Vermont Department of Education

Industrial Maintenance
(CIP: 47.0105)

Occupational Skills

The Student demonstrates the specified level of competency in occupational skills:

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<tbody>
<tr>
<td>No Exposure</td>
<td>Introduced</td>
<td>Practiced</td>
<td>Entry-level</td>
<td>Competency</td>
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0 1 2 3 4

A. **Apply Safety Knowledge**  
   (Vermont Standards: 3.3, 7.18)

B. **Demonstrate Positive Work Attitude**  
   (Vermont Standards: 3.3, 3.10, 3.11, 3.14)

C. **Apply Basic Math and Measurement Skills**  
   (Vermont Standards: 7.6)

D. **Apply Blueprint Reading/Drawing Skills**  
   (Vermont Standards: 1.1, 1.2, 1.4, 5.29, 7.11)

E. **Use Common Hand Tools and Hand Power Tools in Benchwork**  
   (Vermont Standards: 7.6, 7.7, 7.12)

F. **Perform Preventive Maintenance on Building Equipment and Production Machinery**  
   (Vermont Standards: 7.11, 7.17, 7.18, 7.19)

G. **Apply Metals and Materials Knowledge**  
   (Vermont Standards: 7.11, 7.12)

H. **Perform Heat Treatment/Hardness Testing**  
   (Vermont Standards: 7.1, 7.12, 7.16)

I. **Apply Welding Safety Skills**  
   (Vermont Standards: 7.18)

J. **Apply Knowledge of Welding Metallurgy**  
   (Vermont Standards: 7.11, 7.12)

K. **Perform Oxy-fuel Welding and Cutting Tasks**  
   (Vermont Standards: 1.15, 1.22, 3.5, 3.10)

L. **Perform Shielded Metal Arc Welding/Gas Tasks**  
   (Vermont Standards: 1.15, 1.22, 3.5, 3.10, 7.18)

M. **Perform Tasks Using Fasteners**  
   (Vermont Standards: 1.21, 1.22, 7.11, 7.12)
N. Use Coolants and Lubricants
   (Vermont Standards: 1.21, 1.22, 7.11, 7.12)

ELECTRICAL/ELECTRONIC/HVAC/PLUMBING SPECIALIZATION

A. Apply Electrical and Electronic Systems Skills
   (Vermont Standards: 1.18, 1.20, 1.22, 7.7, 7.11, 7.18, 7.19)

B. Apply Air Conditioning, Heating, and Ventilation Skills
   (Vermont Standards: 1.18, 1.20, 1.22, 7.7, 7.11, 7.18, 7.19)

C. Apply Industrial Plumbing Skills
   (Vermont Standards: 1.18, 1.20, 1.22, 7.7, 7.11, 7.18, 7.19)

MACHINE TRADES SPECIALIZATION

A. Apply Drill Press Skills
   (Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

B. Apply Band Saw Skills
   (Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

C. Apply Grinding Wheel Safety Procedures
   (Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

D. Apply Pedestal/Bench Grinder Skills
   (Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

E. Perform Lathe Operations
   (Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

F. Perform Milling Operations
   (Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

G. Perform Surface Grinding Operations
   (Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

POWER MECHANICS SPECIALIZATION

A. Perform Internal Combustion Engine (2-Cycle/4-Cycle) Tasks
   (Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

B. Perform Lubrication System Tasks
   (Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

C. Perform Cooling System Tasks
   (Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

D. Perform Fuel System Tasks
   (Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)
E. Perform Ignition System Tasks
   (Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

F. Perform Power Transmission Tasks
   (Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

G. Perform Hydraulic System Tasks
   (Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

H. Perform Heavy Equipment Operation Tasks
   (Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)
DIRECTIONS

Evaluate the student by checking the appropriate box to indicate the degree of Competency. The rating for each task should reflect employability readiness rather than the grades given in class.

