

Massachusetts Department of Elementary & Secondary Education

Office for Career/Vocational Technical Education



Vocational Technical Education Framework



Manufacturing, Engineering & Technology Services Occupational Cluster

Stationary Engineering (VSENG)

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Massachusetts Department of Elementary and Secondary Education
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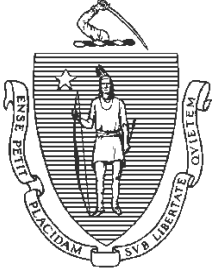
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Mitchell D. Chester, Ed.D.
Commissioner

July 2014

Dear Colleagues,

I am pleased to present to you the *Massachusetts Vocational Technical Education Frameworks*, adopted by the Department of Elementary and Secondary Education in June 2014. These frameworks, one for each of the 44 vocational technical programs, include standards in multiple strands representing all aspects of the industries that students in the vocational technical education program are preparing to enter.

The frameworks also include a crosswalk between the technical standards and relevant standards in Massachusetts Curriculum Frameworks to support effective integration of academic and technical content.

The comments and suggestions received during revision of the 2007 *Massachusetts Vocational Technical Education Frameworks* have strengthened these frameworks. We will continue to work with schools and districts to implement the 2014 *Massachusetts Vocational Technical Education Frameworks* over the next several years, and we encourage your comments.

I want to thank everyone who worked with us to create challenging learning standards for Massachusetts students. I am proud of the work that has been accomplished.

Sincerely,

Mitchell D. Chester, Ed.D.
Commissioner of Elementary and Secondary Education

Introduction

Overview & Organization and Key Changes

Overview

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

With the advent of the Massachusetts Teaching & Learning System the Office for Career/Vocational Technical Education (CVTE) recognized the significance of including career/vocational technical education in the system and developed a comprehensive plan for including vocational technical education. The plan was designed in a Two Phase Process. Phase One included the revision of strands two, three, and six, of all of the Vocational Technical Education Frameworks. Phase Two consisted of three major components (projects) all equally crucial;

1. The revision of Strands One, Four, and Five to complete the revision of all six strands of the Vocational Technical Education Frameworks;
2. Statewide Professional Development on all revised strands, with training on strands two, three, and six delivered fall 2013, and training on strands one, four, and five delivered spring 2014;
3. The creation and development of additional Model Curriculum Unit (MCU) Teams.

The Office for Career/Vocational Technical Education Framework Team, with support from consultants, began Phase One in the 2012-2013 school year, to revise three of the six strands contained in all of the Vocational Technical Education (VTE) Frameworks. The state was organized into “Collaborative Partnerships” comprised of teams of project administrators, highly qualified subject matter educators, and business and industry partners, whose task was to revise Strand Two – Technical, Strand Three – Embedded Academics, and Strand Six – Technology Literacy. Each team met with a vocational advisory committee which included business and industry representatives and postsecondary education professionals, whose mission was to review and revise the team’s draft document during the revisionary process. Once strand two was revised, academic teachers (typically one English Language Arts teacher, one Mathematics teacher, and one Science teacher) worked with the technical subject matter teachers to develop a crosswalk between academic curricula standards and the technical standards, and provided examples of embedded academic content.

The Office for Career/Vocational Technical Education solicited statewide input from technical and academic teachers and administrators at the annual Massachusetts Association of Vocational Administrators (MAVA)/Massachusetts Vocational Association (MVA) - Connecting for Success Conference. Each framework team met with their content colleagues and reviewed the draft revisions and obtained

valuable feedback. Additionally, all drafts were reviewed and revised by the Massachusetts Vocational Technical Teacher Testing Program, to ensure appropriate measurable language.

Project consultants designed a new template to ensure all framework teams entered new standards and additional resources in a consistent manner. The framework teams created an “Appendix” listing potential industry recognized credentials attainable by secondary students; lists of professional, student, and relevant government organizations; and useful resources and websites. ** It is important to note that although most Framework Teams provided information for the “Appendix”, not all teams did. Therefore, sub-headings within the “Appendix” without information have been deleted. 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.*

The Office for Career/Vocational Technical Education facilitated a comprehensive vetting process throughout the Commonwealth. During the fall of 2012 districts throughout Massachusetts solicited feedback from each Vocational Program’s Advisory Committee members at the Fall Board meetings. Additionally, the Office for Career/Vocational Technical Education met with various licensing boards at the Massachusetts Division of Professional Licensure and provided the applicable draft framework to each board for review. All framework drafts were posted on the CVTE website for public comment. Comments and suggested revisions received were shared with each framework team for response and edits, as appropriate.

The Phase I Process was completed on an accelerated timetable and resulted in all Vocational Technical Education Frameworks; Strand Two and Strand Six, revised with current, rigorous, relevant standards. Strand Three has been redesigned into a crosswalk which directly correlates academic and technical standards. An appendix of useful material for technical teachers recommended by their peers was added to each framework.

Phase II of the Framework Revision Process consisted of three major projects;

1. The Strands One, Four & Five Project, to complete the revision of all six strands of the Vocational Technical Education Frameworks;
2. Statewide Professional Development on all revised strands, with training on strands two, three, and six delivered fall 2013, and training on strands one, four, and five delivered spring 2014;
3. The creation and development of additional Model Curriculum Unit (MCU) Teams.

The Strands One, Four, & Five Project began in the fall of 2013 with the formation of a leadership team and three work groups. Co-Managers led the leadership team comprised of three Strand Coordinators who facilitated work teams and reviewed, researched, and revised these common strands. All skills specific to the vocational technical program have been included into Strand Two Technical.

The Strand One Team revised the safety knowledge and skills that all students need to acquire. The team included relevant issues (i.e., bullying, climate), laws, regulations, guidelines and policies pertaining to safety.

The Strand Four Team revised the Employability Knowledge and Skills that all students need to acquire. Teams considered current research on career readiness, including the work of the College Career Readiness Task Force convened by the Department, changes in workplace, technological changes that impact how people perform their work (i.e., communications methods), and included standards that emphasize the need for lifelong learning and adaptability given the multiple career changes over and an individual's working life. The team recommended this strand be renamed to: Career Readiness.

The Strand Five Team revised the Management & Entrepreneurship Knowledge and Skills that all students need to acquire. All business owners and employees must possess management and financial skills to be productive members of society. Skills included financial knowledge and basic business management skills.

All Strand One, Four and Five Project 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 Career/Vocational Technical Education contracted the MAVA Consultant Team to work closely with the office to complete all of the work accomplished during Phase II of the Project.

A remarkable amount of work was accomplished through the efforts of hundreds of professionals who collaborated and diligently supported this work. The Office for Career/Vocational Technical Education is grateful for all the support received from the field, particularly all of 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.

Special thanks to all staff in the Office for Career/Vocational Technical Education and the CVTE Framework Revision Team who provided guidance and numerous contributions during Phase One of the project.

Organization and Key Changes

This section contains the following:

- Highlights of Changes to the Vocational Technical Education Frameworks; which includes a summary of changes made to each strand.
- Organization of the Frameworks – Strand Two illustrates structure of topic headings, standards and objectives, and performance examples.

Highlights of Changes to the Vocational Technical Education Frameworks:

Strand One:

Safety and Health Knowledge and Skills have been revised to contain the safety standards that are common to all programs. The Strand One Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Career and Technical Student Organizations (CTSO) to crosswalk standards to national CTSO Curricula, as applicable.

- No objectives were deleted, only modified.
- Language and wording was clarified.
- Additions included a focus on maintaining a safe school and workplace in terms of creating a positive climate/environment.
- Student safety credential program has been revised.
- Safety attire has been revised.
- Emergency equipment and fire safety has been revised.
- Many new Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: “Organization of the Frameworks – Strand Two”. All strands were organized in that manner, with the exception of the former Strand Three.

Strand Two:

The Technical Standards Knowledge and Skills have been revised to reflect business and industry changes since the adoption of the 2007 Vocational Technical Education Frameworks (VTEF). There are additional changes to Strand Two below:

- The Technical Knowledge and Skills (Strand Two) section contains standards specific to the particular vocational program; suffix “a” (as common to all programs) and suffix “c” (as common within a cluster) have been removed.
- Each VTEF Strand Two begins with safety and health knowledge and skills specific to the particular vocational program.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: “Organization of the Frameworks – Strand Two”. All strands were organized in that manner, with the exception of the former Strand Three.

- Strand Two of the Frameworks for Animal Science, Environmental Science and Technology, and Horticulture, begin with core standards required for all participants in the programs, followed by a series of standards organized in concentrations. See the section below titled: “Organization of the Frameworks – Strand Two” for more information.
- An update to some of the vocational programs framework is the addition of advanced or supplemental standards which are noted in Strand Two by an asterisk (*). *These standards are not required, but 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.* See the section below titled: “Organization of the Frameworks – Strand Two” for more information.

Strand Three:

Since the purpose of Strand Three was to correlate academic content that was *embedded* in the knowledge and skills necessary to perform certain technical skills, it was logical to highlight those connections through a crosswalk between the academic curriculum standards and the technical standards (Strand Two). The crosswalk directly correlates the English Language Arts (2011) and Mathematics (2011) Frameworks, incorporating the Common Core Standards and the Science and Technology/Engineering Frameworks. The crosswalk can be found in the appendix of each vocational framework. The crosswalk also includes performance examples which illustrate integrated academic and technical content.

- Embedded Academics has been replaced with a crosswalk between the academic curriculum standards and the technical knowledge and skills standards. The crosswalk is located in the Appendices.

Strand Four:

Employability (and Career Readiness) Knowledge and Skills focused on providing students with general knowledge and skills to be college and career ready. The Strand Four Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Career and Technical Student Organizations to crosswalk standards to national CTSO Curricula, as applicable.

- Language and wording were clarified.
- Additions included a focus on providing students with skills for employability/career readiness.
- Modifications included Career Exploration & Navigation, Communication in the Workplace, and Work Ethic & Professionalism.
- New Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: “Organization of the Frameworks – Strand Two”. All strands were organized in that manner, with the exception of the former Strand Three.

