



Grades 9 to 12 Refrigeration and Air Conditioning

Manitoba Technical-Vocational
Curriculum Framework
of Outcomes



GRADES 9 TO 12
REFRIGERATION AND AIR
CONDITIONING TECHNOLOGY

Manitoba Technical-Vocational Curriculum
Framework of Outcomes

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This resource is available on the Manitoba Education and Advanced Learning website at <www.edu.gov.mb.ca/k12/>.

Available in alternate formats upon request.

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TECHNICAL-VOCATIONAL EDUCATION OVERVIEW

In 2013, Manitoba Education and Advanced Learning released the document *Technical-Vocational Education Overview* to provide the philosophical and pedagogical underpinnings for curriculum development and the teaching of courses in the Senior Years Technology Education program.

This overview presents educators with the vision and goals of technical-vocational education (TVE) in Manitoba. Topics include the following:

- curriculum revitalization and renewal
- curriculum framework and implementation
- articulation of programming
- assessment and reporting
- safety
- employability/essential skills and career development
- sustainable development

The TVE curriculum includes Grades 9 to 12 courses in a variety of areas, including refrigeration and air conditioning.

REFRIGERATION AND AIR CONDITIONING OVERVIEW

Grades 9 to 12 Refrigeration and Air Conditioning: Manitoba Technical-Vocational Curriculum Framework of Outcomes identifies the goals, general learning outcomes (GLOs), and specific learning outcomes (SLOs) for nine refrigeration and air conditioning courses. This framework is intended for use in all Manitoba schools refrigeration and air conditioning as part of the Senior Years Technology Education program.

All courses are intended for students pursuing a career in refrigeration and air conditioning. They focus on theoretical principles and their practical applications.

A student graduating from the Refrigeration and Air Conditioning Technician program can seek entry-level employment as an apprentice technician in either of the following trades from Apprenticeship Manitoba:

1. residential refrigeration and air conditioning mechanic
2. commercial refrigeration and air conditioning mechanic

Graduates can also seek employment in the following areas: air conditioning mechanic, refrigeration mechanic, heating and cooling mechanic, and air conditioning service technician.

In order to be qualified and continue as a mechanic, students must seek apprenticeship and continue post-secondary training. Graduates are typically employed by refrigeration/heating and air conditioning contractors, service companies, independent service centres, specialty repair shops, parts suppliers, sales and distribution companies, equipment manufacturers, and organizations with large amounts of HVAC and refrigeration equipment. The education requirements for entry to the refrigeration and air conditioning industry vary from high school graduation and/or completion of a technical vocational program at the secondary level for entry-level employment, to college, apprenticeship and university for related employment in the industry.

This program provides a foundation for students to go directly to work, or to continue into post-secondary education in refrigeration and air conditioning mechanic apprenticeship, mechanical engineering, design manufacturing, management in the HVAC service industry. Graduates of this program can be found working on many types of equipment such as residential and commercial heating, cooling, and refrigeration equipment, ventilation systems, and indoor air quality and air handling equipment.

Students who have completed the refrigeration and air conditioning technician courses will be able to

- perform basic maintenance and service
- perform a system inspection
- complete repairs and servicing
- complete preventative maintenance procedures
- perform maintenance related to seasonal concerns

- understand and use theory applied to operating systems
- communicate and work with peers, employers, and customers
- think logically and make decisions
- work independently or as part of a team
- demonstrate the ability for life-long learning to enhance their skills
- manage time
- demonstrate mechanical aptitude and manual dexterity
- solve problems
- demonstrate employability skills

Implementation

To receive a Senior Years Technical Education diploma from Manitoba Education and Advanced Learning, a student must complete eight departmentally developed courses from an approved technical-vocational cluster, together with 16 compulsory credits and six optional credits. The grade level in which the courses are offered are a local school-based decision, but it is highly recommended that the sequencing of credits follow the schedule set out at the end of this overview.

Most courses include outcomes related to the description, diagnosis, and repair of refrigeration and air conditioning components and systems.

Cross-curricular learning outcomes include essential skills from subject areas including, but not limited to, information and communication technologies, science, English language

arts, and mathematics. These learning outcomes are to be integrated into the authentic activities of the course.

Learning outcomes dealing with the following topics are also integrated into most courses:

- health and safety
- sustainability
- ethical and legal standards
- employability skills
- career opportunities
- evolution, technological progression, and emerging trends

In most courses, the emphasis is on applied activities. For instructional purposes, the sequence of outcomes can vary based on the activities within the course. Teachers are advised to select the activities best suited to teach the outcomes, based on a variety of factors, including access to resources or regional needs.

- The curriculum is not sequential. In other words, outcomes might be taught in an order different from how they appear in the document.
- In light of rapid changes in technology, teachers are encouraged to update their activities in order to meet the needs of students.

Partial Congruence with Level 1 Apprenticeship

This high school curriculum contains many, but **not all**, of the objectives found in the Apprenticeship Manitoba refrigeration and air conditioning mechanic curriculum documents. Before teaching the courses, teachers must refer to these documents, which are found at <www.gov.mb.ca/tce/apprent/apprentice/curriculum>. In some cases, the Apprenticeship objectives have been reworded to make them more consistent with the frameworks or more appropriate for high school students.

Therefore, students who successfully complete this high school curriculum will **not** have met the requirements for their Level 1 Apprenticeship for Refrigeration and Air Conditioning Mechanic. However, these students will have received thorough training in this trade, and will therefore be ready to enter a post-secondary program or the workforce.

The Apprenticeship documents provide necessary, detailed information and clarification of the Senior Years frameworks' outcomes. Teachers must teach all of the objectives and content found in the Apprenticeship documents that are referenced in the framework of outcomes.

Some of the specific learning outcomes in this framework of outcomes include an alphanumeric reference in bold letters (such as A3.11). In this case, A3.11 refers to Unit A3, Objective 11 of Refrigeration and Air Conditioning Mechanic Level 1 from Apprenticeship Manitoba, which is on page 5 of the document found at <www.manitoba.ca/wdis/apprenticeship/discover/mbtrades/index.html>.

Trade Safety Awareness Manual

Apprenticeship Manitoba has developed a Trade Safety Awareness Unit, which is intended to increase student awareness of trade safety in the workplace. All students who are studying a designated trade, including those in high school, must complete this seven-hour unit.

Refrigeration and Air Conditioning Goals and General Learning Outcomes (GLOs)

The specific learning outcomes for each course in the refrigeration and air conditioning program were developed based on the following goals and general learning outcomes:

Goal 1: Describe and apply appropriate **health and safety** practices as they relate to refrigeration and air conditioning.

GLO 1.1: Describe and apply appropriate **health and safety** practices.

GLO 1.2: Create and maintain a **safe working environment**.

Goal 2: Demonstrate the safe and appropriate **selection, operation, and management** of shop equipment and tools.

GLO 2.1: Demonstrate the safe and appropriate **selection, operation, and management** of shop **equipment and tools**.

Goal 3: Demonstrate the safe and appropriate **use of materials**.

GLO 3.1: Demonstrate the safe and appropriate use of **fasteners and supports**.

GLO 3.2: Demonstrate the safe and proper manipulation of **pipng and tubing**.

GLO 3.3: Demonstrate the safe and proper manipulation of **sheet metal**.

GLO 3.4: Demonstrate the appropriate **management of materials**.

Goal 4: **Install** heating, cooling, and refrigeration equipment.

GLO 4.1: Demonstrate an awareness of the **installation requirements** for heating.

GLO 4.2: Demonstrate the appropriate **installation** of heating, cooling, and refrigeration equipment.

GLO 4.3: **Test and document** refrigeration and air conditioning systems.

Goal 5: Repair heating, cooling, and refrigeration equipment.

GLO 5.1: **Diagnose** problems in heating, cooling, and refrigeration equipment.

GLO 5.2: **Repair** heating, cooling, and refrigeration equipment.

Goal 6: **Service** heating, cooling, and refrigeration equipment.

GLO 6.1: Demonstrate awareness of the **servicing needs** of heating, cooling, and refrigeration equipment.

Goal 7: Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to the refrigeration and air conditioning service and repair industry.

GLO 7.1: Demonstrate **information and communication technology** skills.

GLO 7.2: Read, interpret, and communicate information relevant to the refrigeration and air conditioning service and repair industry.

