

# **Heating, Refrigeration, and Air Conditioning Technician Program Standard**

**The approved program standard for all Heating, Refrigeration and Air Conditioning Technician programs of instruction leading to an Ontario College Diploma delivered by Ontario Colleges of Applied Arts and Technology.**

**(MTCU funding code 55500)**

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# I. Introduction

*This document is the Program Standard for all Heating, Refrigeration and Air Conditioning Technician programs of instruction leading to an Ontario College Diploma delivered by Ontario colleges of applied arts and technology (MTCU funding code 55500).*

## Development of System-Wide Program Standards

In 1993, the Government of Ontario initiated program standards development with the objectives of bringing a greater degree of consistency to college programming offered across the province, broadening the focus of college programs to ensure graduates have the skills to be flexible and to continue to learn and adapt, and providing public accountability for the quality and relevance of college programs.

The Colleges Branch of the Ministry of Training, Colleges and Universities has responsibility for the development, review, and approval of system-wide standards for programs of instruction at Ontario colleges of applied arts and technology.

## Program Standards

Program standards apply to all similar programs of instruction offered by colleges across the province. Each program standard for a postsecondary program includes the following elements:

- **Vocational standard** (the vocationally specific learning outcomes which apply to the program of instruction in question),
- **Essential employability skills** (the essential employability skills learning outcomes which apply to all programs of instruction), and
- **General education requirement** (the requirement for general education in postsecondary programs of instruction).

Collectively, these elements outline the essential skills and knowledge that a student must reliably demonstrate in order to graduate from the program.

Individual colleges of applied arts and technology offering the program of instruction determine the specific program structure, delivery methods, and other curriculum matters to be used in assisting students to achieve the outcomes articulated in the standard. Individual colleges also determine whether additional local learning outcomes will be required to reflect specific local needs and/or interests.

## The Expression of Program Standards as Learning Outcomes

Learning outcomes represent culminating demonstrations of learning and achievement. They are not simply a listing of discrete skills, nor broad statements of knowledge and comprehension. In addition, learning outcomes are interrelated and cannot be viewed in isolation of one another. As such, they should be viewed as a comprehensive whole. They describe performances that demonstrate that significant integrated learning by graduates of the program has been achieved and verified.

Expressing standards as learning outcomes ensures consistency in the outcomes for program graduates, while leaving to the discretion of individual colleges curriculum matters such as the specific program structure and delivery methods.

## The Presentation of the Learning Outcomes

The **learning outcome** statement sets out the culminating demonstration of learning and achievement that the student must reliably demonstrate before graduation.

The **elements of the performance** for each outcome define and clarify the level and quality of performance necessary to meet the requirements of the learning outcome. However, it is the performance of the learning outcome itself on which students are evaluated. The elements are indicators of the means by which the student may proceed to satisfactory performance of the learning outcome. The elements do not stand alone but rather in reference to the learning outcome of which they form a part.

## The Development of a Program Standard

In establishing the standards development initiative, the Government determined that all postsecondary programs of instruction should include vocational skills coupled with a broader set of essential skills. This combination is considered critical to ensuring that college graduates have the skills required to be successful both upon graduation from the college program and throughout their working and personal lives.

A program standard is developed through a broad consultation process involving a range of stakeholders with a direct interest in the program area, including employers, professional associations, universities, secondary schools, and program graduates working in the field, in addition to students, faculty, and administrators at the colleges themselves. It represents a consensus of participating stakeholders on the essential learning that all program graduates should have achieved.

## Updating the Program Standard

The Ministry of Training, Colleges and Universities will undertake regular reviews of the vocational learning outcomes for this program to ensure that Heating, Refrigeration and Air Conditioning Technician Program Standard remains appropriate and relevant to the needs of students and employers across the Province of Ontario. To confirm that this document is the most up-to-date release, contact the ministry.