Strand Five:

Strand Five contains Management and Entrepreneurship Knowledge and Skills that are general for all students. The Strand Five Team 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.

- Language and wording were clarified and organized into a logical format.
- The Strand Five Team felt that the 2007 curriculum remained valid.
- Additions included a focus on providing students with skills for management and entrepreneurship applicable to all vocational programs.
- Modifications included Starting and Managing a Business, Marketing, and Financial Concepts & Applications in Business, and Legal/Ethical/Social Responsibilities.
- New Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

Strand Six

Strand Six Technology Literacy Knowledge and Skills has been replaced with the 2008 Massachusetts Technology Literacy Standards and Expectations Framework.

Appendix¹

Each framework contains an “Appendix” section which includes an Embedded Academic Crosswalk, Industry Recognized Credentials, Statewide Articulation Agreements, Professional, Governmental, and Student Organizations, Resources, and relevant websites.

The Appendix² contains:

- Embedded Academic crosswalks for English Language Arts, Mathematics, and Science & Technology/Engineering.
- Statewide Articulations: Current statewide Articulation Agreements and/or Apprenticeship Programs available to the specific vocational program are listed on this page. The development of new statewide articulations continues, and therefore these pages will be revised as new agreements are finalized.
- Industry-Recognized Credentials: Technical Teacher Teams generated lists of credentials for the vocational programs. Program Advisory Committees throughout the state reviewed and provided recommendations through the validation process. *The credential list has been provided as a resource only and districts are not obligated to provide all of the specified credentials for students.*
- Other: These pages provide lists of reference materials, government agencies, professional and student organizations, and useful websites created by each framework team. These are intended as helpful resources for technical teachers, identified by peers. These are not recommended or required by the Department of Elementary & Secondary Education.

¹ *Note: Although most Framework Teams provided information for the “Appendix”, not all teams did. Therefore, sub-headings within the “Appendix” without information have been deleted.*

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Organization of the Frameworks – Strand Two

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.

Within each strand, standards and objectives were grouped under topic headings, which are displayed in bold. Each standard is followed by a performance example. In the excerpt below, 2.A is the topic; 2.A.01 is the first standard and 2.A.01.01 and 2.A.01.02 are the objectives under that standard.

2.A Automotive Technology Specific Safety Practices

- 2.A.01 Identify and describe safety procedures when dealing with different types of automotive lifts according to current industry standards.
- 2.A.01.01 Demonstrate procedures for safe lift operations.
 - 2.A.01.02 Demonstrate safe use, placement and storage of floor jacks and jack stands.

2.A.01 Performance Example:

- Student will set up lift using manufacturer’s suggested lift points.

- 2.A.02 Demonstrate and describe safety procedures when dealing with high pressure systems including necessary ventilation according to current industry standards.

- 2.A.02.01 Describe and demonstrate the importance of safety procedures to be used when servicing high pressurized systems (fuel systems, brakes, air conditioning, suspension, hydraulic systems, etc.).
- 2.A.02.02 Describe and demonstrate safe use of oxygen/acetylene torches and electric welding equipment.
- 2.A.02.03 Demonstrate ventilation procedures to be followed when working in the lab/shop area.

2.A.02 Performance Example:

- Student will relieve fuel system pressure to perform necessary repairs.

- 2.A.03 Identify and describe safety procedures when dealing with electrical circuits according to current industry standards.

- 2.A.03.01 Describe safety procedures to be followed when servicing supplemental restraint systems.
- 2.A.03.02 Demonstrate safety awareness of high voltage circuits of electric or hybrid electric vehicles and related safety precautions.

2.A.03 Performance Example:

- Safely disable Supplemental Restraint System (SRS) air bag for repair using manufacturer’s recommendations.

There are additional changes to some of the Frameworks Strand Two (Technical Knowledge and Skills). Specifically, Strand Two of the Frameworks for Animal Science, Environmental Science and Technology and Horticulture begin with core standards required for all participants in the programs, followed by a series of standards organized in concentrations. For example, Strand Two of the Horticulture Framework begins with the core standards required of all Horticulture students

(Topics 2.A through 2.I). These standards are followed by the three concentrations: Arboriculture (Topics 2.J through 2.L), Greenhouse Management and Floriculture (Topics 2.J. through 2.L) and Landscape and Turf Management (Topics 2.M through 2.Q).

Advanced / Supplemental Standards (Not Required)

Another variation that is new to the revised Strand Two Frameworks is the addition of advanced or supplemental standards which are noted with the use of an asterisk (*). *These standards are not required, but 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.*

The following is an example from Automotive Technology, where entire topics were added:

Advanced Automotive Technology Technical Knowledge and Skills

Note: The following competencies are optional, supplementary competencies suitable for advanced students. These are not required.

2.CC Demonstrate appropriate engine repair techniques.

2.CC.01 Perform appropriate cylinder Head Repair.

2.CC.01.01* Diagnose, remove and replace cylinder head(s).

2.CC.01.02* Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition; determine necessary action.

The following is an example from the Strand Two Radio and Television Broadcasting Framework that shows the addition of an advanced objective, 2.B.04.08*:

2.B.04 Explain concepts fundamental to shooting in cinema and video.

- 2.B.04.01 Compare and contrast a single-camera and a multiple-camera production.
- 2.B.04.02 Explain the importance of shooting for the edit (i.e., match on action, sequencing, coverage).
- 2.B.04.03 Explain the importance of continuity.
- 2.B.04.04 Explain the 180° Rule line, and its application in various cinema scenarios.
- 2.B.04.05 Identify and establish a specific point-of-view when shooting from a script.
- 2.B.04.06 Analyze the methods in which specific shots can evoke emotion from an audience.
- 2.B.04.07 Define drop frame and non-drop frame code shooting and explain how to account for both when preparing for an edit.
- 2.B.04.08* Describe various cinematographic methods necessary when shooting scenes that incorporate post-production visual effect

2.B.04 Performance Examples:

- Students will list similarities and differences of single-camera and multiple-camera shoots.
- Students will describe multiple shooting considerations that are useful in streamlining the editing process.

Manufacturing, Engineering & Technology Services Occupational Cluster

Stationary Engineering Framework (VSENG)

Strand 1: Safety and Health Knowledge and Skills

1.A Fundamentals of Health and Safety

- 1.A.01 Describe and apply health and safety regulations.
- 1.A.01.01 Identify, describe and apply health and safety regulations that apply to specific tasks and jobs. Students must complete a safety credential program, e.g., Occupational Safety and Health Administration 10, CareerSafe and ServSafe.
 - 1.A.01.02 Identify, describe and apply Environmental Protection Agency (EPA) and other environmental protection regulations that apply to specific tasks and jobs in the specific occupational area.
 - 1.A.01.03 Identify, describe and apply Right-To-Know (Hazard Communication Policy) and other communicative regulations that apply to specific tasks and jobs in the specific occupational area.
 - 1.A.01.04 Explain procedures for documenting and reporting hazards to appropriate authorities.
 - 1.A.01.05 Identify and describe potential consequences for non-compliance with appropriate health and safety regulations.
 - 1.A.01.06 Identify and list contact information for appropriate health and safety agencies and resources.

1. A.01 Performance Examples:

- List and define OSHA Health and Safety Regulations, EPA and other environmental protection regulations to occupational area.
- List and define Right-to-Know regulations and reporting of hazards and contact information for appropriate health and safety agencies.
- List the laws and rules of regulatory agencies governing sanitation and safety.
- Utilize OSHA as well as health and safety websites for purposes of research.

- 1.A.02 Demonstrate appropriate health and safety practices based on the specific occupational area.
- 1.A.02.01 Identify, describe and demonstrate the effective use of Safety Data Sheets (SDS).
 - 1.A.02.02 Read and interpret chemical, product and equipment labels to determine appropriate health and safety considerations.
 - 1.A.02.03 Identify, describe and demonstrate personal, shop and job site safety practices and procedures.
 - 1.A.02.04 Demonstrate safe dress and use of relevant safety gear, personal protective equipment (PPE) and ergonomics, e.g., wrist rests, adjustable workspaces, equipment, gloves, proper footwear, earplugs, eye protection and breathing apparatus.

- 1.A.02.05 Demonstrate appropriate safe body mechanics, including appropriate lifting techniques and ergonomics.
- 1.A.02.06 Locate emergency equipment, first aid kit, SDS information directories and emergency action/response plan/escape routes in your lab, shop and classroom, including labels and signage that follow OSHA Hazard Communication Program (HAZCOM), eyewash stations, shower facilities, sinks, fire extinguishers, fire blankets, telephone, master power switches and emergency exits.
- 1.A.02.07 Demonstrate the safe use, storage, and maintenance of every piece of equipment in the lab, shop and classroom, e.g., the OSHA Lockout/Tagout Program (LOTO).
- 1.A.02.08 Describe safety practices and procedures to be followed when working with and around electricity, e.g., ground fault circuit interrupter (GFCI) and frayed wiring.
- 1.A.02.09 Handle, store, dispose of and recycle hazardous, flammable and combustible materials, according to EPA, OSHA and product specifications.
- 1.A.02.10 Demonstrate appropriate workspace cleaning, sanitation, disinfection and sterilization procedures required in specific occupational areas, e.g., Workplace Housekeeping OSHA Regulations.

1. A.02 Performance Examples:

- Identify, describe and demonstrate the use of SDS.
- List and demonstrate shop dress code, safety procedures and location of emergency equipment in labor classroom.
- Define and demonstrate safe storage and maintenance of equipment and proper disposal or recycling of hazardous, flammable and combustible materials.
- Identify, describe and demonstrate the Universal Precautions set of guidelines.