GLO 7.3: Apply the knowledge and skills related to the refrigeration and air conditioning service and repair industry from **mathematics**.

GLO 7.4: Apply the knowledge and skills related to the refrigeration and air conditioning service and repair industry from the **sciences**.

Goal 8: Demonstrate awareness of **sustainability** as it pertains to the refrigeration and air conditioning service and repair industry.

GLO 8.1: Describe the impact of **human sustainability** on the health and well-being of refrigeration and air conditioning mechanics and society.

GLO 8.2: Describe the refrigeration and air conditioning industry's sustainability practices and impact on the **environment**.

GLO 8.3: Describe **sustainable business practices** within the refrigeration and air conditioning service and repair industry.

Goal 9: Demonstrate awareness of the **ethical and legal standards** as they pertain to the refrigeration and air conditioning service and repair industry.

GLO 9.1: Practice the **ethical and legal standards** as they pertain to the refrigeration and air conditioning service and repair industry.

Goal 10: Demonstrate **employability skills** related to the refrigeration and air conditioning service and repair industry.

GLO 10.1: Demonstrate **fundamental employability skills**.

GLO 10.2: Demonstrate an understanding of the **business operation** of a refrigeration and air conditioning service and repair facility.

Goal 11: Understand **career opportunities** in the refrigeration and air conditioning service and repair industry and associated professions.

GLO 11.1: Describe **education** and **career opportunities** and **professional organizations** in the refrigeration and air conditioning service and repair industry and associated professions.

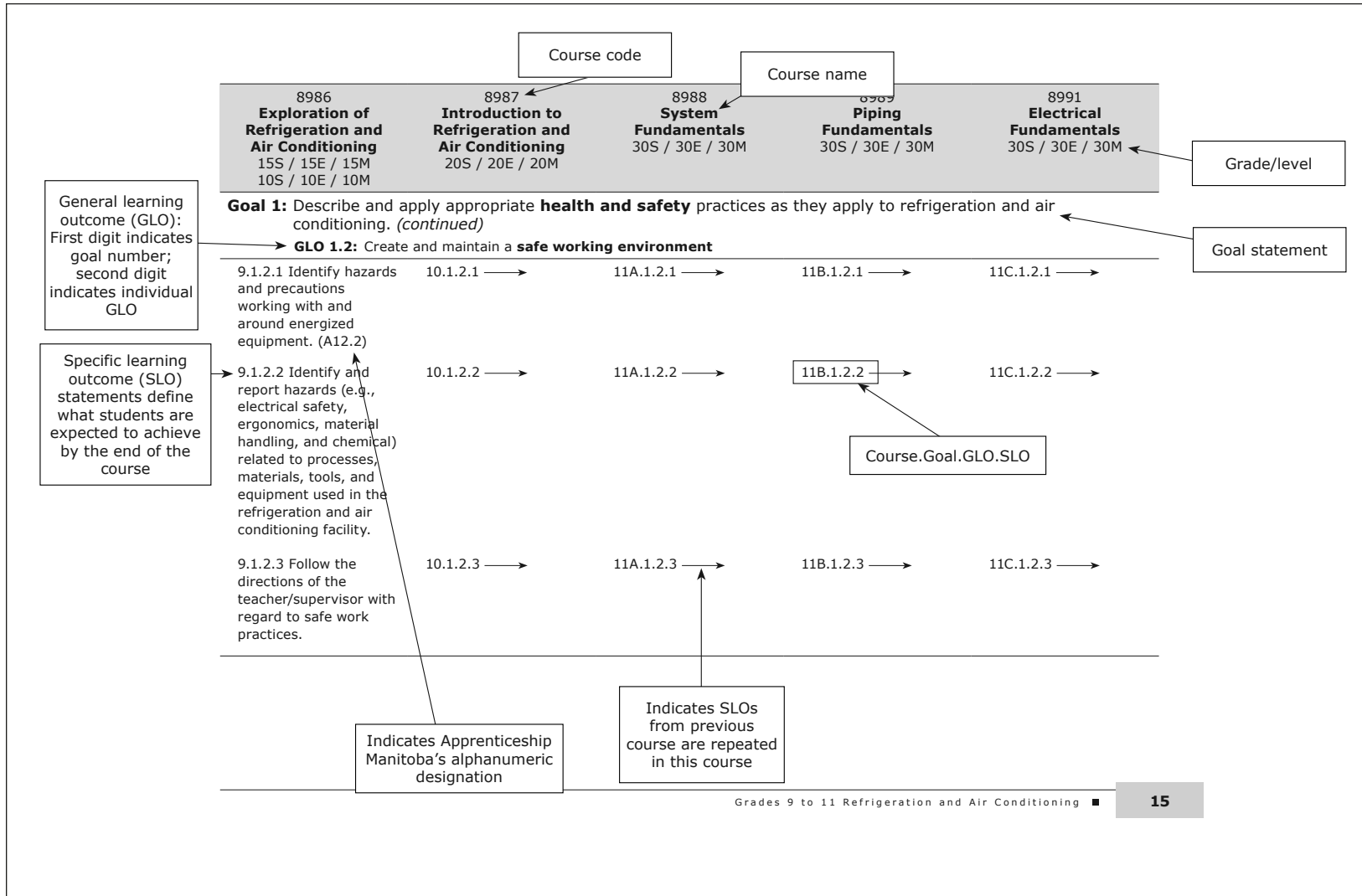
Goal 12: Understand the **evolution, technological progression and emerging trends** in the refrigeration and air conditioning service and repair industry.

GLO 12.1: Describe the **evolution, technological progression**, and **emerging trends** in the refrigeration and air conditioning service and repair industry.

Specific Learning Outcomes

Grades 9 to 12 Refrigeration and Air Conditioning: Manitoba Technical-Vocational Curriculum Framework of Outcomes identifies specific learning outcomes (SLOs) for use in all Manitoba schools teaching Grades 9 to 12 refrigeration and air conditioning courses as part of the Senior Years Technology Education program. Specific learning outcome statements define what students are expected to achieve by the end of the course. There is a great need for students to learn safety and employability skills, and for teachers to teach and assess those SLOs in every course. Therefore, with a few exceptions, all SLOs related to safety and employability skills are repeated in most courses in this program.

Guide to Reading the Refrigeration and Air Conditioning Technology Goals and Learning Outcomes



Course Descriptions

Course titles, descriptions, and codes for the nine refrigeration and air conditioning technology courses follow. For an explanation of the codes, refer to the [Subject Table Handbook: Technology Education: Student Records System and Professional School Personnel System](#) (Manitoba Education and Advanced Learning).

8986 Exploration of Refrigeration and Air Conditioning
15S/15E/15M
10S/10E/10M

This is an optional course intended for students wishing to sample Refrigeration and Air Conditioning Mechanic. The emphasis is on hands-on activities. Students are introduced to safety, tools and equipment, refrigeration and air conditioning systems, and service procedures.

8987 Introduction to Refrigeration and Air Conditioning
20S/20E/20M

A student wanting to develop skills in the refrigeration and air conditioning service and repair industry must have knowledge of the basic principles related to refrigeration and air conditioning equipment systems and service. Students learn safety, tools and equipment, refrigeration and air conditioning equipment systems, air movement systems, and ductwork fabrication.

8988 System Fundamentals

30S/30E/30M

A student wanting to develop skills in the refrigeration and air conditioning service and repair industry must have knowledge of the basic principles of the refrigeration cycle and components, and the basic hand tools necessary to test and install equipment and fabricate sheet metal ducting. The student will learn the procedures to assemble various parts and components.

8989 Piping Fundamentals

30S/30E/30M

A student wanting to develop skills in the refrigeration and air conditioning industry must have knowledge of the basic principles of the piping connection and brazing systems, pressure testing, and evacuation of piping systems. The student will be able to solder, braze, flare, bend, and assemble various piping materials and test for leaks.

8991 Electrical Fundamentals

30S/30E/30M

A student wanting to develop skills in the refrigeration and air conditioning industry must have knowledge of basic electrical systems. The student will develop skills in using basic calculations, tools, and meters to test electrical circuits. The student will also be able to do basic assembly of electrical components and wiring.

8992 Electrical Controls

40S/40E/40M

A student wanting to develop skills in the refrigeration and air conditioning industry must have knowledge of the basic principles of electrical control devices, switches, relays, transformers, and voltage supply systems. The student will be able to diagnose, service, and repair standard control systems and electrical components.

