

Massachusetts Department of Elementary & Secondary Education
Office for College, Career and Technical Education



Vocational Technical Education Framework



Construction Occupational Cluster

Plumbing (VPLUM)

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The Department of Elementary and Secondary Education wishes to thank all the groups that contributed to the development of these standards and all the teachers, administrators, and private sector advisory committee members who provided valuable employer validation of standards.

This updated Framework reflects current business and industry standards and includes the addition of the *Hours of Instruction*, *updates to Industry Recognized Credentials*, *Equipment*, and the *addition of Embedded Academic Performance Examples*.

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Hours of Instruction

Hours of Instruction have been provided for each framework standard to ensure that adequate instructional time is provided for students to attain complete and comprehensive knowledge of the subject matter.

Schedule of Hours		
2.A	Shop Safety & Regulations	150
2.B	Reading Technical Drawings and Blueprints	200
2.C	Plumbing Social Principles and Standards	100
2.D	Pipe Joining Techniques	500
2.E	Water Supplies & State Code	150
2.F	Venting & Drain Systems	150
2.G	Installation and Service Plumbing Components	150
2.H	Troubleshooting and Servicing Plumbing Systems	150
2.I	Installation of Fuel Gas	150
	Total:	1,700

Introduction

Overview & Organization of Strands

The Massachusetts Department of Elementary and Secondary Education understands the necessity of maintaining current Vocational Technical Education Frameworks which ensure that vocational technical students across the Commonwealth are taught the most rigorous and relevant standards aligned to the needs of business and industry.

This Revised Framework models the same format of all Massachusetts' Vocational Technical Education Frameworks and is organized into six strands. Standardized VTE Frameworks Strands 1, 4, 5, and 6 have been revised to ensure currency with industry standards.

Strand Two has been revised to include technical standards aligned to current business and industry standards, including new processes utilizing state-of-the-art equipment. The equipment necessary to deliver standards is also identified in this framework. To meet Chapter 74 vocational technical education standards, the equipment must meet industry standards.

Strand Three, Embedded Academic Knowledge and Skills, has been revised to clarify the direct connection of Core Academic Frameworks as they apply to Vocational Technical Education Frameworks.

Framework revision teams created Embedded Academic Performance Examples to provide specific learning scenarios which are typically utilized in VTE classrooms and labs to create real life learning experiences which provide students with knowledge attainment in Vocational Technical Education Frameworks and Academic Learning Standards. It is understood that most VTE learning experiences include Academic Knowledge attainment. The Performance Examples provided in this Framework are intended to provide awareness of these learning experience.

During Phase 3 of the 2021 Framework Revision Process, Strands One, Four, Five, and Six teams completed the revision of these strands. All Strand One, Four, Five and Six teams worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Massachusetts Career and Technical Student Organizations to crosswalk standards to national Career & Technical Student Organizations Curricula, as applicable. The Office for College, Career and Technical Education contracted the MAVA Consultant Team to work closely with the office to complete all the work accomplished during the 2021 Framework Revision Project. A remarkable amount of work was accomplished through the efforts of numerous professionals who collaborated and diligently supported this work. The Office for College, Career and Technical Education is grateful for all the support received from the field, particularly all the teachers (technical and academic), administrators, advisory committee members, business and industry representatives, the Division of Professional Licensure boards, the Massachusetts Association of Vocational Administrators, the MAVA Consultants, and the Massachusetts Vocational Association, whose contributions were tremendous.

The **Strand Two Team** maintained the structure the 2013 framework that includes topic headings, standards and objectives, and performance examples. The Strand Two Framework now includes Hours of Instruction, as well as identifying Basic, Essential, Advanced and Advanced (A+) skill standards that are coded B, E, A and A+.

The **Strand Three Team** provided embedded academics performance examples that were developed to reflect the Standards for Literacy in Content Areas, the Standards for Mathematical Practice, the High School Science & Engineering Practices, and the Digital Literacy & Computer Science Practices.

Skill Standard Levels

The 2021 Framework identifies vocational competencies in three skill levels: basic, essential and advanced. See below for more information.

B = Basic Standards: Fundamental Skills All Chapter 74 state-approved vocational programs are required to deliver basic standards.

E = Essential Standards: Knowledge and Skills required for industry licensure and credentials. All Chapter 74 state-approved vocational programs are required to deliver essential standards.

A = Advanced Standards: Higher-level knowledge and skills beyond essential entry level employment standards. All Chapter 74 state-approved vocational programs are required to deliver advanced standards.

A+ = Advanced Plus (A+): Denotes Advanced Standards - highest level of supplemental training

- **Advanced (A+) Skills Standards** are identified in Strand Two by a plus sign (A+). Although these standards are not required, they are provided as suggestions that districts may choose to use to increase the depth of a particular topic, or add additional topics, particularly for advanced students or for those seniors who do not participate in cooperative education. Advanced (A+) standards are identified with the use of a plus sign (A+).