- 1.A.03 Demonstrate appropriate responses to situations that may threaten health and safety.
 - 1.A.03.01 Describe First Aid procedures for potential injuries and other health concerns in the specific occupational area.
 - 1.A.03.02 Describe the importance of emergency preparedness and an emergency action/response plan.
 - 1.A.03.03 Describe procedures used to handle emergency situations, defensive measures and accidents, including identification, reporting, response, evacuation plans and follow-up procedures.
 - 1.A.03.04 Identify, describe and demonstrate safety practices in specific occupational areas used to avoid accidents.
 - 1.A.03.05 Identify and describe fire protection, protection, precautions and response procedures.
 - 1.A.03.06 Discuss the role of the individual and the company/organization in ensuring workplace safety including transportation to and from school, school activities and the workplace.
 - 1.A.03.07 Discuss ways to identify, prevent and report school and workplace violence, discrimination, harassment and bullying.
 - 1.A.03.08 Demonstrate positive and appropriate behavior that contributes to a safe and healthy environment in school and the workplace.

1. A.03 Performance Example:

- Define first aid procedures and protocols used to handle emergency situations and practices used to avoid accidents.
- View safety videos and discuss the role of workplace safety.
- Attend or participate in a human rights alliance organization presentation.
- Observe and/or demonstrate the appropriate use of a fire extinguisher using the (PASS) technique: Pull, Aim, Squeeze, Sweep.
- Review and discuss specific policies, procedures and protocols regarding discrimination, harassment and bullying.
- Discuss and/or role-play proper and respectful behavior that contributes to a positive climate.
- Discuss and/or demonstrate behavior that contributes to a collaborative/teamwork environment.

Selected Websites

- Bullying Prevention and Intervention Resources : www.doe.mass.edu/bullying
- Centers for Disease Control and Prevention: www.cdc.gov
- Environmental Protection Agency : www.epa.gov
- “Lost Youth – Four Stories of Injured Young Workers” – WorkSafeBC:
<http://www2.worksafebc.com/Publications/Multimedia/Videos.asp?reportid=34291>
- Massachusetts Department of Elementary and Secondary Education. (2011). Career/Vocational Technical Education Safety Guide: www.doe.mass.edu/cte
- Massachusetts Department of Elementary and Secondary Education: www.doe.mass.edu
- Massachusetts Emergency Management Agency: www.mass.gov/eopss/agencies/mema
- Massachusetts General Law: www.malegislature.gov
- Massachusetts Health and Human Services: www.mass.gov/dph
- Massachusetts Right to Know Law Summary:
<http://www.mass.gov/lwd/docs/dos/mwshp/hib397.pdf>
- Safety Data Sheet: www.sdsonline.com
- National Fire Protection Association: www.nfpa.org
- Protection of Student Rights: Massachusetts General Law:
<https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXII/Chapter76/Section5>
- Occupational Safety and Health Administration: www.osha.gov
- Readiness and Emergency Management for Schools: www.rems.ed.gov
- Safe and Healthy Learning Environments: www.doe.mass.edu/ssce/safety.html

Strand 2: Technical Knowledge and Skills

2.A Stationary Engineering Safety and Health Knowledge and Skills

- 2.A.01 Demonstrate essential safety knowledge and skills for stationary engineering.
- 2.A.01.01 Successfully complete and obtain a 10 hour OSHA certificate in general industries.
 - 2.A.01.02 Determine the fundamentals behind the implementation of a lock and tag out system, secure an energy source, and install a lock and tag out.
 - 2.A.01.03 Explain the dangers of confined space entry, air testing, and monitoring emergency retrieval.
 - 2.A.01.04 State SDS purpose and location in plant.
 - 2.A.01.05 Explain the importance of personal protective equipment and fall protection.
 - 2.A.01.06 Demonstrate safe use of all hand and power tools used in stationary engineering, in accordance with current OSHA standards.

2.A.01 Performance Examples:

- Identify, isolate, and then lock and tag out a boiler power supply. Write work permit and store key in lock box when preparing a boiler for inspection.
- List situations where P.P.E. must be used to safeguard against injury.
- Don a five point body harness, secure to safety tie off, and safely access unguarded elevated area.

2.B Fundamentals of Stationary Engineering

- 2.B.01 Explain concepts fundamental to differentiating between boiler classifications.
- 2.B.01.01 Differentiate between high and low pressure boilers.
 - 2.B.01.02 Describe how a water tube boiler is different from a fire tube boiler.
 - 2.B.01.03 Compare conditions that call for a water tube boiler over a fire tube boiler and vice versa.
 - 2.B.01.04 Contrast the difference between a field-erected and packaged boiler.

2.B.01 Performance Example:

- Enter into both water and fire tube boilers and identify components that are common and uncommon to both.

- 2.B.02 Explain concepts fundamental to safety and relief valves.
- 2.B.02.01 Explain the purpose of a safety valve.
 - 2.B.02.02 Describe American Society of Mechanical Engineers (A.S.M.E.) code requirements for safety valves on boilers.
 - 2.B.02.03 Differentiate between safety and relief valves.
 - 2.B.02.04 Explain when to hand test a safety valve under boiler pressure and describe the procedures used for the test.
 - 2.B.02.05 Explain the purpose of blowback and how to calculate the percentage of safety valve blowback.
 - 2.B.02.06 Disassemble, label and reassemble a spring loaded pop safety valve.

2.B.02 Performance Examples:

- Disassemble, label, and reassemble a spring loaded pop safety valve cut away.
- Bring boiler up to seventy five percent of safety valve popping pressure and perform tri lever test

- 2.B.03 Explain concepts fundamental to soot blowers.
- 2.B.03.01 Explain the purpose of a soot blower.

- 2.B.03.02 Describe the dangers inherent to the operation of a soot blower.
- 2.B.03.03 Give the sequence of blowing tubes on a boiler with auxiliary equipment (e.g., economizers).

2.B.03 Performance Example:

- Perform a soot blowing sequence on a boiler while under operation.

- 2.B.04 Explain concepts fundamental to draft fans and dampers.
 - 2.B.04.01 Examine and describe the difference between mechanical and natural draft.
 - 2.B.04.02 Define forced, induced, and combination draft as they pertain to boiler systems.
 - 2.B.04.03 Report how dampers are used to control the flow of air entering and leaving boiler systems.

2.B.04 Performance Examples:

- Trace the draft system of a boiler starting at air intake and culminating at the stack.
- Take draft reading at boiler stack in low, medium, and high fire operating conditions.

- 2.B.05 Illustrate and explain concepts fundamental to economizers and air pre-heaters.
 - 2.B.05.01 Explain the cost savings associated with the operation of both air pre-heaters and economizers.
 - 2.B.05.02 Assess and describe, with association to steam pressure, when economizers become a necessity.
 - 2.B.05.03 Identify to what medium thermal energy is transferred, in the example of both economizers and air pre-heaters.
 - 2.B.05.04 Diagram and label the piping of a condensing economizer.

2.B.05 Performance Examples:

- Identify the location and purpose of both an economizer and a pre-heater.
- Open and label both the internal and external components of a condensing economizer.

- 2.B.06 Explain concepts fundamental to super heaters and de-super heaters.
 - 2.B.06.01 Describe the purpose of super heated steam and how it differs from saturated steam.
 - 2.B.06.02 Summarize the advantages to using superheated steam.
 - 2.B.06.03 Identify the proper procedure for starting boilers that employ super heaters.
 - 2.B.06.04 Describe how superheated steam temperature is controlled.
 - 2.B.06.05 Specify the inherent dangers to operating super heaters with no flow; super heater safety valve setting in relation to boiler drum safety valve setting; and venting and draining of super heater.

2.B.06 Performance Examples:

- Locate and identify a super heater drain and or vent.
- Analyze the difference between the super heater safety valve and drum safety valve popping pressures; summarize the reason for the differential.

- 2.B.07 Demonstrate an understanding of the concepts fundamental to steam traps.
 - 2.B.07.01 Indicate the purpose of steam traps in a steam system.
 - 2.B.07.02 Discuss the operation of the most common steam traps: inverted bucket, impulse, float thermostatic and thermostatic.
 - 2.B.07.03 Disassemble, label, and reassemble most common steam traps.

2.B.07.04 Isolate, bypass, remove, and rebuild a steam trap when tied into a live line during boiler plant operation.

2.B.07 Performance Examples:

- Disassemble: thermostatic, float thermostatic, impulse, and inverted bucket steam trap cut-always and label their components.
- Isolate, bypass, remove, and rebuild a steam trap tied into a live line during steam plant

2.B.08 Distinguish and report concepts fundamental to combustion.

2.B.08.01 Explain how the combustion of a fuel is required to generate the heat necessary to produce steam in a boiler.

2.B.08.02 Identify the most common fuels used in boilers today.

2.B.08.03 Tabulate, in detail, how fuel is metered: oil gallons in barrel, gas cubic foot through deca therm, and coal in pounds and tons.

2.B.08.04 Explain how coal is ranked.

2.B.08.05 Identify equipment required to burn different fuels.

2.B.08.06 List the requirements for preparing fuels for firing.

2.B.08.07 State the flash point, pour point and fire point of a fuel.

2.B.08.08 State the role of time, temperature, and turbulence related to combustion.

2.B.08.09 Define the terms perfect combustion, complete combustion, and incomplete combustion.

2.B.08.10 Differentiate between primary, secondary, and tertiary air and their role in the combustion process.

2.B.08 Performance Examples:

- Visually identify the difference between number two fuel oil and number six fuel oil.
- Manually adjust boiler burner to cause poor combustion and return to proper adjustment using flue gas analyzer tool.

2.C Heat and Energy

2.C.01 Describe concepts fundamental to heat transfer.

2.C.01.01 Define specific heat and explain the difference between sensible and latent heat of evaporation.

2.C.01.02 Define how energy is transferred, conduction, convection, and radiation and their relation to heat transfer in a boiler.

2.C.01.03 Explain the first two laws of thermodynamics and how they apply to boiler system operations.

2.C.01.04 Explain the importance of the enthalpy of steam.

2.C.01.05 Discuss how the transfer of energy causes circulation in a boiler.

2.C.01.06 Identify and describe the four systems that apply to any steam boiler.