8995 Refrigeration and Air Cooling Systems

40S/40E/40M

A student wanting to develop skills in the refrigeration and air conditioning industry must have knowledge of the concepts of cooling air and the effects cooling air has on the products in storage and on air properties. The student will be able to identify various system components, how they are assembled, and their relationship to one another.

8996 Heating, Ventilation, and Air Conditioning Systems

40S/40E/40M

A student wanting to develop skills in the refrigeration and air conditioning industry must have knowledge of heating, ventilation, and air conditioning fundamentals. The student will learn how to fabricate and assemble ducting systems and related equipment. The student will also learn the basic theory of combustion and how warm air heating systems work. The student will be able to use basic troubleshooting techniques to diagnose and repair basic heating and cooling equipment.

8997 Applied Refrigeration and Air Conditioning

40S/40E/40M

A student wanting to expand skills in the refrigeration and air conditioning industry must be able to apply diagnostic strategies to a variety of refrigeration, heating, and air conditioning components. The students will demonstrate the ability to diagnose and correct basic maintenance procedures on heating, cooling, and refrigeration equipment with some supervision or direction. This may include job shadowing and work with outside contractors in the HVAC/R industry.

Curriculum Implementation Dates

During **voluntary implementation**, teachers have the option of teaching the entire new draft curriculum as soon as Manitoba Education and Advanced Learning releases it on the [Technology Education](#) website. They also have the option of teaching the courses from the previous curriculum. Teachers who implement courses before system-wide implementation need to ensure that students who are already taking courses from the previous curriculum achieve all SLOs with a minimum of redundancy.

Voluntary implementation of all refrigeration and air conditioning technology courses began in the fall of 2013 and will continue until their respective system-wide implementation dates.

Date	System-Wide Implementation
Fall 2014	Grade 9 (optional)
Fall 2015	Grade 10
Fall 2016	Grade 11
Fall 2017	Grade 12

Under **system-wide implementation**, all teachers in Manitoba teach the new curriculum and use the new course codes. Teachers will no longer be able to use the previous course codes. Course codes are found in the [Subject Table Handbook: Technology Education](#).



GRADES 9 TO 11
REFRIGERATION AND
AIR CONDITIONING

General and Specific Learning
Outcomes by Goal

GRADES 9 TO 11 REFRIGERATION AND AIR CONDITIONING GENERAL AND SPECIFIC LEARNING OUTCOMES BY GOAL

8986 Exploration of Refrigeration and Air Conditioning 15S / 15E / 15M 10S / 10E / 10M	8987 Introduction to Refrigeration and Air Conditioning 20S / 20E / 20M	8988 System Fundamentals 30S / 30E / 30M	8989 Piping Fundamentals 30S / 30E / 30M	8991 Electrical Fundamentals 30S / 30E / 30M
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Goal 1: Describe and apply appropriate **health and safety** practices as they apply to refrigeration and air conditioning.

GLO 1.1: Describe and apply appropriate **health and safety** practices.

9.1.1.1 Demonstrate awareness of the principles of Workplace Hazardous Materials Information Systems (WHMIS) as they apply to the refrigeration and air conditioning service and repair industry. (A3.11)	10.1.1.1 →	11A.1.1.1 →	11B.1.1.1 →	11C.1.1.1 →
9.1.1.2 Describe the purpose of Material Safety Data Sheets (MSDS).	10.1.1.2 →	11A.1.1.2 →	11B.1.1.2 →	11C.1.1.2 →
9.1.1.3 Describe workplace health and safety procedures (e.g., S.A.F.E., right to refuse). (A3.11)	10.1.1.3 →	11A.1.1.3 →	11B.1.1.3 →	11C.1.1.3 →

8986 Exploration of Refrigeration and Air Conditioning 15S / 15E / 15M 10S / 10E / 10M	8987 Introduction to Refrigeration and Air Conditioning 20S / 20E / 20M	8988 System Fundamentals 30S / 30E / 30M	8989 Piping Fundamentals 30S / 30E / 30M	8991 Electrical Fundamentals 30S / 30E / 30M
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Goal 1: Describe and apply appropriate **health and safety** practices as they apply to refrigeration and air conditioning. *(continued)*

GLO 1.1: Describe and apply appropriate **health and safety** practices. *(continued)*

9.1.1.4 Demonstrate the ability to follow safety information on supplier labels.	10.1.1.4 →	11A.1.1.4 →	11B.1.1.4 →	11C.1.1.4 →
9.1.1.5 Identify the process for reporting injuries.	10.1.1.5 →	11A.1.1.5 →	11B.1.1.5 →	11C.1.1.5 →
9.1.1.6 Identify ergonomically correct procedures to avoid injury (e.g., stress, strain). (A3.7)	10.1.1.6 →	11A.1.1.6 →	11B.1.1.6 →	11C.1.1.6 →
9.1.1.7 Identify fire prevention and control strategies.	10.1.1.7 →	11A.1.1.7 →	11B.1.1.7 →	11C.1.1.7 →
9.1.1.8 Identify emergency evacuation and response procedures.	10.1.1.8 →	11A.1.1.8 →	11B.1.1.8 →	11C.1.1.8 →
		11A.1.1.9 Identify hazards and describe safe work practices pertaining to air compressors.	11B.1.1.9 →	11C.1.1.9 →

8986 Exploration of Refrigeration and Air Conditioning 15S / 15E / 15M 10S / 10E / 10M	8987 Introduction to Refrigeration and Air Conditioning 20S / 20E / 20M	8988 System Fundamentals 30S / 30E / 30M	8989 Piping Fundamentals 30S / 30E / 30M	8991 Electrical Fundamentals 30S / 30E / 30M
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Goal 1: Describe and apply appropriate **health and safety** practices as they apply to refrigeration and air conditioning. *(continued)*

GLO 1.2: Create and maintain a **safe working environment**.

9.1.2.1 Identify hazards and precautions working with and around energized equipment. (A12.2)	10.1.2.1 →	11A.1.2.1 →	11B.1.2.1 →	11C.1.2.1 →
9.1.2.2 Identify and report hazards (e.g., electrical safety, ergonomics, material handling, and chemical) related to processes, materials, tools, and equipment used in the refrigeration and air conditioning facility.	10.1.2.2 →	11A.1.2.2 →	11B.1.2.2 →	11C.1.2.2 →
9.1.2.3 Follow the directions of the teacher/supervisor with regard to safe work practices.	10.1.2.3 →	11A.1.2.3 →	11B.1.2.3 →	11C.1.2.3 →

8986 Exploration of Refrigeration and Air Conditioning 15S / 15E / 15M 10S / 10E / 10M	8987 Introduction to Refrigeration and Air Conditioning 20S / 20E / 20M	8988 System Fundamentals 30S / 30E / 30M	8989 Piping Fundamentals 30S / 30E / 30M	8991 Electrical Fundamentals 30S / 30E / 30M
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Goal 1: Describe and apply appropriate **health and safety** practices as they apply to refrigeration and air conditioning. *(continued)*

GLO 1.2: Create and maintain a **safe working environment.** *(continued)*

9.1.2.4 Follow safe practices and procedures for facilities, processes, materials, tools, and equipment used in the refrigeration and air conditioning shop (e.g., keep work area clean and organized, avoid distractions).	10.1.2.4 →	11A.1.2.4 →	11B.1.2.4 →	11C.1.2.4 →
9.1.2.5 Describe and use appropriate personal protective equipment (e.g., gloves, safety glasses or goggles, hearing protection, respirator mask, etc.). (A3.2)	10.1.2.5 →	11A.1.2.5 →	11B.1.2.5 →	11C.1.2.5 →
9.1.2.6 Locate first aid and eyewash station.	10.1.2.6 →	11A.1.2.6 →	11B.1.2.6 →	11C.1.2.6 →

8986 Exploration of Refrigeration and Air Conditioning 15S / 15E / 15M 10S / 10E / 10M	8987 Introduction to Refrigeration and Air Conditioning 20S / 20E / 20M	8988 System Fundamentals 30S / 30E / 30M	8989 Piping Fundamentals 30S / 30E / 30M	8991 Electrical Fundamentals 30S / 30E / 30M
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Goal 1: Describe and apply appropriate **health and safety** practices as they apply to refrigeration and air conditioning. *(continued)*

