static pressure Loss of static pressure in a duct Calculation of air speed in a duct based on dynamic pressure Calculations of air flow based on air speed and duct surface
<ul style="list-style-type: none"> <li>Determine the surface of a ventilation duct.</li> </ul>	Calculation of size of duct based on flow and speed to be maintained
<ul style="list-style-type: none"> <li>Determine the flow required in a given space.</li> </ul>	Calculation of ventilation flow required for air exchange based on the number of people, floor area, sensible heat load to be extracted, desired temperature and the sensible and latent cooling capacity of a system

- Modify the air flow required in a given air conditioned space.

Verification of system specifications

- Measurement of air flow in an air conditioned space
- Procedure for modifying air distribution at the diffusers and grilles
- Procedure for modifying air flow in a given space

- Modify the air flow of a ventilator.

Verification of air flow

Verification of static pressure

Procedure for modifying the rotation speed of a belt-driven fan



Competency 23      Duration 60      Hours Credits 4

***Behavioural Objective***

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**Statement of the Competency**

Do an energy analysis of a refrigeration or air conditioning system.

**Achievement Context**

- Using standards and procedures, as well as legislation and regulations pertaining to occupational health and safety and environmental protection
- Using technical documentation
- Using materials, tools and equipment
- To repair or commission a system

**Elements of the Competency**

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**Performance Criteria**

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- |   |   |
|---|---|
| 1. Calculate the heat load of a refrigeration system.     | <ul style="list-style-type: none"> <li>• Accurate determination of type of application</li> <li>• Accurate determination of quantity of heat to be extracted</li> <li>• Appropriate selection of system components</li> </ul>   |
| 2. Calculate the heat load of an air conditioning system. | <ul style="list-style-type: none"> <li>• Accurate determination of type of application</li> <li>• Accurate determination of quantity of heat to be extracted</li> <li>• Appropriate selection of system components</li> </ul>   |
| 3. Analyze the efficiency of a refrigeration system.      | <ul style="list-style-type: none"> <li>• Accurate readings</li> <li>• Accurate interpretation of specifications</li> <li>• Accurate interpretation of manufacturer's specifications</li> <li>• Accurate interpretation of operational data</li> <li>• Accurate evaluation of differences</li> </ul> |
| 4. Analyze the efficiency of an air conditioning system.  | <ul style="list-style-type: none"> <li>• Accurate readings</li> <li>• Accurate interpretation of specifications</li> <li>• Accurate interpretation of manufacturer's specifications</li> <li>• Accurate interpretation of operational data</li> <li>• Accurate evaluation of differences</li> </ul> |

*For the competency as a whole:*

- Appropriate use of terminology
- Proper use of mathematical formulas
- Proper use of measuring instruments

### Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

#### 1. Calculate the heat load of a refrigeration system.

- Determine the heat gain in a refrigerated area. Thermal conductivity (K), thermal conductance (C), coefficient of total heat transmission (U), thermal resistance (R) and air films [interior coefficient (Fi) and exterior coefficient (Fe)]  
Air infiltration  
Heat transmission  
Equipment  
Occupants  
Products
- Use mathematical formulas to calculate the heat load of a refrigeration system. Lengthy or quick calculations: advantages, accuracy and time required  
Chart, tables or software
- Identify the data required to calculate the heat load of a refrigeration system. Consultation of available technical information: plans, technical drawings, diagrams, specifications, installation and operating manuals, catalogues, person in charge of operations and user

#### 2. Calculate the heat load of an air conditioning system.

- Determine the heat loss and gain in an air conditioned room. In heating and air conditioning
- Use mathematical formulas to calculate the heat load of an air conditioning system. Lengthy or quick calculations: advantages, accuracy and time required  
Chart, tables or software
- Identify the data required to calculate the heat load of an air conditioning system. Consultation of available technical information

#### 3. Analyze the efficiency of a refrigeration system.

- Distinguish between the different types of heat exchangers. Dual tube, shell and tube, finned tube, and plate  
Function, operation, construction, applications and installation  
Types of fluids used: water, air, water vapour, ethylene glycol, refrigerants and calcium chloride (brine)  
Condition of fluids
- Locate a heat exchanger in a refrigeration system. Exchanger located: type, function and operation  
Inlet and outlet for hot fluid and cooler fluid