Rating Scale:
0  No exposure
1  Introduced - the student has been exposed through non participatory instruction (e.g. lecture, demonstration, field trip, video).
2  Practiced - the student can perform the task with direct supervision.
3  Entry-Level Competency - the student can perform the task with limited supervision and/or does not perform the task to standard (a typical entry-level performance expectation).
4  Competency - the student consistently performs task to standard with no supervision (on at least two occasions or at instructor’s option).

INDUSTRIAL MECHANICS

GENERAL SKILLS

0 1 2 3 4

A.  Apply Safety Knowledge

*A. 001  Define specific safety terms.

*A.002  Demonstrate the use of proper clothing, safety glasses, aprons, shields and other safety equipment.

*A.003  Know the importance of safety rules (horseplay hazards, misuse of equipment, …).

*A.004  Recognize any unsafe working conditions and practices, reporting them to supervisor.

*A.005  Maintain a clean, safe workstation.

*A.006  Demonstrate knowledge of proper hazardous waste handling and disposal procedures, in accordance with state and federal rules and regulations (“Right to Know” regulations, …).

*A.007  Demonstrate knowledge of proper shop emergency procedures (fire, illness, accident, basic first aid/CPR, … are desirable skills).

B.  Demonstrate Positive Work Attitude

*B.001  Demonstrate growth as a safe, responsible, and disciplined worker.

*B.002  Communicate effectively both orally and in writing.

*B.003  Plan and perform work accurately, neatly and effectively.
*B.004 Demonstrate self-control and adaptability when some planned activity must be changed or fails.

*B.005 Demonstrate citizenship and ability to cooperate by working in a community service project.

**C. Apply Basic Math and Measurement Skills**

*C.001 Compute accurately using addition, subtraction, multiplication, and division processes (whole numbers, decimals, and fractions).

*C.002 Perform measurement tasks using metric and/or English systems.

*C.003 Convert measurement from the metric to the English system (and vice versa) with accuracy.

*C.004 Find and apply mathematical used in mechanical and electrical trades.

*C.005 Recognize units of linear, volume, weight, pressure, temperature, and angle measurement (metric and English).

*C.006 Select correct measurement device for the job.

*C.007 Demonstrate proper care and handling of measuring equipment.

*C.008 Differentiate between specifications and tolerances.

*C.009 Measure to specified tolerances using appropriate instruments and gauges used in the trades.

*C.010 Transfer measurement from print to physical part.

*C.011 Take part in a computer awareness program, including field trips.

**D. Apply Blueprint Reading/Drawing Skills**

*D.001 Define blueprint terminology: a) alphabet of lines, b) basic views, c) special views, and d) common abbreviations and symbols as per American Standards Association.

*D.002 Use prescribed methods of developing and dimensioning a working sketch.

*D.003 Complete visualization exercises.

*D.004 Define major geometric terms and apply geometric principles.

*D.005 Sketch various objects and locate hidden lines, surfaces, and projections.
Vermont Department of Education

*D.006 Visualize and draw three view problems/projections from views.

*D.007 Position multi-view drawings.

*D.008 Identify each type of pictorial drawing.

E. Use Common Hand Tools and Hand Power Tools in Benchwork

*E.001 Define hand tool, power hand tool, and benchwork terms.

*E.002 Identify common hand tools listed in appendix (lit developed by each Area Vocational Center).

*E.003 Demonstrate the safe use of hand tools and power hand tools to perform bench operations, selecting proper tool for job.

*E.004 Maintain and/or sharpen tools while following safety procedures.

F. Perform Preventive Maintenance on Building Equipment and Production Machinery

*F.001 Define preventive maintenance terminology.

*F.002 Use proper electrical and hydraulic “lock out” while working on equipment and machinery.

*F.003 Demonstrate proper lubrication of equipment and machines to manufacturer’s specifications.

*F.004 Demonstrate proper adjustment of machines and equipment (e.g., troubleshoot simple maintenance problems).

*F.005 Demonstrate how to clean and paint equipment.

*F.006 Set up, level, and position machine and equipment.

