

Manufacturing, Engineering & Technology Services Occupational Cluster

Metal Fabrication & Joining Technologies Framework (VMETL)

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 Fundamentals of Safety in Metal Fabrication and Joining Technologies

- 2.A.01 Demonstrate Metal Fabrication and Joining safety practices.
 - 2.A.01.01 Utilize Personal Protective Equipment.
 - 2.A.01.02 Discuss and implement machine guarding.
 - 2.A.01.03 Perform safe and proper operation of equipment.
 - 2.A.01.04 Explain and apply lockout/tagout procedures.

- 2.A.01 Performance Example:
- Student will obtain a 10 hour OSHA general industry safety certification.

2.B Fundamentals of Metal Fabrication and Joining Process

- 2.B.01 Recognize the fundamentals of metal fabrication and joining processes.
 - 2.B.01.01 Identify basic terminology and metallurgy.
 - 2.B.01.02 Identify quality control procedures in various work environments.

- 2.B.01 Performance Example:
- Identification of ferrous and non-ferrous metals:
 - Visual test
 - Spark test
 - File test
 - Magnet test
 - Chip test

2.C Measurement

- 2.C.01 Identify and demonstrate proper measurement devices for specific applications.
 - 2.C.01.01 Define attributes, tolerances, bend allowances, units, and systems of measurement used in Metal Fabrication fields.
 - 2.C.01.02 Determine measurement from a decimal equivalent chart.
 - 2.C.01.03 Determine measurement from common shop hand tools such as: combination squares, tape measures, weld gauges, sheet metal gauges, trammel points, dividers, protractors, vernier calipers, micrometers and centering heads.

- 2.C.01 Performance Example:
- Using appropriate English and Metric measurement tools (both linear and angular), student reads and recognizes scaling and applying mathematical skills to obtain the measurements. The student will also demonstrate the use and application of basic formulae to prove accuracy of an assigned project. Students can select and use measuring tools such as combination square, tape measure, weld gauges, dividers, trammel points, protractors and centering heads

2.D Blueprint Reading

- 2.D.01 Read and interpret prints.
 - 2.D.01.01 Recognize and identify title block, basic print terms, abbreviations, line types, symbols and notes.
 - 2.D.01.02 Interpret and follow drawing dimensions.
 - 2.D.01.03 Determine true measurements from a print, using the appropriate scale.
 - 2.D.01.04 Read and interpret: elevations, section, and detail views.
 - 2.D.01.05 Develop a bill of materials.

- 2.D.01 Performance Example:
- Using a blue print, identify:
 - Title block
 - Scale
 - Bill of material
 - Symbols and notes

2.E Design Process and Material Layout

- 2.E.01 Properly layout materials.
- 2.E.01.01 Develop cut size from sketch or blueprint/drawing.
- 2.E.01.02 Perform basic layout on flat material.
- 2.E.01.03 Use basic pattern development techniques, including parallel line development, triangulation, and radial line development.

- 2.E.01 Performance Example:
- Student will demonstrate the ability to transfer accurate dimensions from a blue print to a flat piece of metal using a material take off technique.
 - Given an existing assembly, student will:
 - Develop a hand sketch.
 - Convert to a CAD drawing.
 - Identify and produce a bill of material with cost.
 - Fabricate project.

- 2.E.02 Demonstrate and apply design process.
- 2.E.02.01 Demonstrate the ability to design metal fabrication parts.

2.F Hand and Power Tools

- 2.F.01 Demonstrate the use of hand tools, according to industry and OSHA standards.
- 2.F.01.01 Use wrenches, hammers and screwdrivers.
- 2.F.01.02 Use clamping tools.
- 2.F.01.03 Create holes using awls and punches.
- 2.F.01.04 Determine square, level, and plumb.
- 2.F.01.05 Use a pop-rivet gun.
- 2.F.01.06 Identify and use the appropriate chisels and center punches for varied applications.
- 2.F.01.07 Select and use taps and dies.
- 2.F.01.08 Select and use appropriate hand files.
- 2.F.01.09 Use hand snips.
- 2.F.01.10 Use a hand held hacksaw.

- 2.F.01 Performance Example:
- Student will prepare materials for fabrication by using appropriate clamping tools safely.