[psu@ontario.ca](mailto:psu@ontario.ca)

## II. Vocational Standard

All graduates of Heating, Refrigeration and Air Conditioning Technician programs of instruction must have achieved the 7 vocational learning outcomes listed in the following pages, in addition to achieving the essential employability skills learning outcomes and meeting the general education requirement.

### Preamble

The Heating, Refrigeration and Air Conditioning Technician program provides students with theoretical knowledge and practical training to install, service, maintain and update heating, refrigeration and air conditioning systems. Upon successful completion of the program, the graduate will receive an Ontario College Diploma.

The vocational learning outcomes articulate a range of skills necessary for entry level positions in the heating, refrigeration, and air conditioning industry.

Graduates of the program may obtain employment as heating technicians or through affiliated trade apprenticeships in plumbing, pipefitting, electrical, sheet metal, or refrigeration. Apprenticeship is required after graduation, for those who wish to become tradespersons. Employment may also occur in sales, design, technical support, or as maintenance personnel in residential, commercial, institutional, and industrial settings.



## Synopsis of the Vocational Learning Outcomes Heating, Refrigeration and Air Conditioning Technician Programs

*The graduate has reliably demonstrated the ability to*

- 1. relate effectively to heating, refrigeration, and air conditioning supervisors, coworkers, and customers.**
- 2. work safely and in accordance with all applicable acts, regulations, legislation, and codes to ensure personal and public safety.**
- 3. select and use a variety of heating, refrigeration, and air conditioning tools and equipment safely and properly.**
- 4. solve math and applied science problems required to effectively install and maintain heating, refrigeration, and air conditioning systems, and associated components.**
- 5. prepare and interpret electrical, mechanical, and piping drawings.**
- 6. install, service, and troubleshoot heating, refrigeration, air conditioning systems, and associated components.**
- 7. develop strategies for ongoing personal and professional development, that will lead to enhanced work performance and career opportunities, and keep pace with industry changes.**

Note: The learning outcomes have been numbered as a point of reference; numbering does not imply prioritization, sequencing, nor weighting of significance.

## The Vocational Learning Outcomes

1. *The graduate has reliably demonstrated the ability to*

**relate effectively to heating, refrigeration, and air conditioning supervisors, coworkers, and customers.**

### **Elements of the Performance**

- communicate in written, graphic, and oral forms to provide an appropriate degree of detail and accuracy
- employ strategies for good customer relations that build on respect and integrity
- apply writing, speaking, and listening skills to develop and strengthen relationships within the field
- identify and prioritize tasks assigned by supervisors and report on activities completed
- summarize and communicate technical information for supervisors, coworkers, and customers
- adapt computer applications to facilitate communications through the retrieval and interpretation of electronic documents
- interpret numerical information for supervisors, coworkers, and customers
- comply with occupational expectations related to appearance and hygiene

2. *The graduate has reliably demonstrated the ability to*

**work safely and in accordance with all applicable acts, regulations, legislation, and codes to ensure personal and public safety.**

### **Elements of the Performance**

- comply with environmental, health, and safety legislation, and their related codes and regulations
- comply with installation codes and government regulations pertaining to heating and cooling equipment
- comply with regulatory and licensing requirements as well as company policies when completing installation, maintenance, and repair of heating, refrigeration, and air conditioning systems and associated components
- conduct safety inspections of the workplace to detect, report, and correct where possible, hazardous conditions
- complete written documentation for work orders and regulatory forms to ensure due diligence of required regulations and codes
- inspect equipment and systems, conduct tests, and compile and compare data in accordance with standard formats and procedures