GLO 1.2: Create and maintain a **safe working environment.** *(continued)*

9.1.2.7 Identify and report hazards (e.g., electrical, ergonomic, material handling, chemicals, and spills) related to materials, processes, tools, and equipment used in the refrigeration and air conditioning facility.	10.1.2.7 →	11A.1.2.7 →	11B.1.2.7 →	11C.1.2.7 →
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8986 Exploration of Refrigeration and Air Conditioning 15S / 15E / 15M 10S / 10E / 10M	8987 Introduction to Refrigeration and Air Conditioning 20S / 20E / 20M	8988 System Fundamentals 30S / 30E / 30M	8989 Piping Fundamentals 30S / 30E / 30M	8991 Electrical Fundamentals 30S / 30E / 30M
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Goal 2: Demonstrate the safe and appropriate **selection, operation, and management** of shop **equipment and tools.**

GLO 2.1: Demonstrate the safe and appropriate **selection, operation, and management** of shop **equipment and tools.**

9.2.1.1 Select the proper tool for the job at hand.	10.2.1.1 Identify types of hand tools, and describe their applications and procedures for use. (A4.1)	11A.2.1.1 Demonstrate use of Freon recovery unit and vacuum pump.	11B.2.1.1 Identify types of piping tools, and describe their applications and procedures for use.	11C.2.1.1 Identify types of electrical tools, and describe their application and procedures for use.
9.2.1.2 Describe and model proper use of hand and power tools applicable to the task at hand.	10.2.1.2 Demonstrate the use of hand, power, and specialized tools and equipment. (A4.13)	11A.2.1.2 Identify types of specialized tools and equipment, and describe their applications. a. Recovery and recycle b. Evacuation c. Charging (A4.5)		
9.2.1.3 Demonstrate safe and proper use of shop equipment and tools.	10.2.1.3 Identify types of flaring and swaging tools, and describe their applications and procedures for use and maintenance. (A9.6)			

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Goal 2: Demonstrate the safe and appropriate **selection, operation,** and **management** of shop **equipment and tools.** *(continued)*

GLO 2.1: Demonstrate the safe and appropriate **selection, operation,** and **management** of shop **equipment and tools.** *(continued)*

<p>9.2.1.6 Demonstrate proper cleaning and maintenance of tools and equipment.</p>	<p>10.2.1.4 Define terminology associated with sheet metal tools and equipment.</p> <p>10.2.1.5 Demonstrate the proper use of tools and equipment to cut, bend, manufacture, and join sheet metal components.</p> <p>10.2.1.6 Describe the procedures used to store and maintain hand tools. (A4.2)</p> <p>10.2.1.7 Describe the procedures used to store and maintain portable and stationary power tools. (A4.4)</p>
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Goal 3: Demonstrate the safe and appropriate **use of materials**.

GLO 3.1: Demonstrate the safe and appropriate use of **fasteners and supports**.

10.3.1.1 Demonstrate the safe and appropriate selection and application of fasteners and supports.

11B.3.1.1 Demonstrate the safe and appropriate selection and application of fasteners and supports used in piping fundamentals.

11C.3.1.1 Demonstrate the safe and appropriate selection and application of fasteners and supports used in electrical fundamentals.

GLO 3.2: Demonstrate the safe and proper manipulation of **piping and tubing**.

9.3.2.1 Demonstrate the proper selection, set-up, modification, and manipulation of related piping and tubing systems.

10.3.2.1 Define terminology associated with piping, flaring, tubing, soldering, and brazing. (A9.1)

11B.3.2.1 Identify types of refrigeration piping and tubing, and describe their characteristics and applications. (A9.3)

10.3.2.2 Describe the process for cutting pipe and tubing to proper sizes. (A9.5)

11B.3.2.2 Identify types of fittings, and describe their applications and procedures for use. (A9.4)

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Goal 3: Demonstrate the safe and appropriate **use of materials.** *(continued)*

GLO 3.2: Demonstrate the safe and proper manipulation of **piping and tubing.** *(continued)*

10.3.2.3 Demonstrate flaring, soldering, and brazing. (A9.18)

11B.3.2.3 Identify types of equipment and accessories used to solder and braze, and describe their applications. (A9.8)

11B.3.2.4 Identify types of soldering and brazing materials and fillers, and describe their characteristics and applications. (A9.9)

11B.3.2.5 Identify types of threaded pipe, and describe their characteristics and applications. (A9.11)

11B.3.2.6 Describe the procedures used to install piping and tubing. (A9.12)

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Goal 3: Demonstrate the safe and appropriate **use of materials.** *(continued)*

GLO 3.2: Demonstrate the safe and proper manipulation of **piping and tubing.** *(continued)*

11B.3.2.7 Demonstrate installation of refrigeration piping and tubing. (A9.17)

GLO 3.3: Demonstrate the safe and proper manipulation of sheet metal.

9.3.3.1 Demonstrate the safe and proper manipulation of sheet metal materials.

10.3.3.1 →

10.3.3.2 Describe the process for measuring, cutting, bending, and joining sheet metal components and for the use of related tools.

10.3.3.3 Fabricate ductwork fittings according to directions.

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Goal 3: Demonstrate the safe and appropriate **use of materials.** *(continued)*

GLO 3.4: Demonstrate the appropriate management of materials.

9.3.4.1 Demonstrate the safe and appropriate management of materials used in the refrigeration and air conditioning trade.	10.3.4.1 →	11B.3.4.1 Demonstrate the safe and appropriate management of piping materials used in the refrigeration and air conditioning trade.	11C.3.4.1 Demonstrate the safe and appropriate management of electrical materials used in the refrigeration and air conditioning trade.
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Goal 4: Install heating, cooling, and refrigeration equipment.

GLO 4.1: Demonstrate an awareness of the **installation requirements for** heating, cooling, and refrigeration equipment.

11A.4.1.1 Define terminology associated with compressors.

11B.4.1.1 Identify procedures for, awareness of, and codes related to piping installations.

11C.4.1.1 Identify procedures for, awareness of, and codes related to electrical installations.

11A.4.1.2 Describe the purpose and operating principles of the compressor in the refrigeration system.

11A.4.1.3 Identify types of compressors, and describe their characteristics and applications (e.g., reciprocating, scroll, rotary, screw, centrifugal).

11A.4.1.4 Identify compressor components, and describe their purpose and operation.

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Goal 4: Install heating, cooling, and refrigeration equipment. *(continued)*

GLO 4.1: Demonstrate an awareness of the **installation requirements for** heating, cooling, and refrigeration equipment. *(continued)*

11A.4.1.5 Identify cooling and lubrication of compressors.

11A.4.1.6 Demonstrate operation of compressors.

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Goal 4: Install heating, cooling, and refrigeration equipment. *(continued)*

GLO 4.2: Demonstrate the appropriate **installation** of heating, cooling, and refrigeration equipment.

	10.4.2.1 Discuss appropriate installation techniques and requirements.	11A.4.2.1 Demonstrate appropriate installation of HVAC/R systems.	11B.4.2.1 Define terminology associated with leak testing, evacuation, and charging. 11B.4.2.2 Identify types of leak detection tools, and describe their applications and procedures for use. 11B.4.2.3 Describe the procedures used to leak-test a refrigeration system. 11B.4.2.4 Identify types of evacuation tools and equipment, and describe their procedures for use and maintenance.	11C.4.2.1 Demonstrate appropriate installation of electrical equipment related to HVAC/R systems.
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Goal 4: Install heating, cooling, and refrigeration equipment. *(continued)*

GLO 4.2: Demonstrate the appropriate **installation** of heating, cooling, and refrigeration equipment. *(continued)*

11B.4.2.5 Describe the procedures used to evacuate and dehydrate a system.

11B.4.2.6 Demonstrate leak testing of refrigeration systems.

11B.4.2.7 Demonstrate evacuating and dehydrating a system.

11B.4.2.8 Demonstrate charging refrigerant into a system.

GLO 4.3: Test and document refrigeration and air conditioning systems.

10.4.3.1 Demonstrate awareness of the importance of testing and documenting refrigeration and air conditioning systems.

11A.4.3.1 Test and document refrigeration and air conditioning systems.

11B.4.3.1 Test piping systems.

11C.4.3.1 Test electrical systems.

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Goal 5: Repair heating, cooling, and refrigeration equipment.