2.C.01 Performance Examples:

- With the boiler open, identify the areas where the transfer of heat by radiation and convection occur.
- Identify the areas on an open boiler that are classified as heating surface.

2.D Chapter 146 Massachusetts General Laws and the A.S.M.E. Code

2.D.01 Demonstrate an understanding of the Massachusetts General Laws and regulations related to Stationary Engineering.

2.D.01.01 Explain the terms chief, commissioner, department, division and inspector as they pertain to Chapter 146.

2.D.01.02 List and describe requirements for both boilers and air tank annual and bi-annual inspections pursuant to state law.

- 2.D.01.03 Use the formula which the state uses to determine boiler horsepower.
- 2.D.01.04 Describe how high pressure boilers are to be monitored based on aggregate horsepower (i.e., Continuous, non continuous and periodic).
- 2.D.01.05 Indicate how and where a boiler operator's license and boiler inspection certificate should be displayed.
- 2.D.01.06 Describe the limitations and capabilities of the second class fireman's license.

2.D.01 Performance Examples:

- Calculate the total horsepower of the teaching boiler room and cite under which monitoring classification it falls.
- Locate and explain where a boiler inspection certificate and a boiler operator license are displayed in a high pressure boiler plant.

2.D.02 Describe rules as they apply to the American Society of Mechanical Engineers.

- 2.D.02.01 State the minimum handhold and manhole dimensions.
- 2.D.02.02 Explain the minimum water column connection sizes and requirements.
- 2.D.02.03 Demonstrate an understanding of main steam line valve configurations.
- 2.D.02.04 Identify the minimum pressure gauge graduation, valve arrangement and purpose of flooding, siphon or pigtail protection when installing a gauge on a boiler.

2.D.02 Performance Examples:

- Properly pipe a boiler pressure gauge and explain hazards associated with improper installation.
- Indicate the difference between the inside and outside boiler stop valves.
- Visually distinguish between pipes sized from half inch through one inch I.D.

2.E Fundamental Mathematics

- 2.E.01 Calculate using whole numbers.
 - 2.E.01.01 Practice using whole numbers and their relation to word problems.
 - 2.E.01.02 Compute word problems using whole numbers in operations requiring multiplication and division.
- 2.E.02 Calculate fractions.
 - 2.E.02.01 Demonstrate how to convert from fractions to decimals.
 - 2.E.02.02 Illustrate adding, subtracting, multiplying and dividing fractions.
- 2.E.03 Calculate decimals.
 - 2.E.03.01 Practice rounding decimals, changing decimals to fractions, multiplying and dividing decimals.
- 2.E.04 Practice calculating percentages.
 - 2.E.04.01 Demonstrate calculating percentage rate, calculate base rate amount and determining cost.
- 2.E.05 Convert measurements.
 - 2.E.05.01 Define and use denominate numbers.
 - 2.E.05.02 Distinguish units of measure.
 - 2.E.05.03 Convert units.
- 2.E.06 Calculate ratios and proportions.
 - 2.E.06.01 Locate the missing term.
 - 2.E.06.02 Solve direct and inverse proportions.
- 2.E.07 Use planes and solid figures to perform calculations.
 - 2.E.07.01 Calculate the radius, diameter and circumference of a circle.
 - 2.E.07.02 Calculate the volume of various solid figures.

- 2.E.08 Create and interpret graphs.
 - 2.E.08.01 Use line, bar and circle graphs.

2.F Fundamentals of Boiler Operations

- 2.F.01 Employ practices related to blowing down a boiler.
 - 2.F.01.01 State valve sequence and procedure for blowing down a boiler, according to manufacturers' specifications and current industry standards.
 - 2.F.01.02 Describe the various valve arrangements and design used on common boiler blow-down systems.
 - 2.F.01.03 Explain the reasoning behind the proper opening sequence of the blow-down valves.
 - 2.F.01.04 Describe the relationship between boiler blow-down and boiler water conductivity.
 - 2.F.01.05 Compare blow-down separators and flash-tanks and describe their function and applications.

2.F.01 Performance Examples:

- Identify the major components of the boiler blow down system and describe their associated functions.
- Demonstrate the proper valve opening and closing sequence to perform a boiler bottom blow down.
- Identify the blow down separator and define its purpose in the blow down system.
- Draw a diagram of the boiler blow down system.

- 2.F.02 Employ practices related to maintaining proper boiler water level.
 - 2.F.02.01 Explain the importance of maintaining a normal operating water level (NOWL) in a boiler.
 - 2.F.02.02 State the dangers of carrying a too high or low water condition in your boiler and means of prevention.
 - 2.F.02.03 Show how to manually add water to the boiler.
 - 2.F.02.04 Demonstrate how to automatically add and adjust water to the boiler using a feed-water regulator.
 - 2.F.02.05 Explain the operation of the float, thermo-expansion, and thermo-hydraulic feed-water regulators.
 - 2.F.02.06 Differentiate and describe the use of single, double, and triple element feed-water regulators.
 - 2.F.02.07 Illustrate the high and low pressure feed-water systems showing all lines, valves and equipment that are pertinent to its operation.

2.F.02 Performance Examples:

- Demonstrate how to manually add water the boiler.
- Demonstrate how to automatically add water to the boiler.
- Draw a diagram of the low and high pressure feedwater systems.

- 2.F.03 Demonstrate practices related to plant start-up and shut down with various boiler arrangements.
 - 2.F.03.01 Employ the steps for starting a cold boiler according to current industry standards.
 - 2.F.03.02 Identify and locate all safety interlocks on the boiler before start-up and their purpose.
 - 2.F.03.03 Demonstrate the appropriate testing and resetting of all safety interlocks before and during boiler start-up.

2.F.03.04 Illustrate the high and low pressure steam systems showing all lines, valves and equipment that are pertinent to its operation.

2.F.03 Performance Examples:

- Demonstrate the start up procedure for a high and low pressure boiler using standard operating procedures.
- Demonstrate the shut down procedure for a high a low pressure boiler using standard operating procedures.
- Draw a diagram of the high and low pressure steam systems with associated equipment.

2.F.04 Utilize practices related to troubleshooting an on-line boiler.

2.F.04.01 Explain and employ the sequence of the pre-purge cycle on the boiler.

2.F.04.02 Implement the necessary steps to troubleshoot and diagnose no power at start-up.

2.F.04.03 Perform the necessary steps to troubleshoot and diagnose no pilot at start-up.

2.F.04.04 Execute the necessary steps to troubleshoot and diagnose no main flame at start-up.

2.F.04.05 Employ the necessary steps to troubleshoot and diagnose flame failure during run period.

2.F.04.06 Perform the necessary steps to troubleshoot and diagnose low water condition during run period.

2.F.04 Performance Examples:

- Diagnose and troubleshoot various causes of no power at boiler start up.
- Diagnose and troubleshoot various causes of no pilot or main flame at ignition point.
- Diagnose and troubleshoot causes of main flame failure during run period.
- Diagnose and troubleshoot causes for low or high water conditions during run period.

2.F.05 Recognize and apply concepts fundamental to the first duties of taking over a shift and logging in the state logbook.

2.F.05.01 Explain the importance of arriving to work early.

2.F.05.02 Demonstrate the record keeping procedures of the Massachusetts operator's state log book.

2.F.05.03 Demonstrate the record keeping procedures of the Massachusetts engineer's log book.

2.F.05.04 Document and record all pertinent information required in the state operator's log book.

2.F.05.05 Determine and explain the importance of establishing a true water level in the boiler.

2.F.05 Performance Examples:

- Record and document plant readings in the Massachusetts Operators State log book.
- Determine a true water level in an operating boiler.
- Explain the importance of arriving to work early to relieve a fireman of a work shift.

2.F.06 Perform practices related to water column and gauge glass, according to current industry standards.

2.F.06.01 Demonstrate blow down procedure on the lab water column and gauge glass.

2.F.06.02 Exhibit blow down procedure on the live boiler water column and gauge glass.

2.F.06.03 Show how to remove, measure, and install a new gauge glass.

- 2.F.06.04 State the purpose the water column serves on the boiler.
- 2.F.06.05 Explain the theory of try cocks and demonstrate how they operate.
- 2.F.06.06 Describe the different methods and frequency of testing a LWFCO.

2.F.06 Performance Examples:

- Identify and define the parts associated with a water column and gauge glass and the purpose they serve.
- Establish a true water level in a high and low pressure boiler.
- Remove and install a new boiler gauge glass using standard operating procedures.
- Draw a diagram of the water column and gauge glass and the associated piping system.

2.F.07 Exemplify practices related to preparing a boiler for inspection.

- 2.F.07.01 Explain the purpose and frequency of boiler inspections.
- 2.F.07.02 Demonstrate the steps used to prepare a boiler for an internal inspection.
- 2.F.07.03 Demonstrate the steps used to prepare a boiler for an external inspection.
- 2.F.07.04 Explain the purpose and function of manhole, and hand-hole plates.
- 2.F.07.05 Describe and demonstrate the removal, preparation and reinstallation of common gaskets and seals used to secure hand-hole and manhole plates.

2.F.07 Performance Example:

- Student will prepare a boiler for an annual internal inspection using standard operating procedures including boiler isolation, opening, cleaning, hydrostatic testing, and closing of

2.F.08 Complete practices related to performing the functions of an auxiliary operator.

- 2.F.08.01 Describe and demonstrate the operation of starting and stopping an electrical driven feed-water pump.
- 2.F.08.02 Demonstrate and explain the operation of starting and stopping of a steam driven feed-water pump.
- 2.F.08.03 Compare and contrast the operation and purpose of the open and closed feed-water heaters and the equipment associated with them.
- 2.F.08.04 Identify all auxiliary equipment associated with the steam plant.

2.F.08 Performance Examples:

- Perform start up and shut down procedures of various auxiliary equipment including electrical driven pumps and steam driven pumps.
- Record, evaluate, and troubleshoot temperatures and pressures of the equipment associated with the auxiliary system.
- Draw a diagram of the assortment of auxiliary systems.

2.F.09 Employ practices related to the operation of burners and boiler flame safety controls.