G. Apply Metals and Materials Knowledge

*G.001 Define terminology of metals, alloys and materials.

*G.002 Identify ferrous and nonferrous materials.

*G.003 Select proper speeds and feeds for the machining of materials.

*G.004 Identify common plastic materials used in industry.

*G.005 Demonstrate knowledge of the compatibility of dissimilar metals.

*G.006 Demonstrate knowledge of metal gauge system.
*G.007 Demonstrate knowledge of common insulating materials used in industry.

*G.008 Select appropriate materials for specific applications.

*G.009 Compare and contrast metal identification systems.

H. Perform Heat Treatment/Hardness Testing

*H.001 Define heat treatment/hardness testing terminology.

*H.002 Perform treatment processes such as: hardening, tempering, annealing and casehardening.

*H.003 Identify various pieces of heat treatment equipment.

*H.004 Explain: steel manufacturer’s heat treatment data and the effects of various heat treatment processes.

*H.005 Perform hardness testing with a file.

*H.006 Perform harness testing by spark (grinder).

*H.007 Perform harness testing machine procedures (Rockwill, Brinell, Scleroscope, …) on flat stock and round stock.

*H.008 Compare, contrast and convert values from one hardness testing method to another.

I. Apply Welding Safety Skills

*I.001 Dress properly to meet industry standard for safety.

*I.002 Control hazardous fume accumulation during welding.

*I.003 Demonstrate how to prevent fires and explosive situations in welding.

*I.004 Explain and demonstrate the safe usage of oxygen, Acetylene, Mapp and inert gases and their related equipment.

J. Apply Knowledge of Welding Metallurgy

*J.001 Demonstrate knowledge of the characteristics of ferrous metals and nonferrous metals.

*J.002 Demonstrate methods of identifying metals: a) spark test, b) oxy-fuel toch test, c) fracture test, d) color test, e) ringing or sound test, f) magnetic test, and g) chip test.
K. **Perform Oxy-Fuel Welding and Cutting Tasks**

*K.001* Set up the oxy-fuel welding equipment using all safety practices, performing leak test and correction procedures: a) soap and water, b) shutting off cylinders.

*K.002* Set up and test the oxy-fuel cutting equipment.

*K.003* Light and adjust the proper flame to oxy-fuel cut.

*K.004* Describe and practice each of the following oxy-fuel cutting processes: a) straight line cut, b) beveling, c) piercing and hole cutting, d) shape cutting, e) gouging, and f) cutting cast iron.

*K.005* Perform basic oxy-fuel welding procedures.

L. **Perform Shielded Metal Arc Welding/Gas Tasks**

*L.001* Identify SMAW power source and equipment.

*L.002* Safely flat position weld to industry standards.

*L.003* Safely horizontal position weld fillets and grooves to industry standards.

*L.004* Safely vertical position weld fillets and grooves to industry standards.

*L.005* Safely set up the GTAW power supply and equipment in accordance with rules and regulations established by the welding industry.

*L.006* Safely start the arc and run a bead; weld in the flat position; weld out of position.

*L.007* Safely perform the following flat welds on aluminum, stainless steel, and mild steel: a) butt, b) lap, and c) tee.

*L.008* Safely perform the following out of position welds on aluminum, stainless steel and mild steel: a) butt, b) lap, and c) tee.

M. **Perform Tasks Using Fasteners**

*M.001* Identify permanent fastener types: a) pop rivet, b) steel/alum rivet, …

*M.002* Identify semi-permanent fastener types: a) bolts, b) screws, c) nails, d) clamps, e) keys, f) turnbuckles, g) clips, h) pins, i) nuts, j) heli-coils, …

*M.003* Identify and/or measure fasteners using thread types: a) USS/Metric, b) length/diameter, c) grading-hardness, d) UNF/UNC, e) head design, f) thread measurement, g) NPT, …

*M.004* Select the appropriate size tap, die, drill, and/or rod.
*M.005 Correctly “chase” old or damaged threads.