- 2.F.02 Demonstrate the operation of power tools, according to industry and OSHA standards.
- 2.F.02.01 Use grinders and sanders.
- 2.F.02.02 Use an electric hand shear.
- 2.F.02.03 Use a hand drill.
- 2.F.02.04 Use a hand held electric jig saw.
- 2.F.02.05 Use a reciprocating saw.
- 2.F.02.06 Use a portable band saw.

- 2.F.02 Performance Example:
- Student will use an electric sander to create a proper finish on fabricated materials according to industry and OSHA standards.

2.G Mechanical Cutting

- 2.G.01 Demonstrate mechanical cutting operations, according to industry and OSHA standards.
- 2.G.01.01 Identify appropriate cutting tools and techniques for specific projects.
 - 2.G.01.02 Use a power shear.
 - 2.G.01.03 Use a foot operated shear.
 - 2.G.01.04 Use a drill press.
 - 2.G.01.05 Use a cold saw.
 - 2.G.01.06 Use a horizontal band saw.
 - 2.G.01.07 Use a vertical band saw.
 - 2.G.01.08 Use an ironworker.

2.G.01 Performance Example:
▪ Student will fabricate holes in material using a drill press.

2.H Metal Forming

- 2.H.01 Demonstrate the fundamentals of forming metal, according to industry and OSHA standards.
- 2.H.01.01 Identify the appropriate metal forming tools and techniques for specific projects.
 - 2.H.01.02 Use a hand operated box and pan brake.
 - 2.H.01.03 Use slip rollers.
 - 2.H.01.04 Use power rollers.
 - 2.H.01.05 Use a power press brake.
 - 2.H.01.06 Use a universal bender.
 - 2.H.01.07 Use a lock former.

2.H.01 Performance Example:
▪ Given a specific material, student will identify the proper metal forming tool.

2.I Cutting and Gouging Processes

- 2.I.01 Demonstrate the oxy-fuel gas cutting process, according to industry and OSHA standards.
- 2.I.01.01 Identify safety procedures.
 - 2.I.01.02 Perform proper set up, start up, and shut down procedures.
 - 2.I.01.03 Perform manual oxy-fuel gas, straight/radius, and shape cutting operations on plain carbon steel.
 - 2.I.01.04 Perform bevel cutting operations on plain carbon steel.

2.I.01 Performance Example:
▪ Given plain carbon steel, student will demonstrate a bevel cut.

- 2.I.02 Demonstrate the plasma arc cutting process, according to industry and OSHA standards.
- 2.I.02.01 Identify safety procedures.
 - 2.I.02.02 Set up and operate manual plasma arc cutting equipment.
 - 2.I.02.03 Set up and operate automatic plasma arc cutting equipment.
 - 2.I.02.04 Identify consumables necessary for cutting ferrous and non-ferrous metals.

2.I.02 Performance Example:
▪ Given a specific material, student will identify the proper consumable to use when plasma arc cutting.

- 2.I.03 Demonstrate the carbon arc air gouging process, according to industry and OSHA standards.
- 2.I.03.01 Identify safety procedures used for carbon arc gouging.
 - 2.I.03.02 Set up and operate manual air carbon arc gouging operations on plain carbon steel.

- 2.I.03 Performance Example:
- Given the proper materials, student will describe the proper safety procedures to follow before performing Carbon Arc Gouging.

2.J Welding and Joining Processes

- 2.J.01 Demonstrate the oxy-acetylene welding process, following industry and OSHA standards.
- 2.J.01.01 Identify safety procedures.
 - 2.J.01.02 Perform set up, start up, and shut down procedures on equipment.
 - 2.J.01.03 Form a weld bead on mild steel.
 - 2.J.01.04 Braze joints in the flat position.

- 2.J.01 Performance Example:
- Students will pass a written safety test which identifies all proper safety procedures to be employed when using plasma arc cutting equipment.

- 2.J.02 Demonstrate the shielded metal arc welding (SMAW) Process.
- 2.J.02.01 Identify safety procedures for SMAW.
 - 2.J.02.02 Set up equipment for operation for SMAW.
 - 2.J.02.03 Identify various types of electrodes by their diameters and characteristics.
 - 2.J.02.04 Form a weld bead using SMAW.
 - 2.J.02.05 Pad weld in flat and horizontal positions.
 - 2.J.02.06 Fillet weld in the 2F and 3F positions on structural shapes and plate.
 - 2.J.02.07 Groove weld in 2G and 3G positions on structural shapes and plate.