- 2.F.09.01 Explain the purpose of automatic combustion controls and identify the four basic types of combustion controls (on/off, modulating, positioning and metering).
- 2.F.09.02 Identify controls for air for combustion and combustion gases.
- 2.F.09.03 Demonstrate a flame failure in the boiler by manipulation of the flame scanner.
- 2.F.09.04 Describe and demonstrate the operation of the low oil pressure switch.
- 2.F.09.05 Explain the importance of the pre-purge and post-purge cycling of the boiler.
- 2.F.09.06 Describe and demonstrate the operation of different types of fuel oil burners.
- 2.F.09.07 List and describe components and accessories associated with the fuel oil system.

2.F.09 Performance Examples:

- Demonstrate flame failure during boiler run period.
- Explain the function and purpose of the automatic combustion control system.
- Demonstrate the procedure of starting a boiler on dual fuels (natural gas and fuel oil).
- Remove and clean a fuel oil burner.
- Draw a diagram of the gas and fuel oil system.

2.G Joining and Assembling Piping and Associated Accessories

2.G.01 Demonstrate practices related to steel piping (ferrous), and tubing (non-ferrous) according to current industry standards.

2.G.01.01 Explain the methods of measuring, cutting, reaming, filing and joining of ferrous (steel) pipe.

2.G.01.02 Explain the methods of measuring, cutting, reaming, filing and joining of non-ferrous (brass, copper and aluminum) pipe and tubing.

2.G.01.03 Compare the different types of support and suspension systems used in the suspension of piping and tubing.

2.G.01 Performance Example:

- Describe practices related to installation and maintenance of different piping (ferrous), tubing (non-ferrous), and associated support systems.

2.G.02 Integrate practices related to steel fittings (ferrous) and non-ferrous fittings as used in stationary engineering.

2.G.02.01 Describe the purpose, use and installation of ferrous (steel) fittings, and non-ferrous fittings (brass, copper).

2.G.02.02 Describe and demonstrate all methods of measuring and joining steel fittings.

2.G.02.03 Describe and demonstrate measuring and joining all types of copper, brass, aluminum and non-ferrous fittings.

2.G.02 Performance Example:

- Identify and integrate practices utilized in the acceptable installation standards of steel fittings (ferrous) and (non-ferrous) fittings.

2.G.03 Employ practices related to valves.

2.G.03.01 Describe and demonstrate the different types, function, purpose and use of: gate valves, globe valves, check valves, non-return valves, bottom blow down valves, control valves, ball valves and butterfly valves.

2.G.03.02 Describe and demonstrate the operation and maintenance of valves in relation to pressure, temperature and application.

2.G.03 Performance Example:

- Explain the function, performance and selection of different types of valves used in the stationary engineering field.

2.G.04 Describe practices related to gauges.

2.G.04.01 Compare and contrast the types of pressure gauges, vacuum gauges, compound gauges and draft gauges commonly used in industry.

2.G.04.02 Explain the purpose, function, location and use of gauges.

2.G.04.03 Describe and demonstrate installation practices applicable to gauges, siphons, flooding and vibration.

- 2.G.04 Performance Example:
- List and describe the functions and purposes of different types of gauges.

2.H Mechanical Drive Systems

- 2.H.01 Demonstrate practices related to couplings.
- 2.H.01.01 List the different types of couplings.
- 2.H.01.02 Describe all methods used to connect couplings to various arrangements of shafts.
- 2.H.01.03 Describe and demonstrate the use of the bearing key-ways, and set screws to fasten coupling to shafts.

- 2.H.01 Performance Example:
- Describe coupling types, and the installation, service, and repair of each type.

- 2.H.02 Employ practices related to bearings.
- 2.H.02.01 Cite different bearing design and applications.
- 2.H.02.02 List and explain methods used to install and remove bearings to and from various arrangements on shafts as well as bearing housings.
- 2.H.02.03 Display an understanding of the use and purpose of bearing oil and water jackets.

- 2.H.02 Performance Example:
- Explain the importance of bearings, including the different types of bearings, and their application in various types of equipment.

- 2.H.03 Utilize practices related to alignment.
- 2.H.03.01 Utilize appropriate coupling and shaft alignment terminology.
- 2.H.03.02 Describe and demonstrate the alignment of shafts and couplings using straight edge and thickness gauge, dial indicator and rim face methods.

- 2.H.03 Performance Example:
- Align shafts, and associated equipment.

2.I Fundamentals of Electrical Systems

- 2.I.01 Explain and apply fundamental electrical concepts related to stationary engineering.
- 2.I.01.01 Explain concepts fundamental to alternating and direct currents.
- 2.I.01.02 Differentiate between parallel and series circuit.
- 2.I.01.03 Measure voltage using a digital multi-meter.
- 2.I.01.04 Isolate a circuit, remove and identify a failed fuse using multi-meter.

- 2.I.01 Performance Example:
- Students identify concepts of direct, and alternating current used in series, parallel circuitry. Students demonstrate knowledge of isolation of circuitry, to diagnose and troubleshoot over-current protective devices in applicable electrical systems.

Strand 3: Embedded Academics

Strand 3: Embedded Academics, a critical piece of a Vocational Technical Education Framework, are presented as Crosswalks between the Massachusetts Vocational Technical Education Frameworks and the Massachusetts Curriculum Frameworks. These Crosswalks are located in the Appendix of this Framework.

Academic Crosswalks

[Appendix A: English Language Arts](#)

[Appendix B: Mathematics](#)

[Appendix C: Science and Technology/Engineering](#)

Earth and Space Science

Life Science (Biology)

Physical Science (Chemistry and Physics)

Technology/Engineering

Strand 4: Employability and Career Readiness

4.A Career Exploration and Navigation

- 4.A.01 Develop a career plan and portfolio.
 - 4.A.01.01 Develop and revise career plan annually based on workplace awareness and skill attainment.
 - 4.A.01.02 Assess personal strengths and interest areas to determine potential careers, career pathways and career ladders.
 - 4.A.01.03 Examine potential career field(s)/discipline(s) and identify criteria to select, secure and keep employment in chosen field(s).
 - 4.A.01.04 Research and evaluate a variety of careers utilizing multiple sources of information and resources to determine potential career(s) and alternatives.
 - 4.A.01.05 Identify training and education requirements that lead to employment in chosen field(s) and demonstrate skills related to evaluating employment opportunities.
 - 4.A.01.06 Explore and evaluate postsecondary educational opportunities including degrees and certifications available, traditional and nontraditional postsecondary pathways, technical school and apprenticeships, cost of education, financing methods including scholarships and loans and the cost of loan repayment.
 - 4.A.01.07 Create a portfolio showcasing academic and career growth including a career plan, safety credential, resume and a competency profile demonstrating the acquisition of the knowledge and skills associated with at least two years of full-time study in the Chapter 74 program.

- 4.A.02 Demonstrate job search skills.
 - 4.A.02.01 Conduct a job search and complete written and electronic job applications, resumes, cover letters and related correspondence for a chosen career path.
 - 4.A.02.02 Explore and evaluate postsecondary job opportunities and career pathways specific to career technical areas.
 - 4.A.02.03 Identify role and use of social media and networking for staying current with career and employment trends as well as networking, job seeking and career development opportunities.
 - 4.A.02.04 Demonstrate ability to use social media and networking to develop useful occupational contacts, job seeking and career development opportunities.

- 4.A.03 Demonstrate all phases of the job interview process.
 - 4.A.03.01 Gather relevant information about potential employer(s) from multiple print and digital sources, assessing the credibility and accuracy of each source.
 - 4.A.03.02 Identify employment eligibility criteria, such as drug/alcohol free status, clean driving record, etc.

- 4.A.03.03 Practice effective interviewing skills: appearance, inquiry and dialogue with interviewer, positive attitude and evidence of work ethic and skills.
- 4.A.03.04 Explore and evaluate employment benefit packages including wages, vacation, health care, union dues, cafeteria plans, tuition reimbursement, retirement and 401K.

4. A Performance Examples:
- Conduct research to analyze and present on specific careers within a cluster.
 - Conduct web-based job search using sites such as Monster.com, CareerBuilder.com, Indeed.com, Snagajob.com, Simplyhired.com and others.
 - Create profile on social media/networking site such as LinkedIn and/or LinkedIn University for postsecondary research and employment opportunities.
 - Complete online job application.
 - Conduct and videotape practice interviews for instructor and student analysis.
 - Provide students with sample employment and benefit packages for evaluation.

4.B Communication in the Workplace

- 4.B.01 Demonstrate appropriate oral and written communication skills in the workplace.
 - 4.B.01.01 Communicate effectively using the language and vocabulary appropriate to a variety of audiences within the workplace including coworkers, supervisors and customers.
 - 4.B.01.02 Read technical and work-related documents and demonstrate understanding in oral discussion and written exercise.
 - 4.B.01.03 Demonstrate professional writing skills in work-related materials and communications (e.g., letters, memoranda, instructions and directions, reports, summaries, notes and/or outlines).
 - 4.B.01.04 Use a variety of writing/publishing/presentation applications to create and present information in the workplace.
 - 4.B.01.05 Identify, locate, evaluate and use print and electronic resources to resolve issues or problems in the workplace.
 - 4.B.01.06 Use a variety of financial and data analysis tools to analyze and interpret information in the workplace.
 - 4.B.01.07 Orally present technical and work-related information to a variety of audiences.
 - 4.B.01.08 Identify and demonstrate professional non-verbal communication.
- 4.B.02 Demonstrate active listening skills.
 - 4.B.02.01 Listen attentively and respectfully to others.
 - 4.B.02.02 Focus attentively, make eye contact or other affirming gestures, confirm understanding and follow directions.
 - 4.B.02.03 Show initiative in improving communication skills by asking follow-up questions of speaker in order to confirm understanding.