It is not required that all students achieve “advanced (A+) level standards”, however, all Chapter 74 state-approved programs must have the capacity to deliver all three skill levels: Basic, Essential, and Advanced.

Definitions - Equipment

Simulator – a computer or application designed to provide a realistic operation of an industry standard or control, not to include educational trainers.

Educational Trainer - equipment which is designed strictly for educational purposes. Trainers cannot be a substitute or replacement for industry standard equipment.

Industry Standard Equipment – current and relevant equipment used in the industry relating to the standard functioning and implementation of operations in the respective fields of production, not to be confused with educational trainers.

Industry Standard - a set of criteria within an industry relating to the standard functioning and carrying out of operations in their respective fields of production. It is the generally accepted requirements followed by the members of an industry.

Software - current and relevant software used in the industry relating to the standard functioning and implementation of operations in the respective fields of production

Organization of Framework – Strand 2

The Vocational Technical Education Frameworks contain knowledge and skills covering all aspects of industry, reflected in six strands: Safety and Health, Technical, Embedded Academics, Employability, Management and Entrepreneurship, and Technological.

Standards and objectives are grouped under topic headings, which are displayed in bold. Each standard is followed by a performance example.

In the excerpt below, 2.G is the topic; 2.G.01 is the first standard and 2.G.01.01 through 2.G.01.11 are the objectives under that standard. Objective 2.G.01.10 and 2.G.01.11 indicate Advanced (A+) Skill Levels as defined on a previous page of this framework.

Strand 2 also includes Hours of Instruction, Equipment Needed, and Skill Levels.

2.G	Installation and Service Plumbing Components	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Plumbing Industry Standards)	
	High Quality Plumbing Hand Tools, Torch Assemblies / Proper Gases, Electric and Battery-operated Drills (sufficient for Wood, Metal, & Concrete), Electric and Battery-operated Saws (sufficient for Wood, Metal, Plastic, or Concrete), Power Threading Machines, Pipe Cutting Tools, Pipe Joining Tools, Ladders, Ventilation System (Maintain Air Quality), Potable Water Supply, Gas Utilization Source (i.e., Natural Gas or Propane), Compressed Air, Testing Equipment, Access to Applicable Codes	
2.G.01	Demonstrate techniques in selecting and installing plumbing fixtures.	SKILL LEVEL
2.G.01.01	Read and interpret manufacturer fixture roughing in sheets.	B, E, A
2.G.01.02	Identify the types and styles of plumbing fixtures.	B, E, A
2.G.01.03	Describe the procedures for the installation and maintenance of plumbing fixtures.	B, E, A
2.G.01.04	Describe the operation and assembly of flushometers, ballcocks, and water closet discharge systems.	B, E, A
2.G.01.05	Describe the types, assembly, and repair of shower valves.	B, E, A
2.G.01.06	List the reasons for installing anti-scald shower valves.	B, E, A
2.G.01.07	Install and repair faucets.	B, E, A
2.G.01.08	Install dishwashers.	B, E, A
2.G.01.09	Install food waste grinders.	B, E, A
2.G.01.10	Install laundry/ washing machine connections.	B, E, A, A+
2.G.01.11	Install, service, and maintain Hydronic Equipment	A+
	Performance Example:	
	The student will install a bathroom fixture group consisting of a water closet, lavatory, and tub & shower combination, laundry connection, and a kitchen group consisting of a kitchen sink, food waste grinders, and dishwasher.	

Strand 2: Technical Knowledge and Skills

2.A	Shop Safety & Regulations	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Plumbing Industry Standards)	
	High Quality Plumbing Hand Tools, Torch Assemblies / Proper Gases, Electric and Battery-operated Drills (sufficient for Wood, Metal, & Concrete), Electric and Battery-operated Saws (sufficient for Wood, Metal, Plastic, or Concrete), Power Threading Machines, Pipe Cutting Tools, Pipe Joining Tools, Ladders, Ventilation System (Maintain Air Quality), Potable Water Supply, Gas Utilization Source (i.e Natural Gas or Propane), Compressed Air	
2.A.01	Define and demonstrate safety techniques and methods with tools & shop procedures.	SKILL LEVEL
2.A.01.01	Describe and demonstrate safety procedures and techniques using hand and power tools.	B, E
2.A.01.02	Describe and demonstrate methods of safely using acetylene and other gases.	B, E
2.A.01.03	Describe and demonstrate methods of safely working with sewage and contaminated soil.	B, E, A
2.A.01.04	Describe and demonstrate basic safety procedures that apply to ladder safety.	B, E
2.A.01.05	Describe and apply regulations for working in confined space.	B, E, A
	Performance Example:	
	Student will participate in daily /weekly “Toolbox Safety Talks” and pass a written and performance test for all shop tools and equipment before using them	
2.B	Reading Technical Drawings and Blueprints	
	Hours of Instruction	200
	Equipment Needed – (Must Meet Plumbing Industry Standards)	
	Drafting Equipment, Price Estimating Equipment, Access to Applicable Codes, Computers with CAD Software	
2.B.01	Read and Interpret Prints	SKILL LEVEL
2.B.01.01	Describe the basic layout of a set of prints as well as the importance of the accompanying job specifications document.	B, E, A
2.B.01.02	Recognize and identify basic print terms, abbreviations, line types, symbols, and notes.	B, E, A
2.B.01.03	Interpret and follow drawing dimensions.	B, E, A
2.B.01.04	Convert measurements from a print using an architect’s scale.	B, E, A
2.B.01.05	Define and interpret floor plans, elevations, sections, details, ceiling plans, and finish schedules.	B, E, A
2.B.01.06	Explain and implement estimating methods in pricing jobs using drawings/prints and permit applications.	B, E, A