*M.006 Accurately and safely drill the required hole for tapping.

*M.007 Use correct counterbore and countersink processes.

*M.008 Demonstrate knowledge of various ways for organizing and staining fasteners.

*M.009 Demonstrate record keeping practices and costs.

N. Use Coolants and Lubricants

*N.001 Demonstrate knowledge of the various types of cutting oils and coolants, understanding their properties, viscosity, heat absorption capabilities, additives, and functions.

*N.002 Safely apply the correct cutting oil or coolant for a specific job.

*N.003 Demonstrate maintenance and cleaning procedures for cooling systems.

*N.004 Understand proper storage and disposal of coolants and lubricants.

*N.005 Understand application of lubricants for industrial and building equipment/machinery maintenance.

0 1 2 3 4

A. Apply Electrical and Electronic Systems Skills

*A.001 Define electrical terminology and basic electronic terminology (including safety terms).

*A.002 Use proper safety equipment with electricity.

*A.003 Recognize any unsafe working conditions and report them to supervisor.

*A.004 Demonstrate familiarity with and use of NEC code book.

*A.005 Understand and apply basic electrical theory and terminology.

*A.006 Identify electrical schematic symbols.

*A.007 Identify AC and/or DC circuits.

*A.008 Determine circuit polarity.

*A.009 Use meters or other instruments to measure ohms, amps, and volts.
A.010 Understand basic transformer theory.

A.011 Safely test internal motor circuits.

A.012 Understand basic alternator/generator theory.

A.013 Measure generator or alternator outputs.

A.014 Identify components of the internal layout of electrical service panels.

A.015 Select the correctly rated wiring materials for the job.

A.016 Understand and apply basic electronic instrumentation and control theory.

B. Apply Air Conditioning, Heating, and Ventilation Skills

B.001 Define air conditioning, heating, refrigeration, and ventilation terms.

B.002 Identify the common environmental systems in use in buildings.

B.003 Identify the basic components of hot water, steam, radiant, storage, and/or air heating systems (electric, oil fired, solar, …).

B.004 Identify the basic components of an air conditioning system.

B.005 Identify the basic components of a ventilation system.

B.006 Identify and understand the application of basic sheet metal tools, machines, and equipment.

B.007 Safely operate basic sheet metal tools, machines, and equipment.

B.008 Understand basic sheet metal lay out (locks, joints, …), selecting proper tools for specific jobs.

B.009 Understand the basic principles of airflow, balancing , and distribution.

B.010 Read and understand HVAC blueprints.

B.011 Understand basic elements of heat gain and heat loss.

B.012 Identify and understand the application of HVAC control systems.

B.013 Participate in a field trip to view a “state of the art” HVAC system.

B.014 Demonstrate knowledge of basic energy conservation techniques and equipment.
B.015 Describe the operation of a heat pump.

C. Apply Industrial Plumbing Skills

*C.001 Identify the most common types of pipe.
*C.002 Be able to measure pipe and tubing accurately.
*C.003 Describe the type of suitable application for each type of pipe.
*C.004 Select the appropriate type and size of pipe or tubing for a specific job.
*C.005 Identify shut-off/gate valves, pressure regulating controls, and solenoid operated controls.
*C.006 Identify the standard types of fittings for pipe and/or tubing applications.
*C.007 Identify the tools associated with iron pipe threading.
*C.008 Safely thread and assemble iron pipes.
*C.009 Safely clean, flux, heat and solder copper pipe and tubing.
*C.010 Safely clean and glue PVC pipes.
*C.011 Safely bend, fit, flare and connect copper and steel tubing.
*C.012 Identify piston, centrifugal, and submersible pumps.
*C.013 Identify and describe operation of pressure cutoff switches and air volume controls.
*C.014 Identify types of water pressure storage systems.
*C.015 Describe the importance of filters and chemical treatment systems.
*C.016 Read and interpret construction piping blueprints.
*C.017 Identify and understand basic piping system design considerations (e.g., support systems, venting, pressure changes, pipe sizing, …).
*C.018 Understand the applications and safety considerations of pipe insulation (e.g., asbestos, foam, …).

