Massachusetts Career Technical Education

Marine Service Technology Framework

2014

DESE is in the process of updating all CTE Frameworks. This framework was adopted in 2014. More information about the process to update frameworks will be provided in DESE’s CCTE Newsletter.

# [Strand 2: Technical Knowledge and Skills](#_bookmark0)

###### Fundamentals of Marine Service and Boating Safety

* + 1. Demonstrate marine services knowledge and safety skills.
       1. Identify and use marine and boating safety personal flotation devices (PFD) and apply related laws.
       2. Identify and use marine and boating vessel safety checklists.
       3. Identify, describe and follow marine and boating safety navigation procedures.
       4. Identify describe and follow marine and boating safety communication procedures.
       5. Identify and describe occupational safety precautions and procedures in safety color codes.
       6. Identify and describe occupational safety precautions and procedures in fire safety.
       7. Demonstrate the proper use of shop safety equipment.
       8. Identify chemicals that are commonly used in marine service.
       9. Demonstrate safe handling, storage and disposal procedures for chemicals.

2.A.01.10 Describe the importance and demonstrate the use of Personal Protective Equipment (PPE) according to current industry and OSHA standards.

* + 1. Performance Examples:
       - Complete the MA boating safety course and pass the exam.
       - Describe safety color codes and give examples of their applications.
       - Describe occupational fire safety precautions and procedures in the marine service industry.
       - Summarize OSHA, SDS, and EPA guidelines that affect the marine service industry.
       - Perform handling, storage and disposal procedures for chemicals used in the marine service industry. according to current industry and OSHA standards.

###### Fundamentals of Hand Tools, Power Tools, Fasteners and Measuring Procedures

* + 1. Compare and contrast fasteners.
       1. Identify commonly used threaded fasteners.
       2. Identify SAE and metric bolt head markings.
       3. Identify commonly used nuts and washers.
       4. Identify and describe commonly used snap rings, cotter pins and retainers.
       5. Identify and describe the types of torque wrenches and explain and demonstrate the basic rules to follow when using them.
    2. Performance Example:
       - Torque fasteners according to manufacturer’s specifications and according to sequence.
    3. Demonstrate measuring procedures.
       1. Describe commonly used low precision measuring tools.
       2. Identify an outside and inside caliper and demonstrate their use.
       3. Identify a feeler gauge and demonstrate its use.
       4. Identify a hole gauge and demonstrate its use.
       5. Identify a telescoping/snap gauge and demonstrate its use.
       6. Identify a vernier caliper and demonstrate its use.
       7. Identify an outside micrometer and demonstrate its use.
       8. Identify a depth indicator gauge and demonstrate its use.
       9. Identify a dial indicator and demonstrate its use.

2.B.02 Performance Example:

* Demonstrate measurement skills using a variety of measuring procedures.
  + 1. Demonstrate the use of hand tools.
       1. Identify and use various types of screwdrivers.
       2. Identify and use various types of pliers.
       3. Identify and use various types of wrenches.
       4. Identify and use various types of punches and chisels.
       5. Identify and use various types of hammers.
       6. Identify and use various types of sockets.
       7. Identify and use various types of extensions.
       8. Identify and use various various types of files.
       9. Identify and use various types of hacksaws.
       10. Identify and use various various types of thread cutting taps and dies.
       11. Identify and use a tubing cutter, double flaring tool and ISO flaring tool.
       12. Identify and use different types of gasket scrapers.
       13. Identify and use various types of wire brushes.
       14. Identify and use various types of bench vises.

2.B.03 Performance Examples:

* Select the appropriate hand tool to complete an assigned task.
* Demonstrate the use of the hand tool.
  + 1. Demonstrate the use of power tools.
       1. Identify and explain the purpose of an air impact wrench.
       2. Identify types of drill bits.
       3. Describe the difference in drilling speed for different metals.
       4. Describe safety procedures to be followed when using an electric drill.
       5. Drill holes to given specifications using an electric drill.
       6. Identify and explain the purpose of impact sockets.
       7. Describe maintenance and safety procedures when using an air impact wrench.
       8. Identify and explain the purpose of an electric soldering iron.
       9. Describe safety procedures to be followed when using an electric soldering iron.
       10. List the type of solder to use when soldering electrical component.
       11. Identify and explain the purpose of a bench grinder.
       12. Describe safety procedures to follow when using a bench grinder.