GLO 5.1: Diagnose problems in heating, cooling, and refrigeration equipment.

	10.5.1.1 Demonstrate an awareness of problems in heating, cooling, and refrigeration equipment.	11A.5.1.1 Identify problems in heating, cooling, and refrigeration equipment, and determine which components need repair/replacement.	11B.5.1.1 Identify problems with piping systems and with checking for leak testing.	11C.5.1.1 Diagnose electrical problems in heating, cooling, and refrigeration equipment.
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GLO 5.2: Repair heating, cooling, and refrigeration equipment.

	11A.5.2.1 Perform repairs to heating and cooling equipment.	11B.5.2.1 Perform repairs on piping systems.	11C.5.2.1 Perform repairs on electrical systems.
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Goal 6: Service heating, cooling, and refrigeration equipment.

GLO 6.1: Demonstrate awareness of the **servicing needs** of heating, cooling, and refrigeration equipment.

	11A.6.1.1 Identify service requirements for HVAC equipment.	11B.6.1.1 Identify service required for piping systems.	11C.6.1.1 Identify service and maintenance required for electrical components.
	11A.6.1.2 Perform services on HVAC equipment.		11C.6.1.2 Perform service on electrical components.

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Goal 7: Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to the refrigeration and air conditioning service and repair industry.

GLO 7.1: Demonstrate skills from **information and communication technology.**

11A.7.1.1 Research topics related to heating and air conditioning service, repair, and technical bulletins using online resources.

11C.7.1.1 Demonstrate awareness of the computerized systems found in refrigeration and air conditioning equipment.

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Goal 7: Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to the refrigeration and air conditioning service and repair industry. *(continued)*

GLO 7.2: Read, interpret, and communicate information relevant to the refrigeration and air conditioning service and repair industry.

11A.7.2.1 Research topics covered in installation and maintenance manuals and manufacturer information.

11B.7.2.1 Read, interpret, and communicate piping diagrams.

11C.7.2.1 Read, interpret, and communicate electrical diagrams.

11A.7.2.2 Read, interpret, and communicate nameplate data.

11C.7.2.2 Read, interpret, and communicate electrical information found on nameplates.

11A.7.2.3 Read, interpret, and communicate information found on product labels.

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Goal 7: Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to the refrigeration and air conditioning service and repair industry. *(continued)*

GLO 7.3: Apply the knowledge and skills related to the refrigeration and air conditioning service and repair industry from **mathematics**.

10.7.3.1 Demonstrate the use of fractions, decimals, ratios, and percentages.

10.7.3.2 Apply mathematical formulas and processes.

10.7.3.3 Convert between imperial, standard, and metric systems of measurement.

11A.7.3.1 Apply mathematical formulas and techniques to related refrigeration and air conditioning calculations.

11A.7.3.2 Convert between Fahrenheit, Celsius, Kelvin, and Rankine systems of measurement.

11B.7.3.1 Apply mathematical calculations to piping design and layout.

11C.7.3.1 Apply mathematical formulas to electrical calculations.

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Goal 7: Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to the refrigeration and air conditioning service and repair industry. *(continued)*

GLO 7.4: Apply the knowledge and skills related to the refrigeration and air conditioning service and repair industry from the **sciences**.

10.7.4.1 Apply scientific knowledge and equations to electrical OHM's law formulas.	11A.7.4.1 Describe heat flow and identify methods of heat transfer.	11C.7.4.1 Identify units of electrical measurement and symbols. (A12.3)
10.7.4.2 Define terminology associated with electrical fundamentals. (A12.1)	11A.7.4.2 Identify states of matter, and describe their characteristics.	11C.7.4.2 Identify types of conductors, and describe their characteristics and applications. (A12.5)
10.7.4.3 Describe current and electron flow in both direct and alternating current circuits.	11A.7.4.3 Describe basic gas laws associated with refrigeration, and perform calculations to demonstrate relationships.	11C.7.4.3 Identify the factors used to determine conductor ampacity rating. (A12.6)
10.7.4.4 Describe the relationship between voltages, current, resistance, and power. (A12.8)	11A.7.4.4 Describe the effect of pressure on evaporation, condensing, freezing, and melting temperatures.	11C.7.4.4 Identify types of wire insulating materials, and describe their characteristics and applications. (A12.7)

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Goal 7: Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to the refrigeration and air conditioning service and repair industry. *(continued)*

GLO 7.4: Apply the knowledge and skills related to the refrigeration and air conditioning service and repair industry from the **sciences**. *(continued)*

10.7.4.5 Calculate voltage, current, and resistance in series, parallel, and combination circuits. (A12.9)

10.7.4.6 Identify series, parallel, and series/parallel electrical circuits, and describe their characteristics. (A12.11)

10.7.4.7 Demonstrate measuring voltage, resistance, current, and power. (A12.20)

11A.7.4.5 Explain the operation of the vapour compression cycle.

11A.7.4.6 Identify components of a vapour compression cycle, and describe their purpose and operation.

11A.7.4.7 Describe the physical changes of the refrigerant as it circulates through the system.

11C.7.4.5 Describe an overloaded, grounded, open, and short circuit. (A12.12)

11C.7.4.6 Identify types of electrical wiring diagrams, and describe their purpose. (A12.19)

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Goal 8: Demonstrate awareness of **sustainability** as it pertains to the refrigeration and air conditioning service and repair industry.

GLO 8.1: Describe the impact of **human sustainability** on the health and well-being of refrigeration and air conditioning mechanics and society.

9.8.1.1 Demonstrate an understanding of human sustainability.	10.8.1.1 →	11A.8.1.1 Discuss the long-term health hazards related to the service and maintenance of HVAC/R equipment.	11B.8.1.1 Discuss the long-term health hazards related to the service and maintenance of piping systems.	11C.8.1.1 Discuss the long-term health hazards related to electrical systems.
	10.8.1.2 Demonstrate an awareness of ergonomics.	11A.8.1.2 Discuss the benefits of HVAC/R to the health and well-being of human beings.		

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Goal 8: Demonstrate awareness of **sustainability** as it pertains to the refrigeration and air conditioning service and repair industry. *(continued)*

GLO 8.2: Describe the refrigeration and air conditioning industry’s sustainability practices and impact on the **environment**.

10.8.2.1 Demonstrate knowledge of efficient material usage to reduce waste and its impact on the environment.

11A.8.2.1 Describe and apply appropriate disposal practices.

11B.8.2.1 Demonstrate the safe and appropriate recovery and reclamation of refrigerant.

11C.8.2.1 Demonstrate the salvaging of scrap copper wire and components.

10.8.2.2 Identify recycling processes for materials.

11A.8.2.2 Discuss concerns regarding environmental damage attributed to HVAC equipment and products.

11B.8.2.2 Discuss the impact of chemical hazards on the environment.

GLO 8.3: Describe **sustainable business practices** within the refrigeration and air conditioning service and repair industry.

10.8.3.1 Discuss business practices and the differences between those that are sustainable and those that are not.

11A.8.3.1 Describe sustainable business practices within the refrigeration and air conditioning industry.

11B.8.3.1 Discuss how business practices can help to sustain a HVAC/R business or department.

11C.8.3.1 Discuss how modern electronic equipment requires more highly qualified technicians to diagnose, repair, and maintain.

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Goal 9: Demonstrate awareness of the ethical and legal standards as they pertain to the refrigeration and air conditioning service and repair industry.

GLO 9.1: Practise the **ethical and legal standards** as they pertain to the refrigeration and air conditioning service and repair industry.

	10.9.1.1 Identify ethical and legal standards.	11A.9.1.1 Identify the ethical and legal expectations of HVAC/R technicians.	11B.9.1.1 Identify legislation regarding HVAC/R, including certification of tradespersons and recovery and disposal of refrigerants.	11C.9.1.1 Discuss the importance of ethics in relation to the servicing of HVAC/R systems.
	10.9.1.2 Discuss the need for building codes.	11A.9.1.2 Identify the necessity for legal standards in the HVAC industry.		

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Goal 10: Demonstrate **employability skills** related to the refrigeration and air conditioning service and repair industry.

GLO 10.1: Demonstrate **fundamental employability skills**.

