Industrial Maintenance Technology II

8576 36 weeks / 280 hours

Table of Contents

Acknowledgments ......................................................................................................................................... 1
Course Description ........................................................................................................................................ 2
Task Essentials Table .................................................................................................................................... 2
Curriculum Framework ................................................................................................................................. 4
Applying Basic Construction Safety Standards (Core Safety) ................................................................. 4
Performing Mathematical Calculations Related to Measurement .............................................................. 12
Demonstrating Mechanical Skill with Hand and Power Tools ................................................................. 15
Maintaining Systems ................................................................................................................................... 17
Performing Welding Operations ................................................................................................................. 29
Working with Technical Drawings ............................................................................................................ 30
Practicing Quality Control .......................................................................................................................... 32
SOL Correlation by Task .............................................................................................................................. 34
Appendix: Credentials, Course Sequences, and Career Cluster Information ............................................. 36

Acknowledgments

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Course Description

**Suggested Grade Level:** 11 or 12
**Prerequisites:** 8575

Industrial maintenance technicians repair and maintain commercial or industrial equipment in buildings. Students are taught safety and precision measurement skills and gain hands-on, practical experience in welding, hydraulics, pneumatics, HVAC, electricity, mechanical fundamentals, machine alignment, technical drawings, and quality control.

*As noted in Superintendent's Memo #058-17 (2-28-2017), this Career and Technical Education (CTE) course must maintain a maximum pupil-to-teacher ratio of 20 students to one teacher, due to safety regulations. The 2016-2018 biennial budget waiver of the teacher-to-pupil ratio staffing requirement does not apply.*

**Task Essentials Table**

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.
<table>
<thead>
<tr>
<th>Task Number</th>
<th>8576</th>
<th>Tasks/Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applying Basic Construction Safety Standards (Core Safety)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
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</tr>
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<td></td>
<td>Maintain a safe working environment.</td>
</tr>
<tr>
<td>41</td>
<td></td>
<td>Explain safe working practices around electrical hazards.</td>
</tr>
<tr>
<td>42</td>
<td></td>
<td>Identify emergency first aid procedures.</td>
</tr>
<tr>
<td>43</td>
<td></td>
<td>Identify the types of fires and the methods used to extinguish them.</td>
</tr>
<tr>
<td>44</td>
<td></td>
<td>Demonstrate the use of a fire extinguisher.</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>Identify personal protective equipment (PPE) requirements.</td>
</tr>
<tr>
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<td></td>
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</tr>
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</tr>
<tr>
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</tr>
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<td></td>
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</tr>
<tr>
<td>51</td>
<td></td>
<td>Describe safe scaffolding techniques.</td>
</tr>
<tr>
<td>52</td>
<td></td>
<td>Report injuries.</td>
</tr>
<tr>
<td>53</td>
<td></td>
<td>Report personal, environmental, and equipment safety violations to the appropriate authority.</td>
</tr>
<tr>
<td>54</td>
<td></td>
<td>Earn the OSHA 10 card.</td>
</tr>
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<td></td>
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</tr>
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<td></td>
<td></td>
</tr>
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<td></td>
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</tr>
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<td></td>
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</tr>
<tr>
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<td></td>
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</tr>
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<td></td>
<td></td>
</tr>
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</tr>
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</tr>
<tr>
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<td></td>
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</tr>
<tr>
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<td></td>
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</tr>
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<td></td>
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</tr>
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<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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</tr>
<tr>
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<td></td>
<td>Interpret diagrams and schematics for hydraulic systems.</td>
</tr>
<tr>
<td>68</td>
<td></td>
<td>Install hydraulic system components.</td>
</tr>
<tr>
<td>69</td>
<td></td>
<td>Apply preventive maintenance measures for hydraulic systems.</td>
</tr>
<tr>
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<td></td>
<td>Inspect and troubleshoot hydraulic systems.</td>
</tr>
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<td>Demonstrate knowledge of pneumatic system operation.</td>
</tr>
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</tr>
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<td>8576</td>
<td>Tasks/Competencies</td>
</tr>
<tr>
<td>-------------</td>
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<td>-------------------</td>
</tr>
<tr>
<td>73</td>
<td>✤</td>
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</tr>
<tr>
<td>74</td>
<td>✤</td>
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</tr>
<tr>
<td>75</td>
<td>✤</td>
<td>Inspect and troubleshoot pneumatic systems.</td>
</tr>
<tr>
<td>76</td>
<td>✤</td>
<td>Demonstrate knowledge of compressed air systems.</td>
</tr>
<tr>
<td>77</td>
<td>✤</td>
<td>Demonstrate knowledge of electrical system operation.</td>
</tr>
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</tr>
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</tr>
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</tr>
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</tr>
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</tr>
<tr>
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<td>✤</td>
<td>Demonstrate knowledge of HVAC system operation.</td>
</tr>
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<td>✤</td>
<td>Interpret diagrams and schematics for HVAC systems.</td>
</tr>
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<td>88</td>
<td>✤</td>
<td>Apply preventive maintenance measures for HVAC systems.</td>
</tr>
<tr>
<td>89</td>
<td>✤</td>
<td>Troubleshoot HVAC systems.</td>
</tr>
</tbody>
</table>