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Compare the actual heat load of a refrigeration system with its reference heat load.</li> </ul>            | <p>Quick calculation method, consultation of drawings and specifications (original and corrected), original heat load and operating conditions<br/>Changes made over the years<br/>Evaluation of differences</p> |
| <ul style="list-style-type: none"> <li>• Identify the parts of a refrigeration system that make it possible to install a heat exchanger.</li> </ul> | <p>Plan, energy consumption, energy-consuming processes, type of exchanger that can be installed and possible savings</p>  |
4. Analyze the efficiency of an air conditioning system.
- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Locate a heat exchanger in an air conditioning system.</li> </ul>  | <p>Exchanger located: type, function and operation<br/>Inlet and outlet for hot fluid and cooler fluid</p>   |
| <ul style="list-style-type: none"> <li>• Compare the actual heat load of an air conditioning system with its reference heat load.</li> </ul>            | <p>Quick calculation method, consultation of drawings and specifications (original and corrected), original heat load and operating conditions<br/>Changes made over the years<br/>Evaluation of differences</p> |
| <ul style="list-style-type: none"> <li>• Identify the parts of an air conditioning system that make it possible to install a heat exchanger.</li> </ul> | <p>Plan, energy consumption, energy-consuming processes, type of exchanger that can be installed and possible savings</p>  |



Competency 24      Duration 75      Hours Credits 5

***Behavioural Objective***

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**Statement of the Competency**

Ensure the operation of a liquid chiller.

**Achievement Context**

- Using drawings and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- Working on HVAC/R systems
- For preventive maintenance or on a service call

**Elements of the Competency****Performance Criteria**

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- |   |   |
|---|---|
| 1. Maintain a liquid chiller.                         | <ul style="list-style-type: none"> <li>• Observance of maintenance methods and schedule</li> <li>• Proper use of tools and measuring instruments</li> <li>• Appropriate adjustment methods</li> <li>• Consideration of operational data</li> </ul>  |
| 2. Locate the source of a liquid chiller malfunction. | <ul style="list-style-type: none"> <li>• Systematic search</li> <li>• Observance of verification techniques</li> <li>• Proper use of tools and measuring instruments</li> <li>• Pertinent links between the malfunction and its causes</li> </ul>   |
| 3. Take corrective action.                            | <ul style="list-style-type: none"> <li>• Adequate preparation of work</li> <li>• Observance of removal and re-installation sequences</li> <li>• Adequate repair techniques</li> <li>• Relevant and appropriate corrective measure</li> <li>• Adequate control of work</li> </ul>                                |
| 4. Start up a liquid chiller.                         | <ul style="list-style-type: none"> <li>• Adequate preparation of system</li> <li>• Appropriate and accurate adjustments</li> <li>• Absence of contaminants</li> <li>• Adequate and sequential controls</li> <li>• Accurate readings of subsystem operating conditions</li> <li>• Successful start-up</li> </ul> |

5. Write a report of the work done.

- Clear description of work
- Full and accurate report
- Accurate and relevant data
- Obvious concern for transparency

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of procedures for accessing hazardous areas of a machine
- Obvious concern for the cleanliness of the work area
- Observance of time limits
- Observance of occupational limitations

### **Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

1. Maintain a liquid chiller.

- |  |  |
|--|--|
| • Distinguish between the different types of liquid chillers.                          | Reciprocating and centrifugal compressor   |
| • Distinguish between the different internal components of a liquid chiller.           | Components of the electrical circuit, ice water circuit and condensed water circuit: characteristics, function and operation<br>Heating media: water, mixes (water/glycol, ethylene glycol, water/methanol, salt, calcium chloride, brine) |
| • Distinguish between the different external components connected to a liquid chiller. | Cooling tower, evaporative condenser and centrifugal pumps: characteristics, function and operation<br>Types of centrifugal pumps: function, operation and components<br>Centrifugal force   |
| • Check the efficiency of a centrifugal pump.  | Performance chart, recognition of variables, recognition of curves, power, efficiency and interpretation<br>Variables that affect operating conditions   |
| • Recognize internal components requiring maintenance.                                 | Maintenance methods<br>Verification methods<br>Maintenance schedule  |

## 2. Locate the source of a liquid chiller malfunction.

- Check the operation of a liquid chiller.