2.B.04 Performance Examples:

* Select the correct power tool to match assigned task.
* Demonstrate the correct use of the power tool selected according to current industry and OSHA standards..

###### Fundamentals of Shop Practices to Industry Standards

* + 1. Describe and demonstrate shop practices to industry standards.
       1. Explain watercraft safety practices (Massachusetts Boating Safety Certification) and navigation.
       2. Remove broken fasteners and install helicoils and similar inserts.
       3. Locate, read, interpret and use parts and service manuals, electronic parts manuals, computer data, when procuring parts for the system being worked on.
       4. Accurately document performed repairs using repair orders, invoices and other common forms.
    2. Performance Examples:
       - Identify and explain water safety practices.
       - Identify and demonstrate the use of industry manuals and commonly used forms.

###### Fundamentals of Marine Service Maintenance Areas

* + 1. Conduct preventative maintenance.
       1. Perform basic vessel inspections according to current industry and OSHA standards.
       2. Identify and service waste systems.
       3. Describe winterizing procedures for vessels.
       4. Describe winterizing procedures for potable water, waste, and wash down systems.
       5. Inspect engine mounts/chocks and alignment.
       6. Inspect cranking motor mounting bolts and electrical connections.
       7. Service and/or replace sparkplugs.
       8. Check and adjust linkage.
       9. Service flame arrestor.
       10. Inspect and replace hoses and connectors.
       11. Inspect, service and adjust belts.
       12. Remove/inspect and replace hoses and clamps.
       13. Demonstrate how to shrinkwrap boats.
       14. Demonstrate how to clean, wax and buff boats.
    2. Performance Examples:
       - Perform preventative maintenance and vessel inspections.
       - Inspect and replace spark plugs, belts, hoses and clamps.
       - Perform detailing on vessels and shrinkwrapping.
    3. Maintain marine fuel and lubrication systems.
       1. Explain Coast Guard fuel systems regulations.
       2. Describe marine fuels, engine oils, and their related systems including service and repair, and mix ratios.
       3. Service, repair, troubleshoot, and/or replace fuel and lubrication systems and evaluate marine fuels and lubricating oils.
       4. Remove/repair oil pump, pan and/or gasket.

2.D.02 Performance Example:

* Identify, service, repair and troubleshoot marine fuel systems.
  + 1. Maintain marine ignition systems.
       1. Troubleshoot, service and repair stern drive/inboard ignition systems.
       2. Perform timing and synchronizing using manual.
       3. Repair, service and bench test distributor.
       4. Inspect primary and secondary circuits.
       5. Remove, repair and reinstall distributors.
       6. Remove, replace and check control modules.

2.D.03 Performance Examples:

* Repair ignition systems and perform timing and synchronizing according to manufacturers’ specifications.
* Repair and replace bench test distributor, secondary circuits, distributors and control modules.
  + 1. Maintain marine electrical systems.
       1. Read and interpret A.B.Y.C. wiring codes and regulations.
       2. Read and interpret electrical meters.
       3. Charge, test, and evaluate engine lead-acid batteries.
       4. Read electrical schematics.
       5. Test and clean terminals and service battery.
       6. Test, repair, and replace neutral safety switch.
       7. Test, repair, and replace charging system components.
       8. Install, troubleshoot, service, and repair electrical systems, starting systems, and marine instrumentation.

2.D.04 Performance Example:

* Troubleshoot, service and repair electrical systems, starting systems and marine instrumentation.
  + 1. Maintain cooling systems.
       1. Describe cooling system operations.
       2. Perform winterizing procedures on cooling systems.
       3. Diagnose, service, and repair raw water systems and closed cooling system.
       4. Troubleshoot, service, and repair outboard, sterndrive, and inboard cooling and exhaust systems.

2.D.05 Performance Example:

* Identify procedures in maintaining all cooling systems.
  + 1. Maintain drive systems.
       1. Describe drive systems and explain the theory of operation for marine applications.
       2. Inspect and service drive train.
       3. Inspect and troubleshoot all drive system component parts.
       4. Inspect, troubleshoot, and service gear cases on marine drive systems.
       5. Check/align engine as required for acceptance of outdrive.
       6. Tune-up stern drive, outboard, and inboard engine systems.
       7. Troubleshoot and repair transom plate systems.
       8. Diagnose, service, repair, and adjust outboard shift lower units and throttle systems.
       9. Service/repair outboard lower units.
       10. Demonstrate the removal and installation procedures for stern drives.
       11. Service/repair transom plate, gimble ring, and bell ring.
       12. Service/repair upper gear housings.