### Performing Welding Operations

<table>
<thead>
<tr>
<th>Task Number</th>
<th>8576</th>
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</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>✤</td>
<td>Analyze defects in welds.</td>
</tr>
<tr>
<td>91</td>
<td>○</td>
<td>Perform oxyfuel brazing operations.</td>
</tr>
</tbody>
</table>

### Working with Technical Drawings

<table>
<thead>
<tr>
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<th>8576</th>
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</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>✤</td>
<td>Interpret assembly drawings.</td>
</tr>
<tr>
<td>93</td>
<td>✤</td>
<td>Interpret building diagrams (including site plans).</td>
</tr>
<tr>
<td>94</td>
<td>✤</td>
<td>Develop sketches (including isometric and orthographic).</td>
</tr>
<tr>
<td>95</td>
<td>✤</td>
<td>Compute materials from drawings.</td>
</tr>
<tr>
<td>96</td>
<td>○</td>
<td>Use a CAD program to create sketches.</td>
</tr>
</tbody>
</table>

### Practicing Quality Control

<table>
<thead>
<tr>
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<th>8576</th>
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</tr>
</thead>
<tbody>
<tr>
<td>97</td>
<td>✤</td>
<td>Apply TQM techniques.</td>
</tr>
<tr>
<td>98</td>
<td>✤</td>
<td>Demonstrate knowledge of ISO quality standards.</td>
</tr>
<tr>
<td>99</td>
<td>✤</td>
<td>Maintain inventory.</td>
</tr>
</tbody>
</table>

Legend: ✤ Essential ○ Non-essential ❌ Omitted

### Curriculum Framework

#### Applying Basic Construction Safety Standards (Core Safety)
Task Number 39

Comply with federal, state, and local safety legal requirements, including the Occupational Safety and Health Administration (OSHA), Virginia OSHA (VOSHA), and Environmental Protection Agency (EPA).

Definition

Compliance should include the identification of the Hazard Communication Standard, the information included on Safety Data Sheets (SDS), and the responsibilities of employers and employees under HazCom.

Process/Skill Questions

• Where should hazardous materials be stored?
• What information can be found on an SDS?

Task Number 40

Maintain a safe working environment.

Definition

Maintenance should be ongoing and result in identifying potential hazards on a job site or in the lab, such as unstable or improperly erected scaffolding, electrical hazards, job site debris, improperly stored materials, and air quality hazards and when present, must be remedied by appropriate measures and comply with the school's and instructor's guidelines.

Process/Skill Questions

• What are some examples of job-site hazards?
• Why is it important to use good housekeeping standards on a job site?
• Why is it important to store materials and tools in their proper place?

Task Number 41
Explain safe working practices around electrical hazards.

**Definition**

Explanation includes

- identifying equipment used to test electrical circuits
- describing safe working conditions
- demonstrating safe work habits

according to industry standards and instructor guidelines.

**Process/Skill Questions**

- What are some examples of electrical hazards?
- What are some methods of testing electrical circuits?
- How are electrical hazards discovered and remedied?

**Task Number 42**

Identify emergency first aid procedures.

**Definition**

Identification includes first aid procedures for accidents involving

- body fluids
- electrical injuries
- eye injuries
- falls
- sprains and strain of limbs
- burns

according to standard first aid and school policies.