Verification of electrical circuit  
Wiring  
Verification of refrigeration circuit  
Verification of heat media circuits  
Use of pre-programmed controller  
Sequence of operations, up time, temperature of returned water, temperature of water supply, equipment supplied, demand, flows, temperatures, pressures, voltages and amperages

- Recognize the symptoms of a liquid chiller malfunction.

Possible situations: the chiller is inoperable; the chiller works but does not cool water; the chiller works but does not cool the water sufficiently; the chiller works for a brief period then shuts down; the chiller works intermittently

- Locate the subsystem responsible for the malfunction.

Refrigeration, cooled water, condensed water, regulation and control subsystems  
Consultation of available technical information  
Analysis of sequence of operations  
Connections made between symptoms, malfunctions and causes

- Check the components of the subsystem responsible for the malfunction.

List of abnormalities observed and links between the abnormalities and the components  
Establishment of checkpoints, types of verifications and elimination of useless verifications

## 3. Take corrective action.

- Determine the necessary corrective action.

Choice of components, possible equivalence, availability of components and alternative solution  
Importance of working quickly

- Remove and re-install a liquid chiller component.

Procedure for recovering refrigerant from a liquid chiller  
Measures to prevent freezing

## 4. Start up a liquid chiller.

- Do a performance test.

Sequence of operations  
Voltage, amperage, temperatures, pressures and fluid flow  
Manufacturer's specifications

- Distinguish between the different shutdown and restart modes.

Depending on the type of chiller and equipment  
Safety measures to take following a short shutdown  
Safety measures to take following a lengthy shutdown

## 5. Write a report of the work done.

- Identify the specifications of the liquid chiller.  
Manufacturer, model, series and colour  
Internal and external components  
Specifications: capacity, quantity and type of refrigerant and oil  
Location of liquid chiller
- Gather the information needed to write the report.  
Readings and operational data before and after the repair  
Abnormalities and diagnosis  
Description of repairs  
Recommendations  
Evaluation of costs: parts and labour

Competency 25      Duration 120      Hours Credits 8

***Behavioural Objective***

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**Statement of the Competency**

Ensure the operation of a central air conditioning system.

**Achievement Context**

- Using plans and specifications
- Using technical documentation
- Using materials, tools and equipment
- Using personal protective equipment
- Following instructions
- Under supervision
- Working with a colleague
- In digital mode
- For preventive maintenance or on a service call

**Elements of the Competency****Performance Criteria**

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1. Maintain a central air conditioning system.

- Observance of maintenance methods and schedule
- Proper use of tools and measuring instruments
- Appropriate adjustment methods
- Consideration of operational data
- Consideration of air quality standards

2. Locate the source of a central air conditioning system malfunction.

- Systematic search
- Observance of verification techniques
- Proper use of tools and measuring instruments
- Pertinent links between the malfunction and its causes

3. Take corrective action.

- Adequate preparation of work
- Observance of removal and re-installation sequences
- Adequate repair techniques
- Relevant and appropriate corrective measure
- Adequate control of work done

4. Start up a central air conditioning system.

- Adequate preparation of system
- Appropriate and accurate adjustments
- Absence of contaminants
- Adequate and sequential controls
- Consideration of operational data and atmospheric conditions
- Successful start-up

5. Write a report of the work done.

- Clear description of work
- Full and accurate report
- Accurate and relevant data
- Obvious concern for transparency

*For the competency as a whole:*

- Observance of legislation and regulations pertaining to occupational health and safety and environmental protection
- Observance of procedures for accessing hazardous areas of a machine
- Obvious concern for the cleanliness of the work area
- Observance of time limits
- Observance of occupational limitations

### **Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

1. Maintain a central air conditioning system.

- Distinguish between the different subsystems of a central air conditioning system.
  - Ventilation subsystem
  - Refrigeration subsystem
  - Heating subsystem
  - Humidification subsystem
  - Control subsystem: detector, regulator and servo-actuator (pneumatic, electrical, electronic and digital)
  - Characteristics and operation
  - Functional links between subsystems
- Check the operation of the pneumatic control.
  - Usefulness, advantages and operating limits
  - Components: compressed air supply, receiver, compressed air distribution network, control elements (detector, regulator and servo-actuator), thermostatic controls and pneumatic/electrical converter
  - Use of specialized calibration instruments
- Distinguish between the different ways of connecting centrifugal pumps.
  - Pump/piping connection
  - Pump/motor connection
- Interpret plans of a central air conditioning system.
- Check the operation of motor circuits and control devices.