2.B.01.07	Describe, develop, and complete material quantity takeoff lists.	B, E, A
2.B.01.08	Explain how state and/or local code requirements apply to prints.	B, E, A
2.B.01.09	Utilize Computer Aided Drafting equipment to design plumbing, gas, and hydronic coordination drawings.	A+
<p>Performance Example: Students will perform shop/job site projects/work from appropriate sets of prints/drawings. Student will develop a material quantity takeoff for a given project/job. Students will develop a cost estimate for materials and from material quantity takeoff for a given project/job. Student will prepare an application for an appropriate plumbing/gas permit.</p>		
2.C	Plumbing Social Principles and Standards	
	Hours of Instruction	100
	Equipment Needed – (Must Meet Plumbing Industry Standards) Access to Applicable Codes Computers with Internet Access	
2.C.01	Describe the fundamentals of the plumbing industry.	SKILL LEVEL
2.C.01.01	Describe the historical development of the plumbing industry.	B
2.C.01.02	Discuss the effects of plumbing on modern society.	B
2.C.01.03	Identify career opportunities available in the plumbing industry.	B
2.C.01.04	Identify and describe the types of regulatory codes & licensure in the plumbing industry.	B, E, A
2.C.01.05	Identify and define jurisdictional boundaries of utilities, fire department, and local inspectors.	B, E, A
<p>Performance Example: The student will construct a table indicating a progression of career paths in the Plumbing and Piping Industry.</p>		
2.D	Pipe Joining Techniques	
	Hours of Instruction	500
	Equipment Needed – (Must Meet Plumbing Industry Standards) High Quality Plumbing Hand Tools, Torch Assemblies / Proper Gases, Electric and Battery-operated Drills (sufficient for Wood, Metal, & Concrete), Electric and Battery-operated Saws (sufficient for Wood, Metal, Plastic, or Concrete), Power Threading Machines, Pipe Cutting Tools, Pipe Joining Tools, Ladders, Ventilation System (Maintain Air Quality), Potable Water Supply, Gas Utilization Source (i.e., Natural Gas or Propane), Compressed Air	
2.D.01	Demonstrate techniques in measuring, cutting, reaming, supporting, and joining steel pipe and fittings.	SKILL LEVEL
2.D.01.01	Identify the common types and schedules of steel pipe and fittings.	B, E

2.D.01.02	Identify the names, classification and sizing of fittings used with steel pipe.	B, E
2.D.01.03	Measure, cut, ream, support and join steel pipe in all sizes using pipe dies.	B, E
2.D.01.04	Measure, cut, ream, support and join steel pipe using the rolled groove method.	B, E
2.D.01.05	Measure, cut, ream, support and join steel pipe using mechanical press technology.	B, E
Performance Example:		
The student will select the appropriate materials for a given project and write a material list, assemble the project to the specified dimensions, and pressure test the project.		
2.D.02	Demonstrate techniques in measuring, cutting, reaming, supporting, and joining copper tubing and fittings.	SKILL LEVEL
2.D.02.01	Identify the common types and schedules of copper tubing and fittings.	B, E
2.D.02.02	Identify the names, classification and sizing of fittings used with copper tubing.	B, E
2.D.02.03	Measure, cut, ream, support and join copper tubing for solder, braze, compression, roll groove, mechanical press technology, push-to-connect, and flare type fittings.	B, E
Performance Example:		
The student will select the appropriate materials for a given project and write a material list, assemble the project to the specified dimensions, and pressure test the project.		
2.D.03	Demonstrate techniques in measuring, cutting, and joining cast iron pipe and fittings.	SKILL LEVEL
2.D.03.01	Identify the common types and schedules of cast iron pipe and fittings.	B, E
2.D.03.02	Identify the names, classifications, and sizing of fittings used with cast iron pipe.	B, E
2.D.03.03	Properly measure, cut, support and join cast iron pipe for lead & oakum, no-hub, and resilient gasket type fittings. (*Pouring lead joints are optional. If pouring lead joints, OSHA safety standards must be in place.)	B, E
Performance Example:		
The student will select the correct material for the project and write a material list, assemble the project to correct dimensions and pressure test the project.		
2.D.04	Demonstrate techniques in measuring, cutting, reaming, and joining plastic pipe & fittings.	SKILL LEVEL
2.D.04.01	Identify the common types and schedules of plastic pipe and fittings.	B, E
2.D.04.02	Identify the names, classifications, and sizing of fittings used with plastic pipe and fittings.	B, E
2.D.04.03	Properly measure, cut, ream, support, and join plastic pipe, utilizing solvent weld, heat fusion, PEX joining methods, and compression type fittings.	B, E