**Process/Skill Questions**

- How do citizens obtain emergency medical assistance in their own locality?
- What are the contents of a standard first aid kit?
- What are the symptoms of shock?
- What universal precautions should be taken by first aid providers?
Task Number 43

Identify the types of fires and the methods used to extinguish them.

Definition

Identification should include

- classifications of fires (A, B, C, D, and K)
- causes and prevention of fires
- types of extinguishers
- extinguishers associated with types of fires.

Process/Skill Questions

- Why do fires have different classifications, and what are they?
- What is the fire triangle?
- What are the three things needed to start a fire?
- Why is it important to know the classification of a fire when trying to extinguish it?
- Why should extinguishers be inspected, and how often should they be inspected?
- What are the classifications of extinguishers?

Task Number 44

Demonstrate the use of a fire extinguisher.

Definition

Demonstration should include the use of the pull, aim, squeeze, sweep (PASS) method.

Process/Skill Questions

- Why is important to know how to use a fire extinguisher?
- When might you have to use a fire extinguisher while welding?

Task Number 45
Identify personal protective equipment (PPE) requirements.

Definition

Identification should include procedures for donning, wearing, and removing PPE (e.g., eye protection, respirator, hard hat, gloves, safety harness, hearing protection, safety shoes steel-toed/leather boots).

Process/Skill Questions

- What are some dangerous effects of exposure, and how can one significantly prevent these effects?
- Why is wearing jewelry prohibited while in the lab or on the job site?

Task Number 46

Describe ventilation requirements and regulations pertaining to welding procedures and materials.

Definition

Description should include determining

- the ventilation system and heating/cooling system in the work area
- the need for a personal breathing apparatus when welding in confined spaces or using fume extractors.

Process/Skill Questions

- What is your welding shop's ventilation system? What are its components?
- Why should there always be a clean supply of fresh air available?
- How do you decide when you should use a personal breathing apparatus when completing welding tasks?

Task Number 47

Inspect hand and power tools to ensure safety and usability.

Definition

Inspection should include
• verifying that components of machinery (e.g., guards, blades, moving parts, start/stop switches) are in good working condition
• identifying any defects in tools, parts, or functions
• adhering to standard safety procedures (i.e., shop practices and manufacturer's recommendations)
• demonstrating the safe operation and use of all welding equipment, tools, and machines.

Process/Skill Questions

• What are some of the basic power tools used in construction?
• What are the proper actions to take before using a power circular saw?
• Why should a power tool always be grounded?

Task Number 48

Demonstrate lifting and carrying techniques.

Definition

Demonstration involves lifting and carrying materials and equipment based on the principles of

• lifting with legs
• keeping back straight
• holding load close to the body
• getting help if necessary

completed in accordance with government regulations and instructor guidelines.

Process/Skill Questions

• What are some common injuries associated with lifting and carrying?
• What are some devices that assist lifting and carrying?

Task Number 49

Identify types of ladders.

Definition

Identification should include
• wall (straight) ladder
• extension ladder
• roof ladder
• attic ladder
• special-purpose ladders (e.g., "A" ladder, folding ladder, pompier ladder)
• solid beam ladder
• truss beam wood ladder
• aluminum ladder
• wood and aluminum truss ladder
• fiberglass ladder.

Process/Skill Questions

• When would you use a wall ladder? Extension ladder?
• Why is important to know the different types and functions of ladders?

Task Number 50

Demonstrate safe laddering techniques for various types of ladders.

Definition

Demonstration should involve using appropriate conduct and safety procedures while using aluminum ladders (e.g., three-point contact), while carrying ladders (e.g., two people at all times) and erecting and setting ladders.

Process/Skill Questions

• Why are ladders rated for certain weights?
• Why is the apex (highest point) of a step ladder not considered a step?

Task Number 51

Describe safe scaffolding techniques.

Definition
Description should include inspecting settings and identifying and adhering to duty ratings and safety tags.

**Process/Skill Questions**

- How can one determine the safe weight limit of any particular scaffolding?
- In what situations is scaffolding preferred or required?

**Task Number 52**

**Report injuries.**

**Definition**

Report should consist of an immediate oral statement of the job-related or non-job-related injury to the instructor or supervisor, which may be followed by a written confirmation reporting the date, extent of the injury, and circumstances of the incident.