Machine Trades Specialization

A. Apply Drill Press Skills

*A.001 Define drill press skills.
Vermont Department of Education

*A.002* Safely perform drill press operations (drilling, tapping, reaming, counterboring, countersinking, spotfacing, and machine finishing, ...).

*A.003* Select and set speeds and feeds for specific jobs.

*A.004* Demonstrate proper use of machinist’s handbook.

*A.005* Lay out center punch and drill to 1/64”.

*A.006* Safely sharpen a drill bit.

**B. Apply Band Saw Skills**

*B.001* Define band saw terminology.

*B.002* Safely perform basic machine maintenance and adjustments.

*B.003* Demonstrate knowledge of types of blades, tooth formation, pitch, gauge width, set and hardness.

*B.004* Identify material to be cut and set proper cutting speed.

*B.005* Safely use horizontal cutoff saw including gang clamping, blade changing, and gauge setting (within 1/16” line) to job specifications.

*B.006* Safely demonstrate proper blade welding procedures.

**C. Apply Grinding Wheel Safety Procedures**

*C.001* Safely ring test wheel.

*C.002* Safely balance grinding wheel.

*C.003* Safely mount and dress a grinding wheel.

*C.004* Correctly adjust work rests and guards.

*C.005* Safely mount (being aware of RPM specifications) and dress a grinding wheel.

**D. Apply Pedestal/Bench Grinder Skills**

*D.001* Define pedestal/bench grinder terminology.

*D.002* Safely grind hand and cutting tools.

**E. Perform Lathe Operations**

*E.001* Define lathe terminology.
E.002 Identify the major components of the lathe and explain their functions.

E.003 Identify specific single-point cutting tool and explain their use.

E.004 Demonstrate the procedures for safely cleaning, lubricating, and maintaining a lathe.

E.005 Safely demonstrate single-point cutting for tool sharpening.

E.006 Safely perform basic lathe operations (facing, straight-turning, shouldering, tabor turning, boring, cut off, …).

E.007 Demonstrate knowledge of speeds and feeds for carbide tooling.

F. Perform Milling Operations

F.001 Define milling terminology.

F.002 Safely perform basic milling machine maintenance.

F.003 Safely perform basic milling machine set-ups.

F.004 Safely perform basic operations (slab, slop, face, straddle, …).

F.005 Select and safely install cutters.

F.006 Select speeds and feeds.

F.007 Select work holding devices.

F.008 Safely mill product to specified tolerances.

F.009 Select mount (rotary table dividing head).

G. Perform Surface Grinding Operations

G.001 Define surface grinding terminology.

G.002 Safely perform basic grinding operations (plunge grinding, angular grinding, cut off grinding, cutter grinding, shoulder grinding, flat grinding, …).

G.003 Select a wheel with correct grain, structure, and bond for a specific job.

G.004 Select feed rates for specific jobs.

G.005 Identify and safely use accessories (toolmaker’s vise, sine bars, …).
A. Perform Internal Combustion Engine (2-Cycle/4-Cycle) Tasks

*A.001 Explain Internal Combustion Engine (2-Cycle/4-Cycle) Tasks.

*A.002 Disassemble two-cycle and four-cycle engines, naming the parts and their functions.

*A.003 Measure engine parts to check specifications and tolerances.

*A.004 Reassemble and safely test-run two-cycle and four-cycle engines.

B. Perform Lubrication System Tasks

*B.001 Identify lubricants and demonstrate a knowledge of types and grades.

*B.002 Safely use lubricants, according to manufacturers’ recommended maintenance procedures and service intervals.

C. Perform Cooling System Tasks

*C.001 Identify specific types of cooling systems and components.