4. B Performance Examples:

- Read and analyze technical instructions to learn what makes them effective.
- Read and analyze technical instructions to follow directions and/or solve a problem.
- Examine a technical document and use it to write a set of instructions for another student to follow and evaluate.
- Analyze websites for effective technical writing and design.
- Create brochures and presentations using software and/or Web 2.0 tools to convey technical information.
- Conduct research using the Internet, print documents, observations and interviews to create a technical guide.

4.C Work Ethic and Professionalism

4.C.01 Demonstrate attendance and punctuality.

4.C.01.01 Identify and practice professional time-management and attendance behaviors including punctuality, reliability, planning and flexibility.

4.C.02 Demonstrate proper workplace appearance.

4.C.02.01 Identify and practice professional appearance specific to the workplace.

4.C.02.02 Identify and practice personal hygiene appropriate for duties specific to the workplace.

4.C.02.03 Identify and wear required safety gear specific to the workplace.

4.C.03 Accepts direction and constructive criticism.

4.C.03.01 Demonstrate ability (both verbally and non-verbally) to accept direction and constructive criticism and to implement solutions to change behaviors.

4.C.03.02 Ask appropriate questions to clarify understanding of feedback.

4.C.03.03 Analyze own learning style and seek instructions in a preferred format that works best for their understanding (such as oral, written or visual instruction).

4.C.04 Demonstrate motivation and initiative.

4.C.04.01 Evaluate assigned tasks for time to completion and prioritization.

4.C.04.02 Demonstrate motivation through enthusiasm, engagement, accurate completion of tasks and activities.

4.C.04.03 Demonstrate initiative by requesting new assignments and challenges.

4.C.04.04 Explain proposed solutions to challenges observed in the workplace.

4.C.04.05 Demonstrate the ability to evaluate multiple solutions to problems and challenges using critical reasoning and workplace/industry knowledge and select the best solution to the problem.

4.C.04.06 Implement solution(s) to challenges and/or problem(s) observed in the workplace.

4.C.04.07 See projects through completion and check work for quality and accuracy.

4.C.05 Demonstrate awareness of workplace culture and policy.

- 4.C.05.01 Display ethical behavior in use of time, resources, computers and information.
- 4.C.05.02 Identify the mission of the organization and/or department.
- 4.C.05.03 Explain the benefits of a diverse workplace.
- 4.C.05.04 Demonstrate a respect for diversity and its benefit to the workplace.

- 4.C.06 Interact appropriately with coworkers.
 - 4.C.06.01 Work productively with individuals and in teams.
 - 4.C.06.02 Develop positive mentoring and collaborative relationships within work environment.
 - 4.C.06.03 Show respect and collegiality, both formally and informally.
 - 4.C.06.04 Explain and follow workplace policy on the use of cell phones and other forms of social media.
 - 4.C.06.05 Maintain focus on tasks and avoid negative topics or excessive personal conversations in the workplace.
 - 4.C.06.06 Negotiate solutions to interpersonal and workplace conflicts.

4. C Performance Examples:

- Complete a learning style analysis tool.
- Develop a rubric to assess work ethic and professionalism as detailed in the standards above.

Student Organizations

Business Professionals of America

www.bpa.org

Selected Websites

- 5 Ways to Ace a Job Interview: http://kidshealth.org/teen/school_jobs/jobs/tips_interview.html
- America’s Career Resource Network: <http://acrn.ovae.org/teachers/careerexpclassrm.htm>
- Career Cruiser – Florida Department of Education: <http://www.fldoe.org/workforce/pdf/cruiser.pdf>
- Career Development Guide and Glossary: <http://www.doe.mass.edu/connect/cde.html>
- Career One Stop: <http://www.careeronestop.org/>
- Career Plan: <http://www.doe.mass.edu/cd/plan/intro.html>
- Career Plan Model: http://www.doe.mass.edu/ccr/epp/samples/cpmodel_11x17.pdf
- Checklist: <http://www.doe.mass.edu/cd/plan/checklist.pdf>
- Career Tech: http://www.okcareertech.org/cac/Pages/resources_products/ethics_web_sites.htm
- Ethics Resource Center: <http://www.ethics.org/>
- Interaction in the Workplace: <http://hrweb.berkeley.edu/guides/managing-hr/interaction/communication>
- Individual Learning Plans: How-to Guide: “Promoting Quality Individualized Learning Plans: A How to Guide on the High School Years” <http://www.ncwd-youth.info/ilp/how-to-guide>

- ILP Fact Sheet: <http://www.ncwd-youth.info/fact-sheet/individualized-learning-plan>
- ILP Policy Brief: <http://www.ncwd-youth.info/ilp/produce-college-and-career-ready-high-school-graduates>
- ILP Resources Home Page: <http://www.ncwd-youth.info/ilp>
- Interview Skills Lesson Plans:
<http://www.amphi.com/media/1220281/interview%20skills%20lesson%20plan.doc>
- Labor and Workforce Development: <http://www.mass.gov/lwd/employment-services/preparing-for-your-job-search/>
- Maine Community College System – Center for Career Development:
http://www.ccd.me.edu/careerprep/CareerPrepCurriculum_LP-6.pdf
- Massachusetts Work-Based Learning: <http://skillspages.com/masswbl>
- North Dakota Association of Agriculture Educators:
http://www.ndaae.org/attachments/File/Preparing_students_for_a_Job_Interview.pptx
- NY CTE Learning Standards—Career Development and Occupational Studies (CDOS) Resource Guide with Core Curriculum: <http://www.p12.nysed.gov/cte/cdlearn/cdosresourceguide.html>
- Occupational Outlook Handbook: <http://www.bls.gov/ooh/>
- Purdue OWL Job Search Resources (for writing resumes, applications, and letters):
<https://owl.english.purdue.edu/engagement/34/>
- Soft Skills to Pay the Bills — Mastering Soft Skills for Workplace Success:
<http://www.dol.gov/odep/topics/youth/softskills/>
- US Department of Labor: <http://www.dol.gov/dol/audience/aud-unemployed.htm>
- Workplace Communication:
<http://www.regionalskillstraining.com/sites/default/files/content/WC%20Book%201.pdf>
- Your Plan For the Future: <http://www.yourplanforthefuture.org>

Strand 5: Management and Entrepreneurship Knowledge and Skills

5.A Starting a Business

- 5.A.01 Demonstrate an understanding of the practices required to start a business.
 - 5.A.01.01 Define entrepreneurship and be able to recognize and describe the characteristics of an entrepreneur.
 - 5.A.01.02 Compare and contrast types of business ownership (i.e., sole proprietorships, franchises, partnerships, corporations).
 - 5.A.01.03 Identify and explain the purpose and contents of a business plan.
 - 5.A.01.04 Demonstrate an understanding of the principles and concepts of a business's supply chain (i.e., suppliers, producers and consumers).

5. A Performance Examples:

- Develop a presentation pertaining to an entrepreneur and their business.
- Communicate with a business owner and discuss the pros and cons of starting and owning a business. Summarize the main points of the discussion.
- Choose a product or service and describe the process leading to distribution.
- Write a business plan for a business in your community.

5.B Managing a Business

- 5.B.01 Demonstrate an understanding of managing a business.
 - 5.B.01.01 Formulate short- and long-term business goals.
 - 5.B.01.02 Demonstrate effective verbal, written and visual communication skills.
 - 5.B.01.03 Utilize a decision-making process to make effective business decisions.
 - 5.B.01.04 Identify a business's chain of command and define its organizational structure.
 - 5.B.01.05 Identify and apply effective customer service skills and practices.
 - 5.B.01.06 Identify, interpret and develop written operating procedures and policies.
 - 5.B.01.07 Track inventory, productivity and labor cost.
 - 5.B.01.08 Demonstrate business meeting skills.
 - 5.B.01.09 Identify professional organizations and explore their benefits.

5. B Performance Examples:

- Working as a team, role-play situations that an entrepreneur might face in dealing with customers or employees.
- Contact a relevant professional organization and request information about its benefits, membership requirements and costs.
- Plan and conduct a business meeting.
- Identify companies that are known for customer service and list the practices that help differentiate themselves from all others in their industry.

5.C Marketing a Business

- 5.C.01 Demonstrate an understanding of marketing and promoting a business.
 - 5.C.01.01 Explain the role of business in the economy.
 - 5.C.01.02 Describe the relationship between business and community.
 - 5.C.01.03 Describe methods of market research and identifying target markets.

- 5.C.01.04 Describe and apply the concepts of a marketing mix (the 4Ps of marketing: product, price, place and promotion).
- 5.C.01.05 Compare and contrast the promotional tools and techniques used to sell products, services, images and ideas.
- 5.C.01.06 Describe the impact of supply and demand on a product or business.
- 5.C.01.07 Identify direct and indirect competition on a business.
- 5.C.01.08 Identify and use sales techniques to meet client needs and wants.
- 5.C.01.09 Discuss strategies to acquire and retain a customer base.

5. C Performance Examples:
- Research reliable sources to identify marketing and industry data related to a business.
 - Conduct market research by developing a survey and presenting the results.
 - Create a promotional campaign using a variety of media.
 - Write a marketing plan for a product.

5.D Financial Concepts and Applications in Business

- 5.D.01 Demonstrate an understanding of financial concepts and applications.
 - 5.D.01.01 Identify essential financial reports and understand their purpose (i.e., budget, balance sheet and income statement).
 - 5.D.01.02 Describe payroll practices (i.e., deductions – federal, FICA and state taxes and insurances).
 - 5.D.01.03 Identify the importance of maintaining accurate records.
 - 5.D.01.04 Apply practices related to pricing, purchasing and billing.
 - 5.D.01.05 Maintain and reconcile a checking account.
 - 5.D.01.06 Identify the options for funding a business.

5. D Performance Examples:
- Given an employee time card and rate of pay, calculate gross pay, taxes, deductions and net pay.
 - Develop a budget for a simulated business or project.
 - Analyze and discuss financial documents from a company.
 - Research various methods of funding a business.