- 2.J.02 Performance Example:
- Student will demonstrate the ability to perform a quality weld using SMAW welding standards.

- 2.J.03 Demonstrate the gas metal arc welding (GMAW) process.
- 2.J.03.01 Identify safety procedures for GMAW.
 - 2.J.03.02 Set up equipment for operation for GMAW.
 - 2.J.03.03 Identify various metal transfer modes, electrodes, and shielding gases.
 - 2.J.03.04 Identify sizes and application of common spool and filler wires.
 - 2.J.03.05 Form a weld bead using GMAW.
 - 2.J.03.06 Pad weld in the flat position.
 - 2.J.03.07 Fillet weld in the 2F and 3F positions on structural shapes and plate.

- 2.J.03 Performance Example:
- Using flashcards, students will demonstrate the ability to properly set up GMAW equipment for operation.

- 2.J.04 Demonstrate the flux core welding process.
- 2.J.04.01 Identify safety procedures for flux core welding.
 - 2.J.04.02 Set up equipment for operation for flux core welding.
 - 2.J.04.03 Identify sizes, application of common spool and filler wires, and proper shielding gases.
 - 2.J.04.04 Form a weld bead using the flux core welding process.
 - 2.J.04.05 Pad weld in the flat position, using the flux core welding process.
 - 2.J.04.06 Fillet weld in the 2F and 3F positions on structural shapes and plate.
 - 2.J.04.07 Groove weld in 2G and 3G positions on structural shapes and plate.

- 2.J.04 Performance Example:
- Students will explain the effects of using improper shielding gases.

- 2.J.05 Demonstrate the gas tungsten arc welding process.
- 2.J.05.01 Identify safety procedures for gas tungsten arc welding.

- 2.J.05.02 Set up equipment for operation on plain carbon, stainless steel, aluminum and dissimilar metals.
- 2.J.05.03 Form a weld bead on plain carbon, stainless steel, and aluminum.
- 2.J.05.04 Perform a fillet weld on ferrous and non-ferrous metals.
- 2.J.05.05 Perform a groove weld on ferrous and non-ferrous metals on structural shapes and plate.

2.J.05 Performance Example:
 ▪ Students will explain how equipment differs for aluminum versus dissimilar metals.

- 2.J.06 Demonstrate the spot welding process.
 - 2.J.06.01 Identify safety procedures for spot welding.
 - 2.J.06.02 Set up and maintain spot welding equipment.
 - 2.J.06.03 Perform a spot weld on thin gauge material.

2.J.06 Performance Example:
 ▪ Students will perform a spot weld.

- 2.J.07 Demonstrate the soldering process.
 - 2.J.07.01 Identify and follow safety procedures for soldering.
 - 2.J.07.02 Set up soldering equipment.
 - 2.J.07.03 Identify various types of solder and flux.
 - 2.J.07.04 Demonstrate proper preparation of materials.
 - 2.J.07.05 Demonstrate soldering operation.

2.J.07 Performance Example:
 ▪ Students will explain the difference between varying types of solder.

- 2.J.08 Demonstrate a basic understanding of weld inspection.
 - 2.J.08.01 Perform visual weld inspection.
 - 2.J.08.02 Describe other non destructive testing methods.

2.J.08 Performance Example:
 ▪ Given welds to inspect students, will determine if a weld is acceptable. If it is not, they will identify why.

2.K Preventive Equipment Maintenance

- 2.K.01 Monitor basic equipment and perform machinery maintenance.
 - 2.K.01.01 Monitor equipment indicators to insure that equipment is operating correctly.
 - 2.K.01.02 Identify and diagnose the source of problems, as related to components and processes of welding and metal forming equipment, then develop steps to resolve the problems.

2.K.01 Performance Example:
 ▪ Troubleshoot a bird nest in GMAW:

- Check the contact tip.
- Check drive roll tension.
- Check liner.
- Check spool winding.
- Take appropriate corrective action.