*C.002 Inspect, test, service, and repair cooling systems to manufacturer’s specifications, exercising safety procedures.

D. Perform Fuel System Tasks

*D.001 Demonstrate knowledge of basic theory of fuel/air mixture in fuel systems (diesel, gasoline...).

*D.002 Identify specific methods of fuel/air delivery in a fuel system (turbo charger/natural aspiration/fuel injection).

*D.003 Inspect, service, and repair fuel systems to manufacturer’s specifications while following safety procedures.

E. Perform Ignition System Tasks

*E.001 Demonstrate knowledge of ignition system theory (conventional and electronic).

*E.002 Demonstrate knowledge of the relationship of ignition system components (e.g., coil, condenser, wiring, distributor, spark plugs, contact module, sensor, resistors, spark contact mechanisms, magnetos, glo plugs, ...).

*E.003 Test, repair, and replace components of ignition systems to manufacturers’ specifications while following safety procedures.
F. Perform Power Transmission Tasks

*F.001 Demonstrate knowledge of safety procedures for the maintenance of power trains.

*F.002 Identify components of a basic clutch system and their relationship to each other.

*F.003 Identify drives in the following categories: belt, gear, chain, shaft, hydraulic, and one-way roller clutches.

*F.004 Safely remove, disassemble, clean, lubricate, and re-assemble bearings.

*F.005 Identify the types of bearings found in power transmission systems (e.g., sleeve, roller, ball, needle, pillow block support, flange, …).

*F.006 Describe the proper lubrication procedures for each type of bearing.

*F.007 Describe the difference between sprocket and gear drive.

*F.008 Demonstrate knowledge of the concepts applying to gear and sprocket tooth design (e.g., pitch, number of teeth, gear ratio, backlash, mech, …).

*F.009 Safely lubricate gear and sprocket drive systems.

*F.010 Identify types of belts used in drive systems (e.g., flat belt, v belts, toothed belts, variable speed, …).

*F.011 Safely replace a worn belt, correctly sizing, aligning, and tensioning, to manufacturer’s specifications.

*F.012 Determine the speed and direction of rotation for each gear in a drive system given the input speed, initial rotation, and gear ratios.

G. Perform Hydraulic System Tasks

*G.001 Demonstrate knowledge of hydraulic system maintenance safety procedures.

*G.002 Describe the basic principles of hydraulics.

*G.003 Define specific hydraulic system terms.

*G.004 Demonstrate basic knowledge of hydraulic system principles related to pressure, volume, and flow.

*G.005 Describe the various types of hydraulic pumps and their applications (gear pumps, vane pumps, pistons pumps, variable/fixed displacement pumps.
*G.006 Describe the various types of hydraulic valves and their applications (relief valves, pressure reducing valves, unloading valves, check valves, spool valves, electro-hydraulic valves, flow control valves, …).

*G.007 Demonstrate knowledge of the basic operating principles of cylinders in hydraulic systems.

*G.008 Identify the basic types of filters and seals used in hydraulic systems.

*G.009 Safely disassemble and re-assemble hydraulic systems to manufacturer’s specifications.

*G.010 Describe the purpose accumulators of hydraulic systems.

*G.011 Safely perform the basic maintenance procedures of hydraulic systems including bleeding system, cleaning/flushing, leak prevention, pre-operation checks, ….

*G.012 Determine the proper size and ratings for reservoir and hoses of hydraulic systems.

**H. Perform Heavy Equipment Operation Tasks**

*H.001 Describe heavy equipment operation safety procedures for specific pieces of equipment.

*H.002 List the sequence of procedures for a general maintenance program for specific pieces of heavy equipment, according to manufacturer’s specifications.

*H.003 Safely perform checklist procedures for equipment operation including: oil, water, battery, lights, fuel, safety shield, grease, air pressure, …. 

*H.004 Demonstrate knowledge of heavy equipment instrumentation and components.

*H.005 Safely operate available pieces of heavy equipment.