	Performance Example: The student will select the appropriate materials for a given project and write a materials list, assemble the project to the specified dimensions and pressure test the project.	
2.D.05	Demonstrate techniques in measuring, cutting, and joining CSST (Corrugated Stainless-Steel Tubing) & fittings.	SKILL LEVEL
2.D.05.01	Identify the common types and of CSST and fittings.	B, E
2.D.05.02	Identify the names, classifications, and sizing of fittings used with tubing.	B, E
2.D.05.03	Measure, cut, support and join CSST tubing for a gas installation.	B, E
	Performance Example: The student will select the correct material for the project and write a material list, assemble the project to correct dimensions and pressure test the project.	
2.D.06	Demonstrate techniques in measuring, cutting, and joining flue systems.	SKILL LEVEL
2.D.06.01	Identify the common types of flue systems.	B, E, A
2.D.06.02	Identify the names and classifications of fittings used with flue systems.	B, E, A
2.D.06.03	Design and size a flue system referencing the NFPA 54 and NFPA 58.	B, E, A
2.D.06.04	Measure, cut, support, connect, and install flue systems.	B, E, A
	Performance Example: Student will explain flue system installation limitations.	
2.E	Water Supplies & State Code	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Plumbing Industry Standards) High Quality Plumbing Hand Tools, Torch Assemblies / Proper Gases, Electric and Battery-operated Drills (sufficient for Wood, Metal, & Concrete), Electric and Battery-operated Saws (sufficient for Wood, Metal, Plastic, or Concrete), Power Threading Machines, Pipe Cutting Tools, Pipe Joining Tools, Ladders, Ventilation System (Maintain Air Quality), Potable Water Supply, Gas Utilization Source (i.e. Natural Gas or Propane), Compressed Air, Testing Equipment, Access to Applicable Codes	
2.E.01	Identify, define, and demonstrate the features and the regulations relating to water supplies.	SKILL LEVEL
2.E.01.01	Identify the major components of a public and private water supply system and describe the function of each component.	B, E, A
2.E.01.02	Design and size a potable water system referencing the Massachusetts State Plumbing Code.	B, E, A
2.E.01.03	Install a water piping system according to the Massachusetts State Plumbing Code.	B, E, A
2.E.01.04	Test a water supply system according to the Massachusetts State Plumbing Code.	B, E, A
2.E.01.05	Identify methods of protecting the potable water system as described in the Massachusetts State Plumbing Code.	B, E, A
2.E.01.06	Identify means of producing hot water and the protection of these systems as described in the Massachusetts State Plumbing Code.	B, E, A

2.E.01.07	Identify and define pipe and fitting materials allowed on water supply systems as described in the Massachusetts State Plumbing Code.	B, E, A
	Performance Example: Student will identify the major components of a public and private water supply system and describe the function of each component.	
2.F	Venting & Drain Systems	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Plumbing Industry Standards) High Quality Plumbing Hand Tools, Torch Assemblies / Proper Gases, Electric and Battery-operated Drills (sufficient for Wood, Metal, & Concrete), Electric and Battery-operated Saws (sufficient for Wood, Metal, Plastic, or Concrete), Power Threading Machines, Pipe Cutting Tools, Pipe Joining Tools, Ladders, Ventilation System (Maintain Air Quality), Potable Water Supply, Gas Utilization Source (i.e. Natural Gas or Propane), Compressed Air, Testing Equipment, Access to Applicable Codes	
2.F.01	Install drainage, waste, and vent piping systems.	SKILL LEVEL
2.F.01.01	Describe how waste moves from a fixture through the drainage system to environment.	B, E, A
2.F.01.02	Identify the major components of a drainage system and describe their functions.	B, E, A
2.F.01.03	Identify types and parts of traps; describe the operation and function of traps; and how they lose their seals.	B, E, A
2.F.01.04	Identify proper drainage pattern fittings that are allowed to be used for a sanitary waste system.	B, E, A
2.F.01.05	Install a waste system according to the Massachusetts State Plumbing Code.	B, E, A
2.F.01.06	Design and size a sanitary waste system according to the Massachusetts State Plumbing Code.	B, E, A
2.F.01.07	Test a sanitary waste according to the Massachusetts State Plumbing Code.	B, E
2.F.01.08	Identify and describe the parts and sizing of an indirect waste pipe system.	B, E, A
2.F.01.09	Identify and define special waste systems as described in the Massachusetts State Code.	B, E, A
2.F.01.10	Identify and define pipe and fitting materials allowed on DWV systems as described in the Massachusetts State Plumbing Code.	B, E, A
	Performance Example: Identify the major components of a public and private drainage system and describe the function of each component.	
2.F.02	Define and demonstrate the fundamentals of venting a plumbing system.	SKILL LEVEL
2.F.02.01	Define and demonstrate the scientific principles of venting.	B, E, A
2.F.02.02	Identify the following types of venting: individual vent, common vent, stack vent, wet vent, bow vent, continuous waste and vent, battery (circuit and loop) and future vent.	B, E, A