3. *The graduate has reliably demonstrated the ability to*

**select and use a variety of heating, refrigeration, and air conditioning tools and equipment safely and properly.**

### **Elements of the Performance**

- differentiate among and use safely and properly specialized hand tools employed by technicians in the heating, refrigeration, and air conditioning field including and not limited to wrenches, crimpers, pliers, saws, nut drivers, pulley and gear pullers, punches, scratch awls, snips, hammers, screwdrivers, strippers, tape measures, and solder guns
- operate power and service tools safely and properly including and not limited to reciprocating saws, power-actuated fastener systems, vacuum pumps, gauge manifolds, refrigerant reclaim units, power drills, screw guns, material lifts, and man lifts
- operate and read test instruments including and not limited to air velocity meters, compound-gauge meters, pressure meters, temperature sensing meters, flow meters, and electrical meters
- utilize pipe and tubing tools safely and appropriately including and not limited to mechanical benders, flare and swage tools, pipe and tube cutters, reamers, manual and electrical pipe threaders, and pipe vises
- operate maintenance tools safely and correctly including and not limited to grease guns, manual oilers, aerosol sprays, automatic lubrication systems, and hand and electric oil pumps for adding or removing oil from compressors in refrigeration systems
- coordinate in a safe and proper manner, the use of fasteners, piping supports, clamping devices, and hand or power tools during the installation or repair of heating, refrigeration, and air conditioning systems
- use appropriate types of condensers, compressors, evaporators, and metering devices in order to install and maintain refrigeration and air conditioning units
- install or replace relays, pressure switches, flow switches, timers, solenoids, and igniters, as required, for the effective operation of heating, refrigeration, and air conditioning units, and associated components

4. *The graduate has reliably demonstrated the ability to*

**solve math and applied science problems required to effectively install and maintain heating, refrigeration, and air conditioning systems, and associated components.**

#### **Elements of the Performance**

- solve mathematics related problems involved in the installation and maintenance of heating, refrigeration, and air conditioning systems, and associated components by applying arithmetic, algebraic, and trigonometric operations
- solve associated physics problems related to the operation, installation, and maintenance of heating, refrigeration, and air conditioning systems, and associated components by applying knowledge about energy, power, work, and magnetism, including thermodynamic principles of heat transfer and state changes
- solve chemistry related problems associated with the safe installation and maintenance of heating systems and associated components by applying knowledge of the properties and structure of matter (solids, liquids, and gases) and the combustion process
- solve chemistry related problems associated with the safe installation and maintenance of refrigerants by applying knowledge of the properties and structure of matter (solids, liquids, and gases) and its effect on the environment
- employ the science of building design and properties of air to determine the appropriate heating and air conditioning requirements for residential, commercial, and industrial buildings regarding comfort, load estimations, and duct and piping design
- solve a variety of heating, refrigeration, and air conditioning operating problems by applying computer modeling software and technology to correct problems or produce satisfactory building design, cost effective systems, and acceptable indoor environments and air quality
- apply knowledge of basic electricity, control circuits, and mechanical or electrical controls to install, maintain, inspect, or commission heating, air conditioning, and refrigeration systems, and associated components

5. *The graduate has reliably demonstrated the ability to*

**prepare and interpret electrical, mechanical, and piping drawings.**

### **Elements of the Performance**

- apply principles of linear and angular measurement, architectural and engineering scales, and standard symbols and abbreviations in the preparation and interpretation of blueprints
- interpret architectural, mechanical, electrical, and control circuit drawings or details for estimating, coordinating, and installing the design requirements for heating, refrigeration, and air conditioning systems and associated components
- read, interpret, and produce drawings or sketches from the designer's layout for installing and maintaining heating, refrigeration, and air conditioning systems, and associated components
- clarify construction project specifications accurately from graphic and written data that may include sketches, drawings, tables, and plans
- identify specific symbols in plans, code books, and specification documents, and interpret project requirements to estimate and construct designs for residential heating, refrigeration, and air conditioning systems that are based upon architectural or engineering blueprints