- Solve the problems inherent in the digital control of a central air conditioning system.
    - Verification of input and output signals, verification of hardware, software and network configuration, controller configuration, parameterization of the controller and replacement of components
  - Analyze the central air conditioning system's air treatment processes.
  - Do an energy analysis of the central air conditioning system.
  - Recognize central air conditioning system components requiring maintenance.
    - Maintenance methods
    - Verification methods
    - Maintenance schedule
    - Manufacturers' specifications
2. Locate the source of a central air conditioning system malfunction.
- Distinguish between the different factors that affect the operation of a central air conditioning system.
    - Uncontrollable variables
    - Air quality standards
  - Check the operation of a central air conditioning system and its subsystems.
    - Modes: heating, cooling, humidifying, dehumidifying, scheduled shutdown and start-up, and emergency shutdown (fire and low frost limit)
  - Identify the operational data for a central air conditioning system.
    - Air circuit
    - Refrigeration circuit
    - Heating circuit
    - Humidification circuit
    - Control circuit
    - Fluidic circuit
  - Recognize the symptoms of a central air conditioning system malfunction.
    - Connections made between symptoms, malfunctions and causes
    - Symptoms related to humidity, temperature, noise, vibration, dust and air quality
  - Locate the subsystem responsible for the malfunction.
    - Subsystem: ventilation, refrigeration, heating, humidification or control
    - Consultation of the available technical information
    - Analysis of sequence of operations
    - Establishment of checkpoints, types of verifications and elimination of useless verifications
  - Check the components of the subsystem responsible for the malfunction.
    - List of abnormalities observed and links between the abnormalities and the components
    - Establishment of checkpoints, types of verifications and elimination of useless verifications
    - Appropriate verification methods for each component

## 3. Take corrective action.

- Determine the necessary corrective action. Choice of components, possible equivalence, availability of components, speed of execution, alternative solution and observance of manufacturers' minimum standards
- Remove and re-install a central air conditioning system component. Safety measures  
Manufacturer's specifications  
Importance of lockout procedure

## 4. Start up a central air conditioning system.

- Do performance tests. Sequence of operations  
Voltage, amperage, temperatures and pressures  
Manufacturer's specifications
- Check the atmospheric conditions in the air conditioned space. Function of air conditioned space: commercial, industrial or institutional  
Comfort  
Performance test
- Distinguish between the different shutdown and restart modes. Depending on the type of central air conditioning system  
Depending on the subsystem  
Depending on the component  
Safety measures to take following a short shutdown  
Safety measures to take following a lengthy shutdown

## 5. Write a report of the work done.

- Identify the specifications of a central air conditioning system, a subsystem or a component, as the case may be. Manufacturer, model, series and location
- Gather the information needed to write the report. Readings and operational data before and after the repair  
Abnormalities and diagnosis  
Description of repairs  
Recommendations  
Cost estimate: parts and labour

Competency 26      Duration 15 hours      Credit 1

## ***Situational Competency***

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### **Statement of the Competency**

Be familiar with construction industry organizations.

### **Elements of the Competency**

- Become familiar with the construction industry.
- Learn about the role and importance of industry organizations.
- Understand labour relations in the industry.

### **Learning Context**

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#### **Information Phase**

- Learning about the construction industry.
- Learning about the roles and responsibilities of construction industry organizations (employer associations, unions, CCQ, CSST, etc.).
- Learning about labour relations in the construction industry.

#### **Participation Phase**

- Participating in activities enabling them to understand:
  - the past and future of the construction industry
  - the relationships between different trades and occupations
  - the effects of regulations on construction work
- Exploring development possibilities for industry workers.

#### **Synthesis Phase**

- Presenting a report summarizing their learning and an evaluation of its impact on their career path.

### **Instructional Guidelines**

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- Provide the necessary sources of information.
- Rely heavily on learning contexts based on real-life situations in the industry.
- Encourage students to engage in discussions and express themselves.
- Guide the students' synthesis process by providing the necessary tools (e.g. a questionnaire).