**Process/Skill Questions**

- Why is it important to report injuries?
- What are common reporting procedures?
- Why is it important to report an injury promptly, before leaving the job site?
- What is workers' compensation?
- What are the key components of a report?

**Task Number 53**

**Report personal, environmental, and equipment safety violations to the appropriate authority.**

**Definition**

Report should include

- providing an oral or written statement identifying the violation and the date it was observed
- submitting it to the instructor, supervisor, or local OSHA inspectors.

**Process/Skill Questions**
• What ethical considerations might be involved when reporting coworkers?
• Why is it important to follow reporting procedures?
• What is liability?

Task Number 54
Earn the OSHA 10 card.

Definition

Earning an OSHA 10 card requires completing the formal training program.

Process/Skill Questions

• What are the benefits of earning the OSHA 10 card?
• What is OSHA, and how are its standards validated?
• Why was OSHA established, and how has it evolved?

Task Number 55
Pass the safety exam.

Definition

Passing the safety exam, when complemented with the OSHA 10 card, should allow the instructor to approve the student for working with course materials and equipment.

Process/Skill Questions

• How often should one participate in safety training programs? Why?
• How does insurance impact the requirement of continuous retraining for safety?
• What is workers' compensation?

Performing Mathematical Calculations Related to Measurement
Task Number 56

Compare numbers and calculate ratios.

Definition

Calculations include determining gear ratios (i.e., the ratio of drive to driven members) and pulley speeds. Numbers are compared to determine whether ratios are over- or under-driven.

Process/Skill Questions

- In what situations is it necessary to determine gear ratios?
- How is it determined that ratios are over-driven? Are under-driven?
- What are the consequences of miscalculating pulley speeds?

Task Number 57

Perform algebraic equations.

Definition

Performance demonstrates the ability to use algebra to solve problems related to inventory, time, and production management.

Process/Skill Questions

- What are some examples of using algebra to solve inventory problems?
- How is production management aided by the use of algebra?

Task Number 58

Apply trigonometric functions.

Definition

Application is beneficial for determining things such as

- height of a stack of gauge blocks necessary to achieve a given angle when combined with a sine bar or sine table
• set and run of a pipe fitting problem.

Process/Skill Questions

• What are some examples of trigonometric functions?
• How do trigonometric functions determine the set and run of a pipe fitting problem?

Task Number 59

Use a height gauge and surface plate to layout and measure parts.

Definition

Performance includes setting up and properly using a height gauge, surface plate, and gauge blocks (if necessary) to measure and/or lay out a part as directed.

Process/Skill Questions

Performance includes setting up and properly using a height gauge, surface plate, and gauge blocks (if necessary) to measure and/or lay out a part as directed.

Task Number 60

Use inside micrometers and telescoping gauges.

Definition

Performance includes using an inside micrometer and telescoping gauges with appropriate outside micrometer to

• measure various size borings in engine blocks or other parts
• determine taper and out-of-round conditions compared to nominal bore sizes gleaned from specifications.

Process/Skill Questions

• Why might it be necessary to measure borings?
• What are nominal bore sizes?
Demonstrating Mechanical Skill with Hand and Power Tools

Task Number 61

Cut internal and external threads with hand tools.

Definition

Performance includes

- identification of thread size designations and tap drill sizes
- selection of threads and taps for a given task
- proper drilling and tapping of threads
- identification and correct use of different taps including pipe, starting, plug, and bottoming taps
- identification and correct use of various types of dies to cut and chase threads.

Process/Skill Questions

- In what situations is it necessary to use a hand tool to cut threads?
- How are thread size designations identified?
- What factors influence the selection of thread size?

Task Number 62

Remove damaged screws with easy-outs.

Definition

Removal technique includes

- selecting the tool
- drilling
- applying heat

according to instructor direction.
Process/Skill Questions

- When is it necessary to use an easy-out to remove a damaged screw?
- What safety precautions should be taken when working with easy-outs?
- What are consequences of failure to follow instructor’s direction?

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Task Number 63

Use reciprocating saws, circular saws, and chop saws.

Definition

Usage includes

- selecting the appropriate saw for the desired application
- selecting blades for use on different materials including wood, metal, and masonry
- changing blades and servicing equipment periodically.