6. *The graduate has reliably demonstrated the ability to*

**install, service, and troubleshoot heating, refrigeration, air conditioning systems, and associated components.**

### **Elements of the Performance**

- execute joining and connection operations that conform to industry code requirements and standards for piping and tubing, as required in the installation and maintenance of heating, refrigeration, and air conditioning systems, and associated components
- apply combustion safety and venting principles to the installation and maintenance of heating systems
- connect appliance electrical wiring circuits and use typical electrical test instruments and meters while installing, servicing, or troubleshooting heating, air conditioning, and refrigeration systems, and associated components
- layout and service residential and light\* commercial heating, air conditioning, and air handling systems
- size, balance, and service add on components such as coils, humidifiers, dehumidifiers, and electronic or standard media air filters for air conditioning and heat recovery systems
- select appropriate types of condensers, evaporators, compressors, and refrigerant flow controls, to install, service, and maintain the equipment and associated components for refrigeration and air conditioning systems
- inspect and test heating, refrigeration, and air conditioning systems, using diagnostic equipment in compliance with regulatory and local government codes, as well as manufacturers' recommendations
- determine electrical or mechanical faults while selecting and using a variety of troubleshooting techniques to resolve system operation problems
- test fuel burning equipment for combustion efficiency and hazardous or noxious by products created during incomplete combustion in heating systems
- analyze a building as a system, and apply the analysis to the design, installation, and maintenance of heating, refrigeration, and air conditioning systems, and associated components

\* Under 400,000 BTU per hour

7. *The graduate has reliably demonstrated the ability to*

**develop strategies for ongoing personal and professional development, that will lead to enhanced work performance and career opportunities, and keep pace with industry changes.**

#### **Elements of the Performance**

- apply problem solving skills for specific knowledge acquisition and skill development
- take responsibility for one's job related performance, both as an individual and as a member of a team
- identify training courses, workshops, and programs at private, public, and industrial institutions to enhance employment opportunities in the field of heating, refrigeration, and air conditioning
- engage in activities that include critical reflection and self evaluation to promote professional competence
- articulate learning strategies and plan learning activities to improve one's skill level and to expand one's skill base
- act in a responsible manner that incorporates due diligence
- use effective time management and organizational skills to accomplish personal and professional goals



## III. Essential Employability Skills

*All graduates of Heating, Refrigeration and Air Conditioning Technician programs of instruction must have reliably demonstrated the essential employability skills learning outcomes listed on the following pages, in addition to achieving the vocational learning outcomes and meeting the general education requirement.*

### Context

Essential Employability Skills (EES) are skills that, regardless of a student's program or discipline, are critical for success in the workplace, in day-to-day living, and for lifelong learning.

The teaching and attainment of these EES for students in, and graduates from, Ontario's colleges of applied arts and technology are anchored in a set of three fundamental assumptions:

- These skills are important for every adult to function successfully in society today.
- Our colleges are well equipped and well positioned to prepare graduates with these skills.
- These skills are equally valuable for all graduates, regardless of the level of their credential, whether they pursue a career path, or they pursue further education.

### Skill Categories

To capture these skills, the following six categories define the essential areas where graduates must demonstrate skills and knowledge.

- Communication
- Numeracy
- Critical Thinking & Problem Solving
- Information Management
- Interpersonal
- Personal

## Application / Implementation

In each of the six skill categories, there are a number of defining skills, or sub skills, identified to further articulate the requisite skills identified in the main skill categories. The following chart illustrates the relationship between the skill categories, the defining skills within the categories, and learning outcomes to be achieved by graduates from all postsecondary programs of instruction that lead to an Ontario College credential.

EES may be embedded in General Education or vocational courses, or developed through discrete courses. However these skills are developed, all graduates with Ontario College credentials must be able to reliably demonstrate the essential skills required in each of the six categories.