5.E Legal/Ethical/Social Responsibilities

- 5.E.01 Demonstrate an understanding of legal, ethical and social responsibility for businesses.
 - 5.E.01.01 Identify state and federal laws and regulations related to managing a business.
 - 5.E.01.02 Describe and identify ethical business practices.
 - 5.E.01.03 Demonstrate an understanding of business contracts.
 - 5.E.01.04 Explain the role of diversity in the workplace.
 - 5.E.01.05 Explain the role of labor organizations.
 - 5.E.01.06 Identify practices that support clean energy technologies and encourage environmental sustainability.
 - 5.E.01.07 Demonstrate an understanding of how technology advancements impact business practices.

- 5.E Performance Example:
- Read and interpret a contract.
 - Complete an application for a license, permit or certificate.
 - Research federal, state and local regulations and laws required for a business.
 - Participate in and summarize a discussion with a member of a labor or civil rights organization.

Selected Websites

- CVTE Strand 1, 4, and 5 Resources: <https://sites.google.com/a/mccanntech.org/cvte-strands-1-4-and-5-resources/>
- Entrepreneur: <http://www.entrepreneur.com>
- Inc. Magazine: <http://www.inc.com/>
- Junior Achievement “Be Entrepreneurial Program”: <https://www.juniorachievement.org/web/ja-usa/home>
- Kahn Academy Interviews with Entrepreneurs: <https://www.khanacademy.org/economics-finance-domain/entrepreneurship2/interviews-entrepreneurs>
- Kauffman Founders School: <http://www.entrepreneurship.org/en/founders-school.aspx>
- National Federation of Independent Business: www.nfib.com
- National Foundation for Teaching Entrepreneurship (NFTE): www.nfte.com
- SBA Loans: <http://www.sba.gov>
- SkillsUSA Professional Development Program Competency List: <http://www.skillsusa.org/downloads/PDF/lessons/professional/PDPPreview.pdf>
- Small Business Administration: www.sba.gov

Glossary

Term	Definition
Balance sheet	A statement of the assets, liabilities and capital of a business at a particular point in time.
Budget	An estimate of income and expenditure for a set period of time.
Business Ownership	Types of business ownership refer to the legal structure of an organization. Legal structures include: Sole Proprietorship, Partnerships, Corporations and Limited Liability Companies.
Business Plan	A written document that describes in detail your business goals and how you are going to achieve them from a marketing, operational and financial point of view.

Term

Chain of Command and Organizational Structure

**Definition**

Refers to the management structure of an organization. It identifies lines of authority, lines of communication, and reporting relationships. Organizational structure determines how the roles, power and responsibilities are assigned and coordinated and how information flows between the different levels of management. (A visual representation of this structure is called an org chart).

FICA

Federal Insurance Contributions Act requires taxes deducted from pay for supporting Social Security.

Income Statement

A financial statement providing operating results for a specific time period showing a business's revenues, expenses and profit or loss.

Market Research

- Primary: Surveys, Focus Groups, Observation
- Secondary: Websites, Internet

Marketing Mix

A set of controlled variables that formulate the strategic position of a product or service in the marketplace. These variables are known as the 4 P's of marketing and include product, place, price and promotion.

Methods to Track Inventory, Productivity and Labor Cost

Refers to the processes a business uses to account for: 1) the inflows and outflows of inventory and materials related to inventory; 2) the efficiency of operations and 3) the cost of labor including salary and benefits.

Promotional Tools and Techniques

The six elements of a promotional mix are: advertising, visual merchandising, public relations, publicity, personal selling and sales promotion.

Supply Chain

The supply chain, or channel of distribution, describes how the product is handled and/or distributed from suppliers with materials, to the manufacturer, wholesaler or retailer and finally to the consumer.

Target Market

Those who are most likely to buy your product or service.

Strand 6: Technology Literacy Knowledge and Skills

6.A Technology Literacy Knowledge and Skills (Grades 9 through 12)

- 6.A.01 Demonstrate proficiency in the use of computers and applications, as well as an understanding of the concepts underlying hardware, software, and connectivity.
 - 6.A.01.01 Use online help and other support to learn about features of hardware and software, as well as to assess and resolve problems.
 - 6.A.01.02 Install and uninstall software; compress and expand files (if the district allows it).
 - 6.A.01.03 Explain effective backup and recovery strategies.
 - 6.A.01.04 Apply advanced formatting and page layout features when appropriate (e.g., columns, templates, and styles) to improve the appearance of documents and materials.
 - 6.A.01.05 Use editing features appropriately (e.g., track changes, insert comments).
 - 6.A.01.06 Identify the use of word processing and desktop publishing skills in various careers.
 - 6.A.01.07 Identify the use of database skills in various careers.
 - 6.A.01.08 Define and use functions of a spreadsheet application (e.g., sort, filter, find).
 - 6.A.01.09 Explain how various formatting options are used to convey information in charts or graphs.
 - 6.A.01.10 Identify the use of spreadsheet skills in various careers.
 - 6.A.01.11 Use search engines and online directories.
 - 6.A.01.12 Explain the differences among various search engines and how they rank results.
 - 6.A.01.13 Explain and demonstrate effective search strategies for locating and retrieving electronic information (e.g., using syntax and Boolean logic operators).
 - 6.A.01.14 Describe good practices for password protection and authentication.
- 6.A.02 Demonstrate the responsible use of technology and an understanding of ethics and safety issues in using electronic media at home, in school, and in society.
 - 6.A.02.01 Demonstrate compliance with the school's Acceptable Use Policy.
 - 6.A.02.02 Explain issues related to the responsible use of technology (e.g., privacy, security).
 - 6.A.02.03 Explain laws restricting the use of copyrighted materials.
 - 6.A.02.04 Identify examples of plagiarism, and discuss the possible consequences of plagiarizing the work of others.
- 6.A.03 Design and implement a personal learning plan that includes the use of technology to support lifelong learning goals.
 - 6.A.03.01 Evaluate the authenticity, accuracy, appropriateness, and bias of electronic resources, including Web sites.
 - 6.A.03.02 Analyze the values and points of view that are presented in media messages.
 - 6.A.03.03 Describe devices, applications, and operating system features that offer accessibility for people with disabilities.

- 6.A.03.04 Evaluate school and work environments in terms of ergonomic practices.
- 6.A.03.05 Describe and use safe and appropriate practices when participating in online communities (e.g., discussion groups, blogs, social networking sites).
- 6.A.03.06 Explain and use practices to protect one's personal safety online (e.g., not sharing personal information with strangers, being alert for online predators, reporting suspicious activities).
- 6.A.03.07 Explain ways individuals can protect their technology systems and information from unethical users.
- 6.A.04 Demonstrate the ability to use technology for research, critical thinking, problem solving, decision making, communication, collaboration, creativity, and innovation.
 - 6.A.04.01 Devise and demonstrate strategies for efficiently collecting and organizing information from electronic sources.
 - 6.A.04.02 Compare, evaluate, and select appropriate electronic resources to locate specific information.
 - 6.A.04.03 Select the most appropriate search engines and directories for specific research tasks.
 - 6.A.04.04 Use a variety of media to present information for specific purposes (e.g., reports, research papers, presentations, newsletters, Web sites, podcasts, blogs), citing sources.
 - 6.A.04.05 Demonstrate how the use of various techniques and effects (e.g., editing, music, color, rhetorical devices) can be used to convey meaning in media.
 - 6.A.04.06 Use online communication tools to collaborate with peers, community members, and field experts as appropriate (e.g., bulletin boards, discussion forums, listservs, Web conferencing).
 - 6.A.04.07 Plan and implement a collaborative project with students in other classrooms and schools using telecommunications tools (e.g., e-mail, discussion forums, groupware, interactive Web sites, video conferencing).

Appendices

The framework teams created an “Appendix” listing potential industry recognized credentials attainable by secondary students; lists of professional, student, and relevant government organizations; and useful resources and websites. **** It is important to note that although most Framework Teams provided information for the “Appendix”, not all teams did. Therefore, sub-headings within the “Appendix” without information have been deleted.***

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.

Embedded Academic Crosswalks

Embedded English Language Arts and Literacy

CVTE Learning Standard Number	Strand Coding Designation Grades ELAs Learning Standard Number	Text of English Language Arts Learning Standard
1.A.01 1.A.02 1.A.03 4.A.02.02 4.A.02.03 4.A.02.04	RST1: 9-12	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
Performance Example: <ul style="list-style-type: none"> 1.A. Identify, describe, and define the fundamentals of safety through citing textual evidence and learned experiences. 4.A.02 Locate trade information in texts and use appropriately. 		
2.B.01	RST2: 9-12	Determine the central ideas or conclusions of a text; summarize complex concepts, process, or information presented in a text by paraphrasing them in simpler but still accurate terms.
Performance Example: <ul style="list-style-type: none"> 2.B.01 Understand and demonstrate the fundamentals of steam engineering by accurately summarizing: differences in boiler classifications, concepts essential to safety and relief valves, soot blowers, draft fans/dampers, economizers/pre-heaters, super-heaters/ de-super heaters, steam traps and heat combustion. 		
2B.01.01- 2B.01.08, 2C.01.01- 2C.01-06, 2F.01.01- 2F.01.09	RST: 9-12	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
Performance Example: <ul style="list-style-type: none"> Students must properly demonstrate knowledge gained from the texts and oral instruction by performing multi-step tasks. 		
2.D.01 2.D.02	RI4: 9-12	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.
Performance Example: <ul style="list-style-type: none"> Determine meanings and demonstrate understanding of Chapter 146 Massachusetts General Laws and the A.S.M.E. Code 		
4.A.01	RI 7: 9-12	Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.
Performance Example: <ul style="list-style-type: none"> Use text books, graphs, charts, equations, technical vocabulary and hands-on learning to solve problems and answer questions. 		
4.A.02.04 4.A.02.05 4.A.02.06 2.A.02.07 6.A.01	W2: 9-12	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. <ol style="list-style-type: none"> a. Introduce a topic; organization complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and

		<p>multimedia when useful to aiding comprehension.</p> <p>b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic.</p> <p>c. Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.</p> <p>d. Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.</p> <p>e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</p> <p>f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> • Create several written documents using technical terminology. Use graphs, charts, diagrams to further illustrate understanding and clearly convey information. [Genres of writing may include: ship essays, product research, compare and contrast essays, etc.] 		
2.F.05 6.A.01	W4: 9-12	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
<p>Performance Example:</p> <ul style="list-style-type: none"> • Demonstrate aptitude in proper record keeping through documentation entered in Massachusetts operator’s state log book and the Massachusetts engineer’s log book. 		