9.10.1.1 Demonstrate critical-thinking and problem-solving skills.	10.10.1.1 →	11A.10.1.1 →	11B.10.1.1 →	11C.10.1.1 →
9.10.1.2 Demonstrate regular attendance and punctuality.	10.10.1.2 →	11A.10.1.2 →	11B.10.1.2 →	11C.10.1.2 →
9.10.1.3 Demonstrate accountability by taking responsibility for their actions.	10.10.1.3 →	11A.10.1.3 →	11B.10.1.3 →	11C.10.1.3 →
9.10.1.4 Demonstrate adaptability, initiative, and effort.	10.10.1.4 →	11A.10.1.4 →	11B.10.1.4 →	11C.10.1.4 →
9.10.1.5 Demonstrate the ability to accept and follow direction and feedback.	10.10.1.5 →	11A.10.1.5 →	11B.10.1.5 →	11C.10.1.5 →
9.10.1.6 Demonstrate teamwork skills.	10.10.1.6 →	11A.10.1.6 →	11B.10.1.6 →	11C.10.1.6 →

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Goal 10: Demonstrate **employability skills** related to the refrigeration and air conditioning service and repair industry. *(continued)*

GLO 10.1: Demonstrate **fundamental employability skills**. *(continued)*

9.10.1.7 Stay on task and use time effectively.	10.10.1.7 →	11A.10.1.7 →	11B.10.1.7 →	11C.10.1.7 →
9.10.1.8 Communicate respectfully and effectively with co-workers and customers.	10.10.1.8 →	11A.10.1.8 →	11B.10.1.8 →	11C.10.1.8 →

GLO 10.2: Demonstrate an understanding of the business operation of a refrigeration and air conditioning service and repair facility.

	10.10.2.1 Identify some factors that are required for the business operation of a refrigeration and air conditioning facility.	11A.10.2.1 Discuss the importance of project management, and how each tradesperson's work affects the work of others, including those in other trades.	11B.10.2.1 Discuss the effect of inefficient work on the business operation of a refrigeration and air conditioning facility. 11B.10.2.2 Discuss the advantages and disadvantages of cleaning or replacing existing piping systems when changing refrigerant types.	11C.10.2.1 Discuss the effect of wasting materials on the business operation of a refrigeration and air conditioning facility.
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Goal 11: Understand **career opportunities** in the refrigeration and air conditioning service and repair industry and associated professions.

GLO 11.1: Describe **education** and **career opportunities** and **professional organizations** in the refrigeration and air conditioning service and repair industry and associated professions.

10.11.1.1 Identify career paths related to the HVAC industry and associated occupations.

11A.11.1.1 Describe education and career opportunities and professional HVAC/R organizations.

11B.11.1.1 Demonstrate an awareness of education and career opportunities and professional organizations in the pipe trades.

11C.11.1.1 Demonstrate an awareness of education and career opportunities and professional organizations in the electrical industry.

10.11.1.2 Identify employment and educational opportunities related to HVAC/R and associated occupations.

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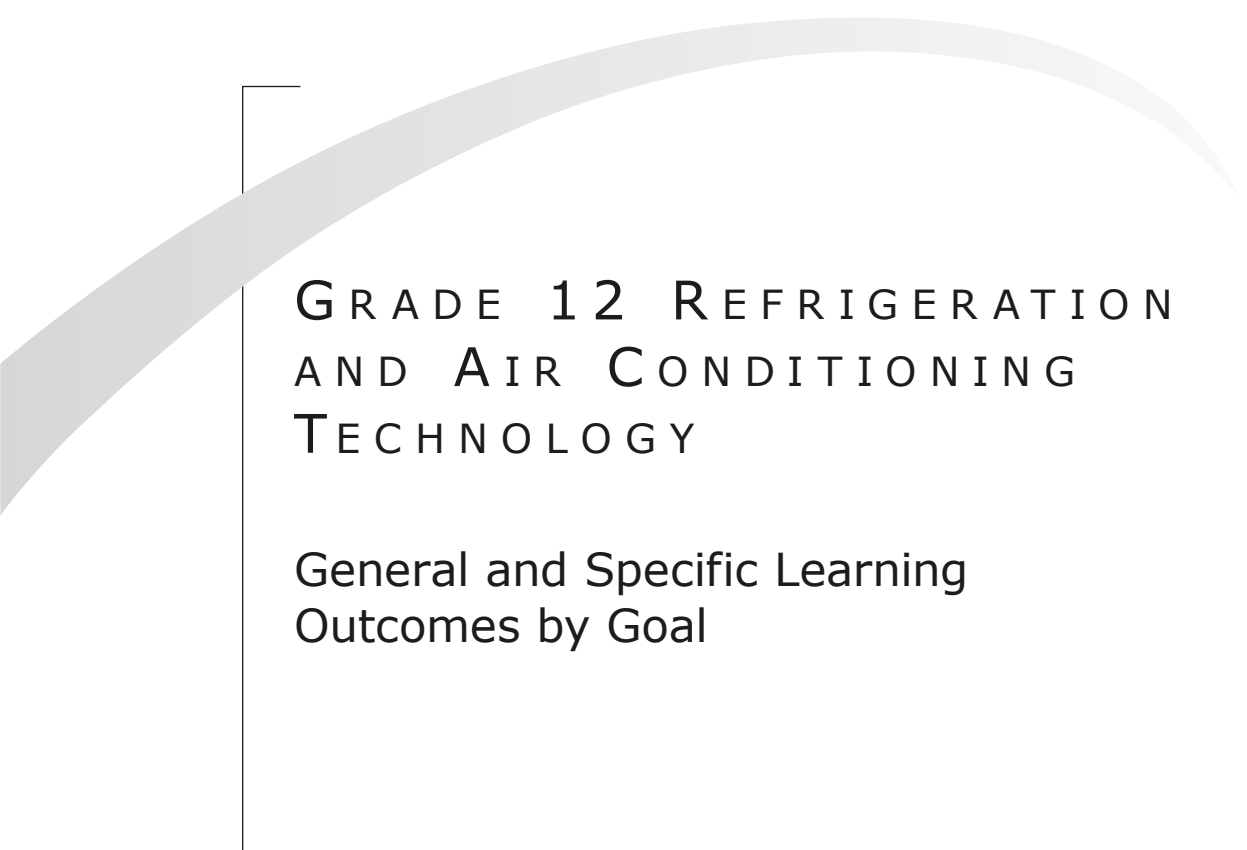
Goal 12: Understand the **evolution, technological progression,** and **emerging trends** in the refrigeration and air conditioning service and repair industry.

GLO 12.1: Describe the **evolution, technological progression,** and **emerging trends** in the refrigeration and air conditioning service and repair industry.

10.12.1.1 Discuss the evolution, technical progression, and emerging trends in the HVAC industry.

11B.12.1.1 Discuss the evolution, technical progression, and emerging trends in piping fundamentals.

11C.12.1.1 Discuss progression of electrical controls and equipment used in the HVAC industry.



GRADE 12 REFRIGERATION
AND AIR CONDITIONING
TECHNOLOGY

General and Specific Learning
Outcomes by Goal

GRADE 12 REFRIGERATION AND AIR CONDITIONING: GENERAL AND SPECIFIC LEARNING OUTCOMES BY GOAL

8992 Electrical Controls (12A) 40S / 40E / 40M	8995 Refrigeration and Air Cooling Systems (12B) 40S / 40E / 40M	8996 Heating, Ventilation, and Air Conditioning Systems (12C) 40S / 40E / 40M	8997 Applied Refrigeration and Air Conditioning (12D) 40S / 40E / 40M
Goal 1: Describe and apply appropriate health and safety practices as they apply to refrigeration and air conditioning.			
GLO 1.1: Describe and apply appropriate health and safety practices.			
12A.1.1.1 Demonstrate awareness of the principles of workplace hazards surrounding electrical environments.	12B.1.1.1 Demonstrate awareness of the principles of workplace hazards surrounding refrigeration and air cooling environments.	12C.1.1.1 Demonstrate awareness of the principles of workplace hazards surrounding HVAC environments.	12D.1.1.1 Demonstrate awareness of the principles of workplace hazards surrounding refrigeration and air cooling environments.
12A.1.1.2 Demonstrate awareness of the principles of Workplace Hazardous Materials Information Systems (WHMIS) as they apply to the refrigeration and air conditioning service and repair industry. (A3.11)	12B.1.1.2 →	12C.1.1.2 →	12D.1.1.2 →
12A.1.1.3 Describe the purpose of Material Safety Data Sheets (MSDS).	12B.1.1.3 →	12C.1.1.3 →	12D.1.1.3 →
12A.1.1.4 Describe workplace health and safety procedures (e.g., S.A.F.E., right to refuse). (A3.11)	12B.1.1.4 →	12C.1.1.4 →	12D.1.1.4 →