2.F.02.03	Size a venting system according to the Massachusetts State Plumbing Code.	B, E, A
2.F.02.04	Identify pipe and fitting materials allowed on venting systems described by the Massachusetts State Plumbing Code.	B, E, A
Performance Example: The student will identify the major components of a designated vent system and describe its function. Size, install, and test the vent system in accordance with the Massachusetts State Plumbing Code.		
2.F.03	Demonstrate techniques in sizing and installing roof and area drains.	
2.F.03.01	Size a roof or area drain using the tables supplied from the Massachusetts State Plumbing Code.	B, E, A
2.F.03.02	Set the elevation of a floor or area drain using a surveyor's level, laser, or transit.	B, E, A
Performance Example: The student will size and install a roof drain according to Massachusetts State Plumbing Code using cast iron no hub pipe.		
2.G	Installation and Service Plumbing Components	
	Hours of Instruction	150
Equipment Needed – (Must Meet Plumbing Industry Standards) High Quality Plumbing Hand Tools, Torch Assemblies / Proper Gases, Electric and Battery-operated Drills (sufficient for Wood, Metal, & Concrete), Electric and Battery-operated Saws (sufficient for Wood, Metal, Plastic, or Concrete), Power Threading Machines, Pipe Cutting Tools, Pipe Joining Tools, Ladders, Ventilation System (Maintain Air Quality), Potable Water Supply, Gas Utilization Source (i.e., Natural Gas or Propane), Compressed Air, Testing Equipment, Access to Applicable Codes		
2.G.01	Demonstrate techniques in selecting and installing plumbing fixtures.	SKILL LEVEL
2.G.01.01	Read and interpret manufacturer fixture roughing in sheets.	B, E, A
2.G.01.02	Identify the types and styles of plumbing fixtures.	B, E, A
2.G.01.03	Describe the procedures for the installation and maintenance of plumbing fixtures.	B, E, A
2.G.01.04	Describe the operation and assembly of flushometers, ballcocks, and water closet discharge systems.	B, E, A
2.G.01.05	Describe the types, assembly, and repair of shower valves.	B, E, A
2.G.01.06	List the reasons for installing anti-scald shower valves.	B, E, A
2.G.01.07	Install and repair faucets.	B, E, A
2.G.01.08	Install dishwashers.	B, E, A
2.G.01.09	Install food waste grinders.	B, E, A
2.G.01.10	Install laundry/ washing machine connections.	B, E, A, A+
2.G.01.11	Install, service, and maintain Hydronic Equipment	A+
Performance Example: The student will install a bathroom fixture group consisting of a water closet, lavatory, and tub & shower combination, laundry connection, and a kitchen group consisting of a kitchen sink, food waste grinders, and dishwasher.		

2.H	Troubleshooting and Servicing Plumbing Systems	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Plumbing Industry Standards) Testing Equipment, Access to Applicable Codes, Access to Manuals, Computer or Tablet, Compressed Air	
2.H.01	Demonstrate techniques in servicing a plumbing system.	SKILL LEVEL
2.H.01.01	Diagnose water supply problems.	B, E, A
2.H.01.02	Identify water quality problems.	B, E, A
2.H.01.03	Identify and service various types of valves.	B, E, A
2.H.01.04	Identify and define different types of corrosion and their effects on piping services.	B, E, A
2.H.01.05	Troubleshoot and repair water supply problems.	B, E, A
2.H.0106	Troubleshoot and repair drainage problems.	B, E, A
	Performance Example: Given several different types of valves the student will dismantle each, identify the major parts and reassemble each to working condition.	
2.I	Installation of Fuel Gas	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Plumbing Industry Standards) High Quality Plumbing Hand Tools , Electric and Battery-operated Drills (sufficient for Wood, Metal, & Concrete), Electric and Battery-operated Saws (sufficient for Wood, Metal, Plastic, or Concrete), Power Threading Machines, Pipe Cutting Tools, Pipe Joining Tools, Ladders, Ventilation System (Maintain Air Quality), Potable Water Supply, Gas Utilization Source (i.e. Natural Gas or Propane), Compressed Air, Testing and Analyzing Equipment, Access to Applicable Codes, Access to Manuals, Manometer, Combustion Analyzer	
2.I.01	Demonstrate techniques in sizing and installing fuel gas systems.	SKILL LEVEL
2.I.01.01	Identify the components of fuel gas systems (natural and LP) and describe the function of each component.	B, E, A
2.I.01.02	Identify the physical properties of natural and LP gases.	B, E, A
2.I.01.03	Identify and describe potential hazards associated with each type of fuel and system and follow safety precautions.	B, E, A
2.I.01.04	Connect appliances to the fuel gas system.	B, E, A
2.I.01.05	Apply the Massachusetts State Fuel Gas Code in the installation and venting of fuel gas systems.	B, E, A
2.I.01.06	Design and size all piping in a fuel gas and venting system using the Massachusetts State Fuel Gas Code.	B, E, A
2.I.01.07	Diagnose and repair problems with the fuel gas system and its connected appliances.	B, E, A
2.I.01.08	Adjust and maintain fuel gas systems and its connected appliances.	B, E, A
	Performance Example: The student will identify the major component of a gas piping system and describe the function of each component.	