### **Participation Criteria**

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#### **Information Phase**

- Consult the sources of information made available.

#### **Participation Phase**

- Participate seriously and consistently in the suggested activities.

**Synthesis Phase**

- Present a report summarizing their learning and evaluating its impact on their career path.

**Suggestions for Competency-Related Knowledge and Know How**

The following is a summary of the knowledge, skills, strategies, attitudes and perceptions related to each phase of the learning context, along with their attendant guidelines.

**Information Phase**

- |  |   |
|--|---|
| • Distinguish between the different characteristics of the construction industry.          | Characteristics and economic impact   |
| • Distinguish between the different employer associations.                                 | Roles and responsibilities<br>Association de la construction du Québec, Association des constructeurs de routes et grands travaux du Québec, Association des entrepreneurs en construction du Québec, Association provinciale des constructeurs d'habitations du Québec, Corporation des maîtres électriciens du Québec and Corporation des maîtres mécaniciens en tuyauterie du Québec |
| • Distinguish between the different unions.  | Roles and responsibilities<br>Fédération des travailleurs du Québec, Conseil provincial du Québec des métiers de la construction, Centrale des syndicats démocratiques, Confédération des syndicats nationaux and Syndicat québécois de la construction   |
| • Recognize the role and responsibilities of the Commission des relations de travail.      | Structure, component parts, functions and powers in the construction industry   |
| • Recognize the role and responsibilities of the Régie du bâtiment du Québec.              | Structure, component parts, functions and powers  |
| • Recognize the role and responsibilities of the Commission de la construction du Québec.  | Structure, component parts, functions and powers  |
| • Recognize the role and responsibilities of occupational health and safety organizations. | CSST and Association sectorielle paritaire<br>Structure, component parts, functions and powers  |

**Participation Phase**

- |   |  |
|---|--|
| • Share their point of view with classmates.                | Usefulness of discussion, attitude toward different viewpoints and usefulness in the practice of the trade |
| • Distinguish between the different trades and occupations. | Criteria for differentiation and characteristics   |

- Distinguish between the different sectorial collective agreements.  
For the different sectors: residential, commercial and institutional, industrial, civil engineering and road works
- Recognize the legislation and regulations governing labour relations in the construction industry.  
Purpose and impact on working conditions  
*Act respecting labour relations, vocational training and manpower management in the construction industry* (R.S.Q., c. 20)  
*Regulation respecting the vocational training and qualification of manpower in the construction industry*  
*Act respecting complementary social benefits in the construction industry* (R.S.Q., c. R-15)
- Recognize the advantages of a training fund.  
Training fund for construction industry workers  
Training plan for residential sector workers



Competency 27      Duration 15      Hours Credit 1

***Behavioural Objective***

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**Statement of the Competency**

Use job search techniques.

**Achievement Context**

- Using personal information
- Using sample letters of application
- Using information about the refrigeration industry
- Using a dictionary and grammar book

**Elements of the Competency****Performance Criteria**

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1. Write a résumé.

- Inclusion of relevant information
- Observance of usual formatting standards
- Observance of spelling and grammar rules

2. Write a letter of application.

- Relevance of text to the job sought
- Observance of usual formatting standards
- Observance of spelling and grammar rules

3. Undergo a job interview.

- Appropriate appearance and conduct
- Relevant answers and comments

*For the competency as a whole:*

- Obvious concern for personal appearance
- Careful presentation of documents
- Quality of written and oral communication

**Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions**

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The following is a list of knowledge, skills, attitudes, perceptions and guidelines related to each element of the competency.

1. Write a résumé.

- Recognize the attitudes required for a dynamic job search.
- List the different sources of placement opportunities.
- Determine the relevant information.
- Show concern for the quality of written communications.

Personal information

Use of telephone book and electronic information  
Construction and other sectors

Work-related information: training and experience

Use of dictionary  
Usual formatting standards

## 2. Write a letter of application.

- Outline a letter of application.

Information about the company  
Information about their job profile

- Show concern for the quality of written communications.

Use of dictionary  
Usual formatting standards

## 3. Undergo a job interview.

- Prepare for the interview.

Information about the company

- Show concern for the quality of oral communications.

- Show concern for their appearance.

Effect of their appearance on others' perceptions of them