<b>SKILL CATEGORY</b>	<b>DEFINING SKILLS: Skill areas to be demonstrated by graduates:</b>	<b>LEARNING OUTCOMES: The levels of achievement required by graduates. The graduate has reliably demonstrated the ability to:</b>
COMMUNICATION	<ul style="list-style-type: none"> <li>• Reading</li> <li>• Writing</li> <li>• Speaking</li> <li>• Listening</li> <li>• Presenting</li> <li>• Visual literacy</li> </ul>	<ol style="list-style-type: none"> <li>1. <i>communicate clearly, concisely and correctly in the written, spoken, and visual form that fulfills the purpose and meets the needs of the audience.</i></li> <li>2. <i>respond to written, spoken, or visual messages in a manner that ensures effective communication.</i></li> </ol>
NUMERACY	<ul style="list-style-type: none"> <li>• Understanding and applying mathematical concepts and reasoning</li> <li>• Analyzing and using numerical data</li> <li>• Conceptualizing</li> </ul>	<ol style="list-style-type: none"> <li>3. <i>execute mathematical operations accurately.</i></li> </ol>
CRITICAL THINKING & PROBLEM SOLVING	<ul style="list-style-type: none"> <li>• Analysing</li> <li>• Synthesising</li> <li>• Evaluating</li> <li>• Decision making</li> <li>• Creative and innovative thinking</li> </ul>	<ol style="list-style-type: none"> <li>4. <i>apply a systematic approach to solve problems.</i></li> <li>5. <i>use a variety of thinking skills to anticipate and solve problems.</i></li> </ol>
INFORMATION MANAGEMENT	<ul style="list-style-type: none"> <li>• Gathering and managing information</li> <li>• Selecting and using appropriate tools and technology for a task or a project</li> <li>• Computer literacy</li> <li>• Internet skills</li> </ul>	<ol style="list-style-type: none"> <li>6. <i>locate, select, organize, and document information using appropriate technology and information systems.</i></li> <li>7. <i>analyze, evaluate, and apply relevant information from a variety of sources.</i></li> </ol>

<b>SKILL CATEGORY</b>	<b>DEFINING SKILLS: Skill areas to be demonstrated by graduates:</b>	<b>LEARNING OUTCOMES: The levels of achievement required by graduates. The graduate has reliably demonstrated the ability to:</b>
INTERPERSONAL	<ul style="list-style-type: none"> <li>• Team work</li> <li>• Relationship management</li> <li>• Conflict resolution</li> <li>• Leadership</li> <li>• Networking</li> </ul>	<p>8. <i>show respect for the diverse opinions, values, belief systems, and contributions of others.</i></p> <p>9. <i>interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals.</i></p>
PERSONAL	<ul style="list-style-type: none"> <li>• Managing self</li> <li>• Managing change and being flexible and adaptable</li> <li>• Engaging in reflective practices</li> <li>• Demonstrating personal responsibility</li> </ul>	<p>10. <i>manage the use of time and other resources to complete projects.</i></p> <p>11. <i>take responsibility for one's own actions, decisions, and consequences.</i></p>

## IV. General Education Requirement

*All graduates of Heating, Refrigeration and Air Conditioning Technician programs must have met the general education requirement described on the following pages, in addition to achieving the vocational and essential employability skills learning outcomes.*

### Requirement

The General Education Requirement for programs of instruction is stipulated in the Credentials Framework (Appendix A in the Minister=s Binding Policy Directive Framework for Programs of Instruction).

In programs of instruction leading to either an Ontario College Diploma or an Ontario College Advanced Diploma, it is required that graduates have been engaged in learning that exposes them to at least one discipline outside their main field of study, and increases their awareness of the society and culture in which they live and work. This will typically be accomplished by students taking 3 to 5 courses (or the equivalent) designed discretely and separately from vocational learning opportunities.

This general education learning would normally be delivered using a combination of required and elective processes.

### Purpose

The purpose of General Education in the Ontario college system is to contribute to the development of citizens who are conscious of the diversity, complexity, and richness of the human experience; who are able to establish meaning through this consciousness; and, who, as a result, are able to contribute thoughtfully, creatively, and positively to the society in which they live and work.

General Education strengthens student's essential employability skills, such as critical analysis, problem solving, and communication, in the context of an exploration of topics with broad-based personal and / or societal importance.