Process/Skill Questions

- What factors influence the choice of saw type (i.e., reciprocating, circular, chop)?
- What are consequences of using an inappropriate blade?
- What servicing procedures are necessary to keep blades and saws in good working condition?

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Task Number 64

Use power sheet metal shears.

Definition

Usage includes

- safe operation to cut sheet metal
- adjustment of blades as needed
- routine service of equipment.

Process/Skill Questions

- What procedure should be followed to ensure safe operation of power sheet metal shears?
• How does one determine that blades need adjustment? How are adjustments made?
• How often do power sheet metal shears need to be serviced?

Task Number 65

Use a bench grinder to sharpen punches, chisels, drill bits, and other cutting tools.

Definition

Usage includes

• selecting grind stones for various applications
• sharpening punches, chisels, drill bits, and other cutting tools
• changing and dressing wheels as needed
• inspecting and servicing equipment routinely.

Process/Skill Questions

• What are the levels of variation among grind stones?
• What are consequences of using grind stones to sharpen inappropriate materials?
• What steps are taken to dress grind wheels?

Maintaining Systems

Task Number 66

Demonstrate knowledge of hydraulic system operation.

Definition

Demonstration confirms an understanding of the physical laws governing water flow, phenomena such as hydraulic transmission of force and energy and control of hydraulic energy, and components of hydraulic systems including pumps and valves. The student should also demonstrate an understanding of maintenance measures that ensure trouble-free operation.
Process/Skill Questions

- How do hydraulic systems incorporate the laws of physics into their operation?
- What maintenance measures are necessary to keep hydraulic systems in working order?

Task Number 67

Interpret diagrams and schematics for hydraulic systems.

Definition

Interpretation requires

- knowledge of the meanings of abbreviations and symbols
- comprehension of related mathematics
- understanding of blueprint layout and assembly standards

and includes

- reading and calculating measurements
- determining symbols’ relationships to other elements in the diagram or schematic
- following instructions, specifications, and notes
- to explain the operation of, make material lists for, and troubleshoot the depicted system.

Process/Skill Questions

- What are the consequences of misinterpreting abbreviations and symbols?
- On schematics, how is the direction of low shown for hydraulics?
- How is an orifice shown on a diagram?

Task Number 68

Install hydraulic system components.

Definition

Installation requires the ability to identify system components and their functions and includes

- removing pressure from the system
- removing and installing valves, pumps, and lines
- checking the system for leaks.

Process/Skill Questions
• What precautions should be taken when removing pressure from the system?
• What is the first step when replacing a pressure valve?
• What is used to ensure a non-leak fitting?

Task Number 69

Apply preventive maintenance measures for hydraulic systems.

Definition

Application increases the operational life of the equipment and includes

• an understanding of preventive maintenance’s purpose
• knowledge of which equipment parts require regular checks
• attention to safety issues
• adherence to an analysis guide
• production of an inspection report.

Process/Skill Questions

• What are consequences of failure to regularly clean hydraulic systems?
• How should an analysis guide be incorporated into preventive maintenance?
• What elements should be included in an inspection report?

Task Number 70

Inspect and troubleshoot hydraulic systems.

Definition

Troubleshooting requires a visual inspection of the system to determine a cause of a given problem and includes using a troubleshooting chart and following established procedures to resolve the problem.

Process/Skill Questions

• What specific parts should be examined during inspection of the hydraulic system?
• What is a possible cause of loss of pressure?
How is a troubleshooting chart used during an inspection?

Task Number 71

Demonstrate knowledge of pneumatic system operation.

Definition

Demonstration confirms an understanding of the physical laws governing air flow, phenomena such as pneumatic transmission of force and energy and control of pneumatic energy, and components of pneumatic systems including pumps and valves. The student should also demonstrate an understanding of maintenance measures that ensure trouble-free operation.

Process/Skill Questions

- What are the major parts of a pneumatic system?
- How does an understanding of air flow benefit one when working with pneumatic systems?
- What maintenance measures are required to ensure proper operation of the pneumatic system?

Task Number 72

Interpret diagrams and schematics for pneumatic systems.