2.D.06 Performance Examples:

* Identify and service all marine drive systems.
* Demonstrate the removal and installation of stern drives.
  + 1. Maintain tilt and trim systems.
       1. Inspect, test, service, and repair/replace power trim tilt systems, including midsections and lines.
       2. Describe how trim systems affect different hull configurations.

2.D.07 Performance Example:

* Repair/ replace trim tilt system.
  + 1. Maintain steering systems.
       1. Service/repair marine cable steering systems.
       2. Service/repair marine hydraulic steering systems.
       3. Service/repair marine steering accessories.

2.D.08 Performance Example:

* Identify and service steering systems.

###### Fundamentals of Overhaul of Four and Two Stroke Engines

* + 1. Overhaul four stroke cycle engines.
       1. Identify characteristics and cycles of the four stroke cycle engine.
       2. Disassemble/reassemble a four stroke cycle engine.
       3. Diagnose valve and head problems using the compression and leak down testers.
       4. Remove and inspect cylinder head and gasket.
       5. Remove, clean and inspect all internal components, connecting rods, pistons, camshaft, bearings and crankshaft.
       6. Precision measure internal engine components.
       7. Measure bearing clearance with plastigauge.
       8. Hone and clean cylinders.
       9. Check crankshaft end play for run-out.
       10. Install pistons on piston pins and check orientation; install rings on pistons.
       11. Install oil seals.
       12. Demonstrate overhaul diagnostic and service procedures for four stroke cycle engines.
       13. Diagnose failure analysis.
    2. Performance Examples:
       - Identify a four stroke cycle engine, disassemble and reassemble a four stroke cycle engine and diagnose valve and head problems using leak down testers.
       - Remove, clean and inspect all internal components, connecting rods, pistons, camshaft, bearings and crankshaft.
       - Precision measure internal engine components, measuring bearing clearance with plastigauge.
       - Install pistons on piston pins and check orientation; install rings on pistons and install oil seals.
       - Identify overhaul diagnostic and service procedures for four stroke cycle engines and diagnose failure analysis
    3. Overhaul two stroke cycle engines.
       1. Identify characteristics and cycles of the two stroke cycle engine.
       2. Diagnose engine combustion chamber problems using the compression tester method.
       3. Remove, clean and inspect cylinder heads for cracks, warped surfaces and damage to spark plug threads.
       4. Disassemble two stroke cycle engines.
       5. Demonstrate diagnostic and service procedures for two stroke cycle engines.
       6. Inspect, clean and measure pistons, connecting rods, crankshaft, bearing surfaces, piston pins and all related components.
       7. Measure cylinders for out-of-round, taper and examine ports.
       8. Hone and clean cylinders.
       9. Inspect and clean intake manifold; check/replace reed valves.

2.E.02.10 Reassemble engine to factory specifications.

2.E.02 Performance Examples:

* Disassemble two stroke cycle engines, diagnose and apply service procedures for two stroke cycle engines.
* Disassemble and reassemble two stroke cycle engines to factory specifications.

###### Fundamentals of all Fuel Systems in Marine Services

* + 1. Maintain and repair outboard fuel systems.
       1. Remove, disassemble, clean and rebuild outboard carburetors.
       2. Adjust, synchronize and lubricate throttle linkages and check for proper operation.
       3. Check, inspect and repair fuel lines, fuel filters and fuel tanks.
       4. Test, inspect and repair oil injection systems.
       5. Diagnose, inspect and repair outboard EFI fuel systems.
       6. Diagnose, inspect and repair outboard direct fuel injection systems.
       7. Service and inspect vapor separated tank.
    2. Performance Examples:
       - Disassemble, clean and rebuild outboard carburetors and then adjust, synchronize and lubricate throttle linkages and check for proper operation.
       - Test, diagnose, inspect and repair oil injection systems, outboard EFI fuel systems and outboard direct fuel injection systems.
    3. Maintain and repair inboard and stern drive fuel systems.
       1. Maintain, inspect and repair fuel lines, fuel tanks, and anti-siphon systems and fuel filters.
       2. Remove, inspect and repair carburetors.
       3. Check and adjust carburetor linkages and choke systems.
       4. Maintain, inspect and repair EFI Throttle Body fuel systems.
       5. Maintain, inspect and repair Multi-Port fuel injection systems.