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Goal 1: Describe and apply appropriate **health and safety practices** as they relate to the **maintenance of a safe workspace.** *(continued)*

GLO 1.1: Create and maintain a **safe working environment.** *(continued)*

12A.1.1.5 Follow safety information on supplier labels.	12B.1.1.5 →	12C.1.1.5 →	12D.1.1.5 →
12A.1.1.6 Identify the process for reporting injuries.	12B.1.1.6 →	12C.1.1.6 →	12D.1.1.6 →
12A.1.1.7 Identify ergonomically correct procedures to avoid injury (e.g., stress, strain). (A3.7)	12B.1.1.7 →	12C.1.1.7 →	12D.1.1.7 →
12A.1.1.8 Identify fire prevention and control strategies.	12B.1.1.8 →	12C.1.1.8 →	12D.1.1.8 →
12A.1.1.9 Identify emergency evacuation and response procedures.	12B.1.1.9 →	12C.1.1.9 →	12D.1.1.9 →

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Goal 1: Describe and apply appropriate **health and safety practices** as they relate to the **maintenance of a safe workspace.** *(continued)*

GLO 1.2: Create and maintain a **safe working environment.**

12A.1.2.1 Identify hazards and precautions working with and around energized electrical equipment.	12B.1.2.1 Identify hazards and precautions working with and around pressurized equipment.	12C.1.2.1 Identify hazards and precautions working with and around air handling equipment.	12D.1.2.1 Identify hazards and precautions working with and around all types of energized equipment.
12A.1.2.2 Identify hazards and precautions working with and around energized equipment. (A12.2)	12B.1.2.2 →	12C.1.2.2 →	12D.1.2.2 →
12A.1.2.3 Identify and report hazards (e.g., electrical safety, ergonomics, material handling, and chemical) related to processes, materials, tools, and equipment used in the refrigeration and air conditioning shop.	12B.1.2.3 →	12C.1.2.3 →	12D.1.2.3 →
12A.1.2.4 Follow the directions of the teacher/supervisor in regards to safe work practices.	12B.1.2.4 →	12C.1.2.4 →	12D.1.2.4 →

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Goal 1: Describe and apply appropriate **health and safety practices** as they relate to the **maintenance of a safe workspace.** *(continued)*

GLO 1.2: Create and maintain a **safe working environment.** *(continued)*

12A.1.2.5 Follow safe practices and procedures for facilities, processes, materials, tools, and equipment used in the refrigeration and air conditioning shop (e.g., keep work area clean and organized, avoid horseplay).	12B.1.2.5 →	12C.1.2.5 →	12D.1.2.5 →
12A.1.2.6 Describe and use appropriate personal protective equipment (e.g., gloves, safety glasses or goggles, hearing protection, respirator mask, etc.). (A3.2)	12B.1.2.6 →	12C.1.2.6 →	12D.1.2.6 →
12A.1.2.7 Locate first aid and eyewash station.	12B.1.2.7 →	12C.1.2.7 →	12D.1.2.7 →

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Goal 1: Describe and apply appropriate **health and safety practices** as they relate to the **maintenance of a safe workspace.** *(continued)*

GLO 1.2: Create and maintain a **safe working environment.** *(continued)*

12A.1.2.8 Identify and report hazards (e.g., electrical, ergonomic, material handling, chemicals, and spills) related to materials, processes, tools, and equipment used in the refrigeration and air conditioning facility.	12B.1.2.8 →	12C.1.2.8 →	12D.1.2.8 →
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Goal 2: Demonstrate the safe and appropriate **selection, operation, and management** of shop **equipment and tools.**

GLO 2.1: Demonstrate the safe and appropriate **selection, operation, and management** of shop **equipment and tools.**

12A.2.1.1 Demonstrate the safe and appropriate selection, operation, and management of equipment and tools used in electrical controls.	12B.2.1.1 Demonstrate the safe and appropriate selection, operation, and management of equipment and tools used in refrigeration and air cooling systems.	12C.2.1.1 Demonstrate the safe and appropriate selection, operation, and management of equipment and tools used to manipulate sheet metal.	12D.2.1.1 Select, operate, and manage equipment and tools used in refrigeration and air conditioning.
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Goal 3: Demonstrate the safe and appropriate selection and utilization of **materials**.

GLO 3.1 Demonstrate the safe and proper appropriate selection and utilization of **fasteners and supports**.

12B.3.1.1 Identify and describe proper selection and application of fasteners and supports.

12C.3.1.1 →

12D.3.1.1 Select and utilize fasteners and supports.

GLO 3.2 Demonstrate the safe and proper manipulation of **piping and tubing**.

12A.3.2.1 Describe and demonstrate the proper selection, set-up, modification, and manipulation of related conduits and piping for electrical and controls.

12B.3.2.1 Describe and demonstrate the proper selection, set-up, modification, and manipulation of related piping and tubing systems.

12C.3.2.1 Describe and demonstrate the proper selection, set-up, modification, and manipulation of related piping and tubing systems.

12D.3.2.1 Select, set up, modify, and manipulate piping and tubing systems.

GLO 3.3 Demonstrate the safe and appropriate manipulation of **sheet metal**.

12C.3.3.1 Demonstrate the safe and appropriate manipulation of sheet metal.

12D.3.3.1 →

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Goal 4: Install heating, cooling, and refrigeration equipment.

GLO 4.1 Demonstrate an awareness of the **installation requirements** for heating, cooling, and refrigeration equipment.

12A.4.1.1 Identify proper system control selection and types for various installation applications.

12B.4.1.1 →

12C.4.1.1 Identify proper system types for various installation applications.

12D.4.1.1 Determine the installation requirements for heating, cooling, and refrigeration equipment.

GLO 4.2 Demonstrate the appropriate installation of heating, cooling, and refrigeration equipment.

12A.4.2.1 Demonstrate appropriate installation of electrical equipment related to HVAC/R systems.

12B.4.2.1 Demonstrate appropriate installation of refrigeration and air cooling systems.

12C.4.2.1 Demonstrate appropriate installation of heating, ventilation, and air conditioning systems.

12D.4.2.1 Install heating, cooling, and refrigeration equipment.

GLO 4.3: Test and document refrigeration and air conditioning systems.

12A.4.3.1 Test electrical systems, record measurements, and compare to nameplate data.

12B.4.3.1 Test HVAC/R systems, and record temperatures and pressure measurements.

12C.4.3.1 Test HVAC/R systems, and record pressures and temperatures.

12D.4.3.1 Test HVAC/R systems.

12D.4.3.2 Document HVAC/R systems.

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Goal 5: Diagnose and repair heating, cooling, and refrigeration equipment.

GLO 5.1: Diagnose problems in heating, cooling, and refrigeration equipment.

12A.5.1.1 Diagnose electrical problems in HVAC/R equipment.	12B.5.1.1 Diagnose problems in HVAC/R equipment.	12C.5.1.1 →	12D.5.1.1 →
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GLO 5.2: Repair heating, cooling, and refrigeration equipment.

12A.5.2.1 Perform electrical repairs to heating and cooling equipment.	12B.5.2.1 Perform necessary and assigned repairs to refrigeration and air cooling systems.	12C.5.2.1 Perform necessary repairs to heating, ventilation, and air conditioning systems.	12D.5.2.1 Perform repairs to heating, cooling, and refrigeration equipment and systems.
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Goal 6: Service heating, cooling, and refrigeration equipment.

GLO 6.1: Demonstrate awareness of the **servicing needs** of heating, cooling, and refrigeration equipment.

12A.6.1.1 Identify service and maintenance required for electrical components.	12B.6.1.1 Identify service and maintenance required for refrigeration and air cooling systems.	12C.6.1.1 Identify service and maintenance required for heating ventilation and air conditioning systems.	12D.6.1.1 Identify service and maintenance required for refrigeration and air conditioning systems.
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Goal 6: Service heating, cooling, and refrigeration equipment. *(continued)*

GLO 6.2: Demonstrate the appropriate **servicing** of heating, cooling, and refrigeration equipment.