Strand 3: Embedded Academics

Embedded Academics Grades 9 –14 for Chapter 74 Vocational Technical Education Programs

Due to the thoughtful planning that went into the revisions of the English Language Arts & Literacy (2017), Mathematics (2017), Science and Technology Engineering (2016), and Digital Literacy Frameworks (2016), the current Vocational Technical Education Frameworks can move forward with a new level of embedded academics that are more content focused and more meaningful to students as they attain transferrable skills. Core content area experts carefully developed the literacy standards and academic practices in the aforementioned Massachusetts Frameworks documents which are highlighted. The Standards for Literacy in Content Areas, the Standards for Mathematical Practice, the High School Science & Engineering Practices, and the Digital Literacy & Computer Science Practices complement but do not take the place of the grade-level or course-level content standards in any of the discipline-specific Vocational Technical Education Frameworks.

Mathematics, science, technology, reading, writing, speaking, and listening skills and standards focus on understanding and practicing discipline-specific literacy, math, STE, and communication skills, using resources and characteristics of specific Vocational Technical Education programs. The philosophy of the embedded academics is not to have vocational teachers become traditional content teachers of English, science, and mathematics but is intended to reinforce the concept that it is the responsibility of all teachers to embed rich academic experiences in Vocational Technical Education. This will ensure that students recognize the transferrable skills that are essential for success in 21st century careers and in college. In rigorous Vocational Technical Education, students have hands-on and real-world experiences which develop relevant connections both from academic areas to Vocational Technical areas and vice versa.

The performance examples included in Strand Three are models developed using the portrait from the English Language Arts & Literacy (2017) of Students Who Are Ready for College, Careers, and Civic Participation. The examples illustrate how individual vocational teachers may use academic practices and literacy standards from the Massachusetts Frameworks listed above to seamlessly embed and explicitly teach relevant academics through Vocational Technical Education.

Vocational Technical Education of the past and of the 21st century naturally embed the elements of the portrait of Students Who are Ready for College, Careers, and Civic Participation through the hands-on and real-world experiences that students engage in throughout their tenure as Vocational Technical students. The following guidelines and practices that are collated in this document for easy reference are directly from the English Language Arts & Literacy (2017), Mathematics (2017), Science & Technology Engineering (2016), and Digital Literacy Frameworks (2016).

Plumbing Performance Task 1

Students acting in the role of a plumber will generate an estimate after assessing what will be needed to replace a tank type water closet. Plumbers will need to determine which tools to use, parts to order, and create a written estimate. In order to create the estimate, plumbers will read an illustrated manual for relevant technical terms, such as ballcock, flush valve, wax ring, water closet bolts, water closet flange, as well as documentation for building codes. The project consists of removing the previous water closet, assembling and installing new tank type water closet according to manufacturer's specifications, and test for performance. Upon completion of the project, plumbers will create a detailed invoice for the customer. Plumbers will also communicate to the customer in writing or orally what steps s/he should take to maintain a safe and operational water closet.

Embedded Math:

- [SMP.1] Make sense of problems and persevere in solving them.
- [SMP.5] Use appropriate tools strategically.
- [SMP.6] Attend to precision.

Embedded Science & Engineering:

- [SEP.1] Asking questions (for science) & defining problems (for engineering).
- [SEP.3] Planning and carrying out investigations.
- [SEP.4] Analyzing and interpreting data.
- [SEP.8] Obtaining, evaluating, and communicating information.

Embedded Reading in Science & Technical Subjects:

- [RCA-ST.11-12.4] Determine the meaning of general academic vocabulary as well as symbols, notation, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to plumbing texts and topics.
- [RCA-ST.11-12.8] Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- [RCA-ST.11-12.9] Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
- [RCA-ST.11-12.10] Independently and proficiently read and comprehend science/technical texts exhibiting complexity appropriate for the grade/course.

Embedded Writing in Content Areas:

- [WCA.11-12.2] Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
- [WCA.11-12.4] Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Embedded Digital Literacy:

- [DLCS.4] Analyzing
- [DLCS.7] Researching

Embedded Speaking & Listening in Content Areas:

[SLCA.11-12.4] Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, vocabulary, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

Vocational Technical Education Standards:

[PL-2.G.01.01] Read and interpret manufacturer fixture roughing in sheets.

[PL-2.G.01.02] Identify the types and styles of plumbing fixtures.

[PL-2.G.01.03] Describe the procedures for the installation and maintenance of plumbing fixtures.