## Themes

The themes listed below will be used to provide direction to colleges in the development and identification of courses that are designed to fulfil the General Education Requirement for programs of instructions.

Each theme provides a statement of Rationale and offers suggestions related to more specific topic areas that could be explored within each area. These suggestions are neither prescriptive nor exhaustive. They are included to provide guidance regarding the nature and scope of content that would be judged as meeting the intent and overall goals of General Education.

### **1. Arts in Society:**

#### *Rationale:*

The capacity of a person to recognize and evaluate artistic and creative achievements is useful in many aspects of his/her life. Since artistic expression is a fundamentally human activity, which both reflects and anticipates developments in the larger culture, its study will enhance the student's cultural and self-awareness.

#### *Content:*

Courses in this area should provide students with an understanding of the importance of visual and creative arts in human affairs, of the artist's and writer's perceptions of the world and the means by which those perceptions are translated into the language of literature and artistic expression. They will also provide an appreciation of the aesthetic values used in examining works of art and possibly, a direct experience in expressing perceptions in an artistic medium.

### **2. Civic Life:**

#### *Rationale:*

In order for individuals to live responsibly and to reach their potential as individuals and as citizens of society, they need to understand the patterns of human relationships that underlie the orderly interactions of a society's various structural units. Informed people will have knowledge of the meaning of civic life in relation to diverse communities at the local, national, and global level, and an awareness of international issues and the effects of these on Canada, and Canada's place in the international community.

#### *Content:*

Courses in this area should provide students with an understanding of the meaning of freedoms, rights, and participation in community and public life, in addition to a working knowledge of the structure and function of various levels of government (municipal, provincial, national) in Canada and/or in an international context. They may also provide an historical understanding of major political issues affecting relations between the various levels of government in Canada and their constituents.

### **3. Social and Cultural Understanding:**

*Rationale:*

Knowledge of the patterns and precedents of the past provide the means for a person to gain an awareness of his or her place in contemporary culture and society. In addition to this awareness, students will acquire a sense of the main currents of their culture and that of other cultures over an extended period of time in order to link personal history to the broader study of culture.

*Content:*

Courses in this area are those that deal broadly with major social and cultural themes. These courses may also stress the nature and validity of historical evidence and the variety of historical interpretation of events. Courses will provide the students with a view and understanding of the impact of cultural, social, ethnic, or linguistic characteristics.

### **4. Personal Understanding:**

*Rationale:*

Educated people are equipped for life-long understanding and development of themselves as integrated physiological and psychological entities. They are aware of the ideal need to be fully functioning persons: mentally, physically, emotionally, socially, spiritually, and vocationally.

*Content:*

Courses in this area will focus on understanding the individual: his or her evolution; situation; relationship with others; place in the environment and universe; achievements and problems; and his or her meaning and purpose. They will also allow students the opportunity to study institutionalized human social behaviour in a systematic way. Courses fulfilling this requirement may be oriented to the study of the individual within a variety of contexts.

### **5. Science and Technology:**

*Rationale:*

Matter and energy are universal concepts in science, forming a basis for understanding the interactions that occur in living and non-living systems in our universe. Study in this area provides an understanding of the behaviour of matter that provides a foundation for further scientific study and the creation of broader understanding about natural phenomena.

Similarly, the various applications and developments in the area of technology have an increasing impact on all aspects of human endeavour and have numerous social, economic, and philosophical implications. For example, the operation of computers to process data at high speed has invoked an interaction between machines and the human mind that is unique in human history. This development and other technological developments have a powerful impact on how we deal with many of the complex questions in our society.

*Content:*

Courses in this area should stress scientific inquiry and deal with basic or fundamental questions of science rather than applied ones. They may be formulated from traditional basic courses in such areas of study as biology, chemistry, physics, astronomy, geology, or agriculture. As well, courses related to understanding the role and functions of computers (e.g., data management and information processing), and assorted computer-related technologies, should be offered in a non-applied manner to provide students with an opportunity to explore the impact of these concepts and practices on their lives.