2.F.02 Performance Examples:

* Inspect and repair fuel lines, fuel tank, anti-siphon systems, fuel filters, carburetors, EFI throttle body fuel systems and multi-port fuel injection systems.
* Inspect, repair and adjust carburetors, carburetor linkages and choke systems
  + 1. Describe and apply marine diesel engine technology.
       1. Describe principles of operation.
       2. Describe and identify turbocharger, intercooler and supercharger.
       3. Explain two stroke and four stroke diesel engines.
       4. Describe and identify internal engine components.
       5. Perform compression test.
       6. Inspect and service valve train.
       7. Explain, identify and trouble shoot fuel systems.
       8. Change fuel filters and bleed fuel system.
       9. Identify and explain lubrication system.
       10. Diagnose, service and repair electrical system.
       11. Identify and explain electrical system.
       12. Check cold start system.

2.F.03 Performance Examples:

* Identify and explain two and four stroke diesel engines and identify internal engine components.
* Perform compression test and inspect service valve train.
* Troubleshoot fuel system, change fuel filters and bleed fuel system.
* Identify and explain lubrication system and check cold start system.
* Diagnose and repair electric system.
* Identify and explain lubrication system and check cold start system.

###### Fundamentals of ARC, MIG and TIG Welding

* + 1. Describe and demonstrate welding and cutting fabrication.
       1. Explain ARC welding and its function.
       2. Demonstrate various ARC welding techniques in multiple positions using various welding rods.
       3. Explain MIG (Metal Inert Gas) welding and its function.
       4. Demonstrate various MIG welding techniques in multiple positions.
       5. Explain TIG (Tungsten Inert Gas) welding and its function.
       6. Demonstrate various TIG welding techniques in various positions using A/C and D/C electricity.
       7. Explain and demonstrate the use of a plasma cutter.
       8. Explain oxygen/acetylene torches and their functions.
       9. Demonstrate lighting, heating and cutting operation according to current industry and OSHA standards.
    2. Performance Examples:
       - Explain and demonstrate various ARC welding techniques in multiple positions using various welding rods.
       - Explain and demonstrate MIG and TIG welding techniques and their function and proper use of plasma cutter, proper light, heating and cutting operation.
       - Identify and explain oxygen/acetylene torches and their function.

###### Fundamentals of Boatbuilding and Repair

* + 1. Describe and demonstrate fiberglass maintenance, repair and boatbuilding.
       1. Identify, describe and demonstrate the use of fiberglass materials, chemicals and tools.
       2. Identify the characteristics and demonstrate the uses of: polyester, vinalester and epoxy resins, solvents, additives and release agents.
       3. Compare and contrast characteristics of fiberglass boatbuilding methods.
       4. Explain and perform gel coat applications, maintenance and repair procedures.
       5. Explain and perform laminating procedures.
       6. Explain and perform secondary repairs of cured fiberglass laminates.
       7. Describe plug and mold construction and maintenance.
    2. Performance Examples:
       - Demonstrate the use of fiberglass materials, chemicals and tools according to current industry and OSHA standards.
       - Perform proper gel coat applications, maintenance and repair procedures.