[PL-2.G.01.04] Describe the operation and assembly of flushometers, ballcocks, and water closet discharge systems.

Plumbing Performance Task 2

Students in the role of plumbers will pressure test a drainage system using water in preparation for an inspection. The project consists of calculating the pressure at the base of the drainage system filled with water in an attempt to demonstrate that the drainage system is watertight. The plumbers will complete a written job summary for their employer, detailing the steps they took to successfully complete the inspection. In order to prepare for the inspection, plumbers will read and use the hydraulic data sheets and Massachusetts State Plumbing Code Section 10:04 in order to complete the drainage system test. Plumbers will incorporate relevant technical terms for this assessment including total pressure, psi, and gauge pressure.

Embedded Math:

- [SMP.1] Make sense of problems and persevere in solving them.
[SMP.4] Model with mathematics.

Embedded Science & Engineering:

- [SEP.1] Asking questions (for science) & defining problems (for engineering).
[SEP.3] Planning and carrying out investigations.
[SEP.5] Using mathematics and computational thinking.

Embedded Reading in Science & Technical Subjects:

- [RCA-ST.11-12.3] Follow precisely a complex multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
[RCA-ST.11-12.4] Determine the meaning of general academic vocabulary as well as symbols, notation, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to plumbing texts and topics.
[RCA-ST.11-12.9] Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Embedded Writing in Content Areas:

- [WCA.11-12.1] Write arguments focused on plumbing specific content.
[WCA.11-12.2] Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
[WCA.11-12.3] In technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations, analyses, or technical work that others can replicate them and (possibly) reach the same results. In addition, career/vocational courses may involve more specific forms of narrative composition for example: instructions for a tool's assembly or safe use in plumbing.

Embedded Digital Literacy:

- [DLCS.4] Analyzing
[DLCS.7] Researching

Embedded Speaking & Listening in Content Areas:

[SLCA.11-12.4] Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, vocabulary, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

Vocational Technical Education Standards:

- [PL-2.B.01.03] Interpret and follow drawing dimensions.
- [PL-2.B.01.04] Convert measurements from a print using an architect's scale.
- [PL-2.B.01.05] Define and interpret floor plans, elevations, sections, details, ceiling plans, and finish schedules.
- [PL-2.B.01.07] Describe, develop and complete material quantity takeoff list.
- [PL-2.B.01.08] Explain how state and/or local code requirements apply to prints.
- [PL-2.D.03.01] Identify the common types and schedules of cast iron pipe and fittings.
- [PL-2.D.03.02] Identify the names, classifications, and sizing of fittings used with cast iron pipe.
- [PL-2.D.03.03] Properly measure, cut, support and join cast iron pipe for lead & oakum, no-hub, and resilient gasket type fittings. (**Pouring lead joints are optional. If pouring lead joints, OSHA safety standards must be in place.)
- [PL-2.D.04.01] Identify the common types and schedules of plastic pipe and fittings.
- [PL-2.D.04.02] Identify the names, classifications, and sizing of fittings used with plastic pipe and fittings.
- [PL-2.D.04.03] Properly measure, cut, ream, support and join plastic pipe for solvent weld, heat fusion, PEX joining methods, and compression type fittings.
- [PL-2.F.01.07] Test a sanitary waste according to the Massachusetts State Plumbing Code.

Plumbing Performance Task 3

Students in the role of plumbing company owner will collaborate with journeyman and apprentice plumbers to design and submit an estimate based on installing a Drainage, Waste, & Vent (DWV) system in a single-family residence. The company owner will analyze and calculate the amount of materials needed to complete the DWV system and communicate the process and information to the team of journeymen and apprentice plumbers. The design must be drawn to scale including precise units of measure. Along with the estimate, the owner will provide a written timeline to the customer utilizing key terms such as: stack vent, wet vent, common vent, individual vent, future vent, and a bow vent. In order to prepare for the design, students will read and use job blueprints, fixture specifications, and the Massachusetts State Plumbing Code Book.

Embedded Math:

- [SMP.1] Make sense of problems and persevere in solving them.
- [SMP.2] Reason abstractly and quantitatively.
- [SMP.3] Construct viable arguments and critique the reasoning of others.
- [SMP.4] Model with mathematics.
- [SMP.6] Attend to precision.

Embedded Science & Engineering:

- [SEP.1] Asking questions (for science) & defining problems (for engineering).
- [SEP.2] Developing and using models.
- [SEP.3] Planning and carrying out investigations.

Embedded Reading in Science & Technical Subjects:

- [RCA-ST.11-12.3] Follow precisely a complex multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
- [RCA-ST.11-12.4] Determine the meaning of general academic vocabulary as well as symbols, notations, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.
- [RCA-ST.11-12.7] Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- [RCA-ST.11-12.10] Independently and proficiently read and comprehend science/technical texts exhibiting complexity appropriate for the grade/course.