Definition

Interpretation requires

- knowledge of the meanings of abbreviations and symbols
- comprehension of related mathematics
- understanding of blueprint layout and assembly standards

and includes

- reading and calculating measurements
- determining symbols’ relationships to other elements in the diagram or schematic
- following instructions, specifications, and notes

to explain the operation of, make material lists for, and troubleshoot the depicted system.
Process/Skill Questions

- What symbols are unique to pneumatic system diagrams?
- What mathematical principles can be applied to the understanding of pneumatic systems?
- How are instructions, specifications, and notes indicated on diagrams and schematics?

Task Number 73

Install pneumatic system components.

Definition

Installation requires the ability to identify system components and their functions and includes

- removing pressure from the system
- removing and installing valves, pumps, and lines
- checking the system for leaks.

Process/Skill Questions

- What preparation is necessary prior to removing valves, pumps, and lines?
- What methods are most effective in checking for leaks?

Task Number 74

Apply preventive maintenance measures for pneumatic systems.

Definition

Application increases the operational life of the equipment and includes

- an understanding of preventive maintenance’s purpose
- knowledge of which equipment parts require regular checks
- attention to safety issues
- adherence to an analysis guide
- production of an inspection report.

Process/Skill Questions

- What are consequences of neglecting to service pneumatic systems?
What safety-related conditions should be looked for during an inspection?

Task Number 75

Inspect and troubleshoot pneumatic systems.

Definition

Troubleshooting requires a visual inspection of the system to determine a cause of a given problem and includes using a troubleshooting chart and following established procedures to resolve the problem.

Process/Skill Questions

- What are some resources for established procedures?
- What methods of inspection are best suited for pneumatic systems?

Task Number 76

Demonstrate knowledge of compressed air systems.

Definition

Demonstration should include an understanding of

- air quality systems (air dryers, filters)
- constant pressure and volume (regulators and pipe sizing).

Process/Skill Questions

- What are some common compressed air systems?
- How does pipe sizing affect air pressure?

Task Number 77

Demonstrate knowledge of electrical system operation.
Definition

Demonstration confirms an understanding of the laws governing electricity; the relationship between voltage, current, and resistance; and circuits and other electrical devices. The student should also demonstrate an understanding of maintenance measures that ensure trouble-free operation.

Process/Skill Questions

- What laws governing electricity must be understood before demonstrating knowledge of electrical systems?
- What maintenance measures are necessary to ensure dependable electrical system operation?

Task Number 78

Interpret diagrams and schematics for electrical systems.

Definition

Interpretation requires

- knowledge of the meanings of abbreviations and symbols
- comprehension of related mathematics
- understanding of blueprint layout and assembly standards

and includes

- identifying components in a circuit
- reading and calculating measurements
- determining symbols’ relationships to other elements in the diagram or schematic
- following instructions, specifications, and notes
- to explain the operation of, make material lists for, and troubleshoot the depicted system.

Process/Skill Questions

- What mathematics principles must be understood to interpret diagrams and schematics for electrical systems?
- How are relationships among elements indicated?

Task Number 79
Apply preventive maintenance measures for electrical systems.

Definition

Application increases the operational life of the equipment and includes

- an understanding of preventive maintenance’s purpose
- knowledge of which equipment parts require regular checks
- attention to safety issues
- adherence to an analysis guide
- production of an inspection report.

Process/Skill Questions

- What safety hazards can be attributed to poorly maintained electrical systems?
- What elements of an electrical system are most likely to fail?

Task Number 80

Inspect and troubleshoot electrical systems.

Definition

Troubleshooting requires a visual inspection of the system to determine a cause of a given problem and includes using a troubleshooting chart and following established procedures to resolve the problem.

Process/Skill Questions

- What are some common methods of inspecting electrical systems?
- How is a troubleshooting chart applied to electrical systems?

Task Number 81

Demonstrate knowledge of mechanical system operation.

Definition
Demonstration confirms an understanding of the physical laws governing mechanical systems, phenomena such as transmission of force and energy and control of energy, and components of mechanical systems. The student should also demonstrate an understanding of maintenance measures that ensure trouble-free operation.

**Process/Skill Questions**

- What role does the control of energy play in the operation of mechanical systems?
- What are the primary components of mechanical systems?

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**Task Number 82**

**Interpret diagrams and schematics for mechanical systems.**

**Definition**

Interpretation requires

- knowledge of the meanings of abbreviations and symbols
- comprehension of related mathematics
- understanding of blueprint layout and assembly standards

and includes

- reading and calculating measurements
- determining symbols’ relationships to other elements in the diagram or schematic
- following instructions, specifications, and notes
- to explain the operation of, make material lists for, and troubleshoot the depicted system.