Embedded Mathematics

CVTE Learning Standard Number	Math Content Conceptual Category and Domain Code Learning Standard Number	Text of Mathematics Learning Standard
2.E.01.01 2.E.01.02	4OA3	Solve multi-step word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
<p>Performance Example:</p> <ul style="list-style-type: none"> • Students must master the fundamentals of the four operations; including borrowing, place value, carrying, and being able to write numbers as words and words as numbers. 		
2.E.02.01	5NF3	Interpret a fraction as division of the numerator by the denominator ($a/b = a$ divided by b). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem.
<p>Performance Example:</p> <ul style="list-style-type: none"> • For example, interpret $3/4$ as the result of dividing 3 by 4, noting that $3/4$ multiplied by 4 equals 3, and that when 3 wholes are shared equally among four people each person has a share of size $3/4$. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds should each person get? Between what two whole numbers does your answer lie? 		
2.E.02.02	5NF1	Add and subtract fractions with unlike denominators (including

	5NF4 5NF7 6NS1	<p>mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators.</p> <p>Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.</p> <p>Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.</p> <p>Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem.</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. For example, create a story context for $(1/3)$ divided by 4, and use a visual fraction model to show the quotient. 		
2.E.03.01	5NBT4 5NBT7	<p>Use place value understanding to round decimals to any place.</p> <p>Add, subtract, multiply, divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> Students must be able to read, write and compare decimal to thousandths using base-ten numerals, number names, and expanded form. 		
2.E.04.01	6RP3 6RP3b 6RP3c	<p>Use ratio and rate reasoning to solve real-world problems and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.</p> <p>Solve unit rate problems, including those involving unit pricing and constant speed.</p> <p>Find a percent of a quantity as a rate per 100; solve problems involving finding the whole, given a part and the percent.</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> Understand ratio concepts and use ratio reasoning to solve problems. 		
2.E.05.01 2.E.05.02 2.E.05.03	5MD1 6RP3d	<p>Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to .05m), and use these conversions to solve multi-step, real-world problems.</p> <p>Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> Use ratio and rate reasoning to solve real-world and mathematical problems. 		
2.E.06.01 2.E.06.02	6RP3a	<p>Make tables of equivalent ratios relating quantities with whole number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> Understand the concept of a ratio and use ratio language to describe a ratio relationship between two 		

		quantities. <ul style="list-style-type: none"> For example, Boiler Operation. Steam piping expands when heated. If a 200 ft. section expands 5 in., how much does a 240 ft. section expand?
2.E.07.01	6G(MA1a)	Use the relationships among radius, diameter, and center of a circle to find its circumference and area.
	6G(MA1b)	Solve real-world and mathematical problems involving the measurements of circles.
Performance Example: <ul style="list-style-type: none"> Students should understand the relationship between radius and diameter as well as the relationship between radius and circumference, pi. Boiler Operation: The amount of steam flow through an orifice meter depends on the area of the circular hole in the meter. What is the area of a hole with a radius of 1.5 in.? 		
2.E.07.02	8G9	Know the formulas for the volume of cones, cylinders, and spheres, and use them to solve real-world and mathematical problems.
Performance Example: <ul style="list-style-type: none"> A geothermal system includes a cylindrical heat exchanger that is 18" in diameter and 42" tall. What is the volume of the heat exchanger? 		
2.E.08.01	6SP4	Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
	6SP(MA4a)	Read and interpret circle graphs.
Performance Example: <ul style="list-style-type: none"> Boiler operators use a daily water treatment log to track the condition of the boiler water. Students should be able to create various graphs, models and data displays from the log book. 		

Embedded Science and Technology/Engineering

Earth and Space Science

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Earth and Space Science Learning Standard
2.C.01	Earth and Space Science, Grades 6-8, 23	Differentiate among radiation, conduction, and convection, the three Mechanisms by which heat is transferred through the earth's system.
Performance Example: <ul style="list-style-type: none"> 		
1.A.01	Earth and Space Science, High School 2.1	Recognize, describe, and compare renewable energy resources (e.g., solar, wind, water, biomass) and nonrenewable energy resources (e.g., fossil fuels, nuclear energy).
Performance Example: <ul style="list-style-type: none"> 		
2.B.08	Earth and Space Science, High School 2.2	Describe the effects on the environment and on the carbon cycle of using both renewable and nonrenewable sources of energy.
Performance Example: <ul style="list-style-type: none"> 		

Physical Science (Chemistry)

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Chemistry Learning Standard
2.B.01	Chemistry, High School 6.1	Using the kinetic molecular theory, explain the behavior of gases and the relationship between pressure and volume (Boyle's law), volume and temperature (Charles's law), pressure and temperature (Gay-Lussac's law), and the number of particles in a gas sample (Avogadro's hypothesis). Use the combined gas law to determine changes in pressure, volume, and temperature.
Performance Example: <ul style="list-style-type: none"> Use kinetic molecular theory and the properties of gases to explain the differences between the various types of boilers. 		
2.B.05	Chemistry, High School 6.5	Recognize that there is a natural tendency for systems to move in a direction of disorder or randomness (entropy).
Performance Example: <ul style="list-style-type: none"> Use the concept of entropy to explain why economizers and air pre heaters make the steam cycle more economical. 		
2.B.06	Chemistry, High School 6.5	Recognize that there is a natural tendency for systems to move in a direction of disorder or randomness (entropy).
Performance Example: <ul style="list-style-type: none"> Use the concept of entropy and entropy to explain the advantages of using super-heated steam. 		
2.B.08	Chemistry, High School 6.4	Describe the law of conservation of energy. Explain the difference between an endothermic process and an exothermic process.
Performance Example: <ul style="list-style-type: none"> Use the law of conservation of energy to explain why the combustion of fuel is necessary to generate heat. 		
2.C.01	Chemistry, High School 6.1	Using the kinetic molecular theory, explain the behavior of gases and the relationship between pressure and volume (Boyle's law), volume and temperature (Charles's law), pressure and temperature (Gay-Lussac's law), and the number of particles in a gas sample (Avogadro's hypothesis). Use the combined gas law to determine changes in pressure, volume, and temperature.
Performance Example: <ul style="list-style-type: none"> User kinetic molecular theory to explain heat transfer via various means and an understanding of the concept of enthalpy. 		

Physical Science (Physics)

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Physics Learning Standard
2.B.01	Introductory Physics, High School 3.4	Explain the relationships among temperature changes in a substance, the amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.
Performance Example: <ul style="list-style-type: none"> Use Concepts of thermodynamics to explain the different types of boilers. 		
2.B.05	Introductory Physics, High School 3.3	Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released when a substance changes from a gas to a liquid to a solid.

		Explain the relationships among evaporation, condensation, cooling, and warming.
Performance Example:		
<ul style="list-style-type: none"> Use the concepts of thermodynamics to explain why economizers and air pre heaters make the steam cycle more economical. 		
2.B.06	Introductory Physics, High School 3.4	Explain the relationships among temperature changes in a substance, the amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.
Performance Example:		
<ul style="list-style-type: none"> 		
2.B.08	Introductory Physics, High School 2.1	Interpret and provide examples that illustrate the law of conservation of energy.
Performance Example:		
<ul style="list-style-type: none"> 		
2.C.01	Introductory Physics, High School 3.1	Explain how heat energy is transferred by convection, conduction, and radiation.
Performance Example:		
<ul style="list-style-type: none"> 		

DESE Statewide Articulation Agreements

No Statewide Articulation Agreements at this time.

Industry Recognized Credentials (Licenses and Certifications/Specialty Programs)

Massachusetts Second Class Fireman's License
OSHA 10 General Industries

Other

Reference Materials

- Green, Denis. Gosse, Jonathan F., Industrial Maintenance. second edition, American Technical Publishers, Inc. Homewood Illinois 60430.2006.ISBN
- Steingress, Frederick M., Frost, Harold J., Walker, Daryl R., High Pressure Boilers. fourth edition. American Technical Publishers, Inc., United States of America. 2009. ISBN 978-0-8269-4309-5.
- Steingress, Frederick M., Walker, Daryl R., Low Pressure Boilers. third edition. American Technical Publisher, Inc., Homewood, Illinois 60430-4600. 2009.ISBN 978-0-8269-4358-3.
- Wilson, R. Dean, Boiler Operator's Workbook. Fourth edition. American Technical Publishers, Inc., USA.2008.ISBN 978-0-8269-4497-9.

Student Organizations

- Skills USA www.maskillsusa.org

Selected Websites

- <http://www.epa.gov/> (Environmental Protection Agency)
- <http://www.state.ma.us/dps/> (Commonwealth of Massachusetts Dept. of Public Safety)
- <http://www.asme.org/> (American Society of Mechanical Engineers)
- <http://www.massengineers.com/> (Massachusetts Engineers)
- <http://www.Cleaver-Brooks.com> (Cleaver Brooks Boilers)
- <http://scienceworld.wolfram.com/physics/topics/Thermodynamics.html>
- <http://www.normas.com/ASME/BPVC/index.html>
- <http://www.armstrong-intl.com/university/map.php3> (Armstrong Steam Traps)
- <http://www.animatedsoftware.com/pumpglos/duplexpu.htm>
- <http://www.eere.energy.gov/industry/> (Office of Industrial Technologies)
- http://www.accidents-inspections.com/Tutorials/factor_of_safety.htm
- <http://www.pumpschool.com/applications/fueloil.htm> (Pump School)
- <http://www.petersonschool.com/> (Petersons School of Engineering)
- <http://www.maritime.edu/> (Massachusetts Maritime Academy)