# [Embedded Academic Crosswalks](#_bookmark0)

### [Embedded English Language Arts and Literacy](#_bookmark0)

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| CTE  Learning Standard Number | Strand Coding Designation Grades ELAs  Learning Standard Number | Text of English Language Arts Learning Standard |
| 2.C.01 | W.11-12.2  W.11-12.4  L.11-12.1  L.11-12.2  L.11-12.3  L.11-12.4  L.11-12.6 | Writing Standards (W)  Language Standards (L)  Performance Example:  Explain watercraft safety practices (Massachusetts Boating Safety Certification) and navigation. |
| 2.C.01 | RI.11-12.1  RI.11-12.3  RI.11-12.4  RI.11-12.6  RI.11-12.7  RI.11-12.10 | Reading Standards for Informational Texts (RI)  Performance Example:  Locate, read, interpret, and use parts and service manuals, electronic parts manuals, computer data, when procuring parts for the system being worked on. |
| 2.D.02 | W.11-12.2  W.11-12.4  L.11-12.1  L.11-12.2  L.11-12.3  L.11-12.4  L.11-12.6 | Writing Standards (W)  Language Standards (L)  Performance Example:  Explain Coast Guard fuel systems regulations. |
| 2.D.04 | RI.11-12.1  RI.11-12.3  RI.11-12.4  RI.11-12.6  RI.11-12.7  RI.11-12.10 | Reading Standards for Informational Texts (RI)  Performance Example:  Read and interpret A.B.Y.C. wiring codes and regulations. |
| 2.F.03 | W.11-12.2  W.11-12.4  L.11-12.1  L.11-12.2  L.11-12.3  L.11-12.4  L.11-12.6 | Writing Standards (W) Language Standards (L)  Performance Example:  Describe principles of operation. |
| 2.H. 01 | W.11-12.2  W.11-12.4  L.11-12.1  L.11-12.2  L.11-12.3  L.11-12.4 | Writing Standards (W)  Language Standards (L)  Performance Example:  Compare and contrast characteristics if fiberglass boatbuilding methods. |

### [Embedded Mathematics](#_bookmark0)

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| CTE  Learning Standard Number | Math Content Conceptual Category and Domain Code Learning Standard Number | Text of Mathematics Learning Standard |
| 2.B.02 | N-Q-3  N-Q-3 | Number and Quantity  Performance Example:  When using measurement devices such as vernier calipers, feeler gauges, and micrometers, choose a level of accuracy appropriate to limitations on measurement when reporting quantities. |
| 2.B.04 | F-IF-5 | Interpreting Functions  Performance Example:   * Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, the function used to show the number of person-hours it takes to assemble n engines in a factory or the number of person-hours required to overhaul an engine or perform other major   repairs on a marine vessel. |
| 2.D.02 | N-Q-1 | Quantities  Performance Example:  Use units as a way to understand problems and to guide the solution of multi-step problems; when working with marine fuels and engine oil mix rations, choose and interpret units consistently in formulas. |
| 2.A.09.01 | A-CED-4 | Creating Equations |
| 2.A.09.02 | A-CED-4 | Performance Example:   * When installing, troubleshooting, servicing or repairing electrical systems, starting systems, and marine   instrumentation, it may be necessary to rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange OHM’s law V=IR to highlight resistance R. |
| 2.E.01 | A-CED-1 | Creating equations |
|  | A-CED-2 | Performance Example:   * When diagnosing valve and head problems during overhaul of four and two stroke engines, it will help to   create equations in one variable and use them to solve problems. Create equations in two or more variables to represent relationships between quantities. Represent constraints by equations and interpret solutions as viable or non-viable options while performing diagnostic failure analysis on the engine. |
| 2.G.01 | G-GMD-3 | Geometric Measurement and Dimension  Performance Example:   * When performing welding and cutting fabrication (ex.: ARC welding, MIG welding, and TIG welding) use volume formulas for cylinders, pyramids, cones, spheres and other three dimensional objects to solve   problems. |
| 2.E.02 | A-CED-3 |  |

### [Embedded Science and Technology/Engineering](#_bookmark0)

#### [Life Science (Biology)](#_bookmark0)

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| CTE  Learning Standard Number | Subject Area, Topic Heading and  Learning Standard Number | Text of Biology Learning Standard |
| 2.D.02 | Biology 1.2 | The Chemistry of Life (carbohydrates: lubricants and fuels)  Performance Example:   * Utilizing basic knowledge of carbohydrates, there viscosities and or energy contents, determine the appropriate fuel or lubricant for a given application. Utilizing laboratory mathematics, figure the correct   volume of fuel to lubricant to achieve the desired ratio when mixing fuel for two-stroke engines. Perform labs to determine the chemistry of life of carbohydrates: lubricants and fuels. |
| 2.F.03 | Biology 1.2 | The Chemistry of Life (carbohydrates: lubricants and fuels)  Performance Examples:   * Utilizing knowledge of marine biologic action on fuel and lubrication systems, determine if fuel samples and lubricating oil samples are contaminated and in need of replacement.   Perform labs to determine the chemistry of life of carbohydrates: lubricants and fuels. |