**Process/Skill Questions**

- What are the consequences of inability to interpret abbreviations and symbols on diagrams and schematics?
- Why is it necessary to determine symbols’ relationships to each other?

---

**Task Number 83**

**Install mechanical system components.**

**Definition**

Installation requires the ability to identify system components and their functions and includes
• preparing the area for installation
• positioning and securing machinery
• aligning components
• connecting system to power source.

Process/Skill Questions

• What are consequences of failure to fully prepare the installation area?
• What equipment should be used to position and secure machinery?
• What precautions should be taken prior to connecting the system to its power source?

Task Number 84

Apply preventive maintenance measures for mechanical systems.

Definition

Application increases the operational life of the equipment and includes

• an understanding of preventive maintenance’s purpose
• knowledge of which equipment parts require regular checks
• attention to safety issues
• adherence to an analysis guide
• production of an inspection report.

Process/Skill Questions

• By how much does regular maintenance extend the life of typical mechanical systems?
• Which parts of a mechanical system require service most often?

Task Number 85

Inspect and troubleshoot mechanical systems.

Definition
Troubleshooting requires a visual inspection of the system to determine a cause of a given problem and includes using a troubleshooting chart and following established procedures to resolve the problem.

**Process/Skill Questions**

- How often should a mechanical system be inspected?
- When is it acceptable to modify established troubleshooting procedures? How does one document the modification?

---

**Task Number 86**

**Demonstrate knowledge of HVAC system operation.**

**Definition**

Demonstration confirms an understanding of the fundamentals of refrigeration, tools and materials and their accepted methods of use, and compressors and other components of compression systems. The student should also demonstrate an understanding of maintenance measures that ensure trouble-free operation.

**Process/Skill Questions**

- What concepts and elements are common to all HVAC systems?
- What equipment is unique to HVAC system service?

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**Task Number 87**

**Interpret diagrams and schematics for HVAC systems.**

**Definition**

Interpretation requires

- knowledge of the meanings of abbreviations and symbols
- comprehension of related mathematics
- understanding of blueprint layout and assembly standards

and includes
- reading and calculating measurements
- determining symbols’ relationships to other elements in the diagram or schematic
- following instructions, specifications, and notes

to explain the operation of, make material lists for, and troubleshoot the depicted system.

**Process/Skill Questions**

- Why is interpretation of a diagram necessary to make a material list?
- How does one incorporate a knowledge of mathematics with the servicing of HVAC systems?

**Task Number 88**

**Apply preventive maintenance measures for HVAC systems.**

**Definition**

Application increases the operational life of the equipment and includes

- an understanding of preventive maintenance’s purpose
- knowledge of which equipment parts require regular checks
- attention to safety issues
- adherence to an analysis guide
- production of an inspection report.

**Process/Skill Questions**

- What are consequences of failure to keep filters clean?
- What are some examples of HVAC components that require regular maintenance?

**Task Number 89**

**Troubleshoot HVAC systems.**

**Definition**

Troubleshooting requires a visual inspection of the system to determine a cause of a given problem and includes using a troubleshooting chart and following established procedures to resolve the problem.

**Process/Skill Questions**
- How does a troubleshooting chart save time when checking a malfunctioning heating or air conditioning system?
- What are four general tasks performed during all HVAC maintenance calls?
- What EPA regulations apply to the repair of HVAC systems?

Performing Welding Operations

Task Number 90

Analyze defects in welds.

Definition

Analysis should include

- recognizing defects
- determining causes of defects
- determining how to repair defects

in accordance with the instructor’s guidelines.

Process/Skill Questions

- What are possible causes of undercut?
- What is overlap?
- What are possible causes of porosity?
- What is the difference between a discontinuity and a defect?

Task Number 91

Perform oxyfuel brazing operations.

Definition

Performance includes the ability to place equipment in operation; perform minor repairs; select proper operating pressures, tips, and filler rods; and perform the following procedures:
• set up and use a manual oxyfuel cutting torch to braze carbon steel
• fusion weld carbon steel sheet metal without filler rod
• weld butt and lap joints on steel sheet metal and tubing with filler rod
• braze single and multipass joints on steel and cast iron.