12A.6.2.1 Perform service on electrical components.	12B.6.2.1 Perform service and testing on refrigeration and air cooling systems.	12C.6.2.1 Perform service and testing for heating, ventilation, and air conditioning systems.	12D.6.2.1 Perform service and testing on refrigeration and air conditioning systems.
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Goal 7: Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to the refrigeration and air conditioning service and repair industry.

GLO 7.1: Demonstrate skills from **information and communication technology**.

			12D.7.1.1 Research appropriate system selection for specific installation requirements, and make necessary calculations.
			12D.7.1.2 Locate and utilize online installation guides and servicing information.

GLO 7.2: Read, interpret, and communicate information relevant to the refrigeration and air conditioning service and repair industry.

12A.7.2.1 Apply electrical diagrams to troubleshooting electrical faults in HVAC/R equipment.	12B.7.2.1 Apply use of manuals to refrigeration and air cooling systems.	12C.7.2.1 Apply use of manuals to the commission, repair, and maintenance of heating, ventilation, and air conditioning systems.	12D.7.2.1 Apply use of manuals to the commission, repair, and maintenance of refrigeration and air conditioning systems.
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Goal 7: Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to the refrigeration and air conditioning service and repair industry. (*continued*)

GLO 7.3: Apply the knowledge and skills related to the refrigeration and air conditioning service and repair industry from **mathematics**.

12A.7.3.1 Apply necessary mathematical formulas to make electrical calculations surrounding OHM's law, etc.

12C.7.3.1 Apply necessary mathematical formulas to make air movement calculations.

GLO 7.4: Apply knowledge and skills from the sciences to the refrigeration and air conditioning service and repair industry.

12A.7.4.1 Apply necessary mathematical formulas to make pressure/temperature calculations.

12B.7.4.1 Apply necessary mathematical formulas to perform air movement calculations.

12B.7.4.2 Perform superheating and sub-cooling calculations.

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Goal 8: Demonstrate awareness of **sustainability** as it pertains to the refrigeration and air conditioning service and repair industry.

GLO 8.1: Describe the impact of human **sustainability** on the health and well-being of refrigeration and air conditioning mechanics and their clients.

12A.8.1.1 Discuss the long-term health and human sustainability concerns for refrigeration and air conditioning technicians.	12B.8.1.1 →	12C.8.1.1 →	12D.8.1.1 →
12A.8.1.2 Discuss the contribution of electrical controls to human health and well-being.	12B.8.1.2 Discuss the contribution of refrigeration and air cooling systems to human health and well-being.	12C.8.1.2 Discuss the contribution of heating, ventilation, and air conditioning systems to human health and well-being.	12D.8.1.2 Discuss the contribution of refrigeration and air conditioning to human health and well-being.

GLO 8.2: Describe the refrigeration and air conditioning industry's **sustainability practices and impact on the environment.**

12A.8.2.1 Discuss the need to recover refrigerants to prevent their release into the environment.	12B.8.2.1 →	12C.8.2.1 →	12D.8.2.1 →
12A.8.2.2 Discuss the new energy-efficient electrical projects that reduce the impact on our environment.	12B.8.2.2 Discuss energy efficiency and its benefits.	12C.8.2.2 Discuss new innovations in high-efficiency equipment.	

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Goal 8: Demonstrate awareness of **sustainability** as it pertains to the refrigeration and air conditioning service and repair industry. (*continued*)

GLO 8.3: Describe **sustainable business practices** within the refrigeration and air conditioning service and repair industry.

12A.8.3.1 Discuss the influence of refrigeration and air conditioning businesses on the local economy.	12B.8.3.1 Discuss the relationship between the state of the local economy and the repair of existing HVAC/R appliances, and the purchase of new appliances.	12C.8.3.1 Discuss some of the factors that help sustain a business in the long term (e.g., quality of work, good customer relations, working conditions, etc.).	12D.8.3.1 Discuss how refrigeration and air conditioning businesses can adapt to a changing economy and changing demographics.
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Goal 9: Demonstrate awareness of the **ethical and legal standards** as they pertain to the refrigeration and air conditioning service and repair industry.

GLO 9.1: Practice the **ethical and legal standards** as they pertain to the refrigeration and air conditioning service and repair industry.

12A.9.1.1 Demonstrate an understanding of codes and regulations related to electrical controls.	12B.9.1.1 Demonstrate an understanding of codes and regulations related to refrigeration and air conditioning systems.	12C.9.1.1 Demonstrate an understanding of codes and regulations related to heating, ventilation, and air conditioning systems.	12D.9.1.1 Demonstrate an understanding of codes and regulations related to refrigeration and air conditioning.
12A.9.1.2 Demonstrate ethical behaviour by producing high-quality work.			12D.9.1.2 Demonstrate an awareness of liability concerns related to HVAC/R systems and service.

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Goal 10: Demonstrate **employability skills** related to the refrigeration and air conditioning service and repair industry.

GLO 10.1: Demonstrate fundamental **employability skills**.

12A.10.1.1 Demonstrate critical-thinking and problem-solving skills.	12B.10.1.1 →	12C.10.1.1 →	12D.10.1.1 →
12A.10.1.2 Demonstrate regular attendance and punctuality.	12B.10.1.2 →	12C.10.1.2 →	12D.10.1.2 →
12A.10.1.3 Demonstrate accountability by taking responsibility for their actions.	12B.10.1.3 →	12C.10.1.3 →	12D.10.1.3 →
12A.10.1.4 Demonstrate adaptability, initiative, and effort.	12B.10.1.4 →	12C.10.1.4 →	12D.10.1.4 →
12A.10.1.5 Demonstrate the ability to accept and follow direction and feedback.	12B.10.1.5 →	12C.10.1.5 →	12D.10.1.5 →
12A.10.1.6 Demonstrate the ability to stay on task and to use time in class and in the shop effectively.	12B.10.1.6 →	12C.10.1.6 →	12D.10.1.6 →
12A.10.1.7 Demonstrate the ability to communicate respectfully with co-workers and customers.	12B.10.1.7 →	12C.10.1.7 →	12D.10.1.7 →

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Goal 10: Demonstrate **employability skills** related to the refrigeration and air conditioning service and repair industry. *(continued)*

GLO 10.2: Demonstrate an understanding of the **business operation** of a refrigeration and air conditioning service and repair shop.

12A.10.2.1 Identify business activities that affect profit and loss.	12B.10.2.1 Demonstrate an awareness of the importance of record keeping (e.g., invoices, inventory, work orders, etc.) in a refrigeration and air conditioning facility.	12C.10.2.1 Discuss how the work of refrigeration and air conditioning technicians contributes to the business operation of a facility.	12D.10.2.1 Demonstrate awareness of the business operation of an HVAC facility.
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Goal 11: Understand **career opportunities** in the refrigeration and air conditioning service and repair industry and associated professions.

GLO 11.1: Describe **education and career opportunities** and **professional organizations** in the refrigeration and air conditioning service and repair industry and associated professions.

12A.11.1.1 Discuss the electrical trade and opportunities in cross-training with the HVAC/R industry.	12B.11.1.1 Discuss the opportunities for employment in the refrigeration and air cooling industry.	12C.11.1.1 Discuss the opportunities for employment in the heating, ventilation, and air conditioning industry.	12D.11.1.1 Discuss the opportunities for employment in the refrigeration and air conditioning industry.
			12D.11.1.2 Create a portfolio showcasing the student's accomplishments in refrigeration and air conditioning.
			12D.11.1.3 Create a cover letter and resumé for the purpose of gaining employment in refrigeration and air conditioning.

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Goal 12: Understand the **evolution, technological progression, and emerging trends** in the refrigeration and air conditioning service and repair industry.

GLO 12.1: Describe the **evolution, technological progression, and emerging trends** in the refrigeration and air conditioning service and repair industry.

12A.12.1.1 Discuss the progression of electrical and electronic controls in the HVAC/R industry (e.g., the necessity for energy conservation, etc.).	12B.12.1.1 Discuss new trends in energy efficiency in the marketplace and its effect on system complexity and service requirements.	12C.12.1.1 Discuss new trends in heating, ventilation, and air conditioning systems.	12D.12.1.1 Discuss the evolution, technological progression, and emerging trends in refrigeration and air conditioning, and how these pertain to the work done in an HVAC/R facility.
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