#### [Physical Science (Chemistry)](#_bookmark0)

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| CTE  Learning Standard Number | Subject Area, Topic Heading and  Learning Standard Number | Text of Chemistry Learning Standard |
| 2.D.02 | Chemistry 7.1  7.4  8.4 | Solutions, Rates of Reaction, and Equilibrium  Acids and Bases and Oxidation-Reduction Reactions  Performance Example:   * Utilizing basic knowledge of carbohydrates, and their viscosities and/or energy contents, determine the   appropriate fuel or lubricant for a given application. Utilizing laboratory mathematics, figure the correct volume of fuel to lubricant to achieve the desired ratio when mixing fuel for two-stroke engines. |
| 2.D.04 | Chemistry 8.4 | Acids and Bases and Oxidation-Reduction Reactions  Performance Example:  Utilizing knowledge of electrochemical reactions, troubleshoot lead-acid batteries to determine if replacement of electrolyte or cathode or anode decay is the reason for a loss of battery power. |
| 2.E.01 | Chemistry 8.4 | Acids and Bases and Oxidation-Reduction Reactions  Performance Example:  Utilizing basic knowledge of chemical reactions in an internal combustion engine, determine if engine has undergone chemical damage from improper coolant or coolant contamination to the engine. |
| 2.F. 01 | Chemistry 5.5  6.1  6.2  6.4  7.5  8.4 | Chemical Reactions and Stoichiometry  States of Matter, Kinetic Molecular Theory, and Thermochemistry Solutions, Rates of Reaction, and Equilibrium  Acids and Bases and Oxidation-Reduction Reactions  Performance Example:  Utilizing knowledge of basic combustion reactions, troubleshoot diesel engines to determine if proper fuel and air ratio’s (stoichiometric balance) is achieved. |
| 2.G.01 | Chemistry 7.5  8.4  6.4  8.4 | Solutions, Rates of Reaction, and Equilibrium Acids and Bases and Oxidation-Reduction Reaction  States of Matter, Kinetic Molecular Theory, and Thermochemistry Solutions, Rates of Reaction, and Equilibrium  Acids and Bases and Oxidation-Reduction Reactions  Performance Example:  Utilizing knowledge of oxidation reactions and their unintended effects on metals, weld a surface utilizing ARC, MIG or TIG techniques and determine if any potential damage to substrate material results. |

#### [Physical Science (Physics)](#_bookmark0)

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| CTE  Learning Standard Number | Subject Area, Topic Heading and  Learning Standard Number | Text of Physics Learning Standard |
| 2.D.01 | Physics 1.4  1.5 | Motion and Forces  Performance Example:  Create equations in one variable and use them to solve problems for marine fuel systems. |
| 2.D. 04 | Physics 5.2  5.3  5.5 | Electromagnetism (Ohm’s Law and Coulombs Law and Power) Electromagnetism  Electromagnetism (Charge and Voltage)  Performance Example:  Rearrange formulas to highlight a quantity of interest using the same reasoning as in solving equations for marine fuel systems. |
| 2.D.05 | Physics 1.4  1.8  3.1  3.2  3.3  3.4 | Motion and Forces (Forces and circular motion in pumps) Heat and Heat Transfer  Performance Example:  Rearrange formulas to highlight a quantity of interest using the same reasoning as in solving equations for marine fuel systems. |
| 2.D.06 | Physics 1.4  1.8 | Motion and Forces (Linear and Circular)  Performance Example:  Rearrange formulas to highlight a quantity of interest using the same reasoning as in solving equations for marine fuel systems. |
| 2.D.07 | Physics 1.8 | Motion and Forces (Forces and Vectors)  Performance Example:  Rearrange formulas to highlight a quantity of interest using the same reasoning as in solving equations for marine fuel systems. |

[Industry Recognized Credentials](#_bookmark0) (Licenses and Certifications/Specialty Programs)

* American Boat and Yacht Council Certification
* American Boat Builders & Repairers Association: Marine Diesel Certification, Service Manger Certification Composite and Fiberglass repair Certification
* Mercury Marine Certification Association of Marine Technicians (AMTECH)