Embedded Writing in Content Areas:

- [WCA.11-12.2] Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
- [WCA.11-12.10] Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences

Embedded Digital Literacy:

- [DLCS.2] Connecting
- [DLCS.3] Abstracting
- [DLCS.4] Analyzing

Embedded Academics Speaking & Listening in Content Areas:

- [SLCA.11-12.1] Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on discipline-specific topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- [SLCA.11-12.6] Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.

Vocational Technical Education Standards:

- [PL-2.B.01.05] Define and interpret floor plans, elevations, sections, details, ceiling plans, and finish schedules.
- [PL-2.B.01.06] Explain and implement estimating methods in pricing jobs using drawings/prints and permit applications.
- [PL-2.B.01.07] Describe, develop and complete material quantity takeoff list
- [PL-2.B.01.08] Explain how state and/or local code requirements apply to prints

Appendices

Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education or the Massachusetts Association of Vocational Administrators.

Appendix A

Industry Recognized Credentials (IRCs)

An **Industry Recognized Credential** is verification of an individual's qualification or competence. An authoritative third party issues the credential. **IRCs** are valued in the labor market and are a validation of an individual's knowledge and skill.

Industry-recognized credentials are accepted by multiple employers across an industry. They are often endorsed by recognized trade associations or organizations representing a significant part of an industry or sector.

IRCs are identified as either “**Essential**” or “**Optional**”.

Essential IRCs indicate credentials that are in high demand by employers.

School districts that offer VTE programs with “**Essential**” IRCs must ensure that adequate time and resources are available for students to be instructed in the standards necessary to be prepared for the certification examination, as well as, provide opportunities for students to obtain these certifications.

Optional IRCs provide credentials that enhance employment opportunities.

Plumbing IRCs (Industry Recognized Credentials)	Essential	Optional	Hours of Instruction needed to attain this Credential
Credit toward Massachusetts Plumbing License (Work) 248 CMR 11.00	X		Up to 1700 hours
Credit toward Massachusetts Plumbing License (Theory) 248 CMR 11.00 (Tiered Units require 110 hours of instruction per unit. Tiered credit cannot be attained without completing the Unit in its entirety.)	Minimum requirement Tiers 1 & 2	Optional Tier 3	Up to Tier 3
Hot Work Safety	X		1
OSHA Construction, Safety & Health - 10 Hr (OSHA C10)	X		10
OSHA Construction, Safety & Health - 30 Hr (OSHA C30)		X	30
American Red Cross CPR/AED Certification		X	4
American Red Cross First Aid (First Aid)		X	2
Lead-Safe Renovation, Repair and Painting		X	
OSHA Permit Required Confined Space *		X	16
Aerial Work Platform Training *		X	
Confined Space Awareness *		X	
Silica Dust Training *		X	
Powder Actuated Tools *		X	

Arc Flash Training (NFPA 70E) *		X	6
Asbestos Awareness Training *		X	8
Ladder Safety *		X	
Fall Protection *		X	
<p>Students who successfully complete a CHAPTER 74 Plumbing program approved by the Board of State Examiners of Plumbers and Gas Fitters may be granted a maximum of 1,700 hours of Work Experience credit and up to Tier 3 of Theory Experience from that program towards their journeyman license. Related theory classes must follow the scope and sequence outlined in the tiers which are designed and approved by the Board of State Examiners of Plumbers and Gasfitters, in order for students to receive credit toward licensure.</p>			

*** Resource Options for IRC Certification Training**

Aerial Work Platform Training	Aerial and Scissors Lifts On-line course	OSHA On-Line Education Center (valid for 3 years) https://www.oshaeducationcenter.com/
Confined Space Awareness	Confined Space Entry	https://www.osha.com/courses/confined-space-entry-training.html
Silica Dust Training	Silica Training	https://www.compliancetrainingonline.com/construction_silica.cfm
		https://www.silica-training.com/
Powder Actuated Tools	Powder Actuated Tools (Direct Fastening)	https://www.hilti.com/content/hilti/W1/US/en/services/contractor-services/certification-and-training.html
Arc Flash Training NFPA 70e	Arc Flash Training NFPA 70e	http://www.bostonsafetytraining.com/electrical-safety-training-system
Ladder Safety	Ladder Safety	https://go.bluevolt.com/Werner/s/coursedetail/101290/werner---ladder---core-training
Asbestos Awareness Training	Asbestos Awareness Training 2 hour OSHA	https://www.hazmatschool.com/osha-asbestos-awareness-training-1360/
Fall Protection	Fall Protection	https://go.bluevolt.com/Werner/s/coursedetail/101290/werner---ladder---core-training
Massachusetts State Training Provider List		https://www.mass.gov/files/documents/2017/12/06/safety-training-providers-list.pdf

DESE Statewide Articulation Agreement

ARTICULATION AGREEMENT

Between

Massachusetts Community Colleges

And

Massachusetts Chapter 74 State-Approved

for more information, click

<http://www.masscc.org/partnerships-initiatives/voc-schools-articulation-agreements>

Student Organizations

- SkillsUSA www.maskillsusa.org