Process/Skill Questions

• What are the dangers of working with oxygen, and what precautions should be taken?
• What equipment must be changed when the fuel gas type is changed? Why?
• How is the proper cutting tip selected?
• What is the process for selecting a brazing rod?
• What is the difference between welding and brazing?

Working with Technical Drawings

Task Number 92
Interpret assembly drawings.
Definition
Interpretation includes

• identification of parts and associated part numbers
• order of operation in assembly/disassembly
• dissemination of title block information.

Process/Skill Questions

• What information is found on assembly drawings?
• What other types of drawings and documentation are usually associated with assembly drawings?

Task Number 93
Interpret building diagrams (including site plans).
Definition
Interpretation demonstrates knowledge of symbols and schematics used in building drawings and site plans and includes

- identification of systems such as plumbing, HVAC, and electrical
- identification of basic building features such as doors, windows, rooms, hallways, stairs, loading docks
- identification of features such as contour, landscape, traffic issues, drainage, utilities.

Process/Skill Questions

- What are some types of building drawings?
- What kinds of information are found on building drawings?

Task Number 94

Develop sketches (including isometric and orthographic).

Definition

Performance requires knowledge of orthographic projection, demonstrated by developing a three-view sketch of an object using appropriate drafting conventions and symbols such as various line types, dimensioning techniques, and proper views. Performance also requires the ability to

- develop isometric sketches from orthographic views
- sketch both orthographic and isometric views of objects that would solve mechanical problems such as brackets, mounts, parts of mechanisms
- sketch objects from oral descriptions.

Process/Skill Questions

- When might it be necessary to draw sketches?
- When developing new products or processes, what happens after a sketch is made?

Task Number 95

Compute materials from drawings.

Definition

Computation includes
• viewing a drawing of an object or assembly and developing a bill of materials required to fabricate the item
• knowing standard dimensions for given material (e.g., 4’ x 8’ sheets of plywood, 1” round stock x 20’ lengths) and allowance for loss of materials and hardware.

Process/Skill Questions

• How is the amount of material to be ordered for a given job determined?
• How does calculating material fit in with modern “just-in-time” manufacturing methods?

Task Number 96

Use a CAD program to create sketches.

Definition

Usage includes

• developing sketches with basic drawing tools and appropriate geometry
• solving problems such as layout
• designing fitting parts for fabrication.

Process/Skill Questions

• How does a CAD program help to solve design problems?
• In what ways does CAD differ from manual drafting? How are the two similar?

Practicing Quality Control

Task Number 97

Apply TQM techniques.

Definition

Application includes incorporating feedback with the four categories of Total Quality Management (TQM),
• planning (i.e., identifying and researching the problem)
• doing (i.e., developing a solution)
• checking (i.e., confirming results of the solution)
• acting (i.e., documenting results and making recommendations),

to ensure a structured approach to improving the quality of products and services.

Process/Skill Questions

• What are some ways in which TQM techniques can be applied to industrial maintenance?
• How is feedback processed?
• What is the benefit of documenting solution results?

Task Number 98

Demonstrate knowledge of ISO quality standards.

Definition

Demonstration illustrates an understanding of the ways ISO standards can be applied to industrial maintenance.

Process/Skill Questions

• How do ISO standards apply to industrial maintenance practices?
• What is the ISO? How are ISO standards developed?
• How is energy efficiency addressed by ISO standards?

Task Number 99

Maintain inventory.

Definition

Maintaining inventory includes using computerized systems to track data related to

• products
• materials
• equipment
• purchasing
• cataloging
• distribution.
Process/Skill Questions

- What are the consequences not having an inventory management system?
- How can accuracy be ensured when maintaining inventory?
- Why is it important that purchasing and distribution activities be well documented?

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SOL Correlation by Task

<table>
<thead>
<tr>
<th>Task</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comply with federal, state, and local safety legal requirements,</td>
<td>History and Social</td>
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<tr>
<td>including the Occupational Safety and Health Administration (OSHA),</td>
<td>Science: GOVT.1,</td>
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<tr>
<td>Virginia OSHA (VOSHA), and Environmental Protection Agency (EPA).</td>
<td>GOVT.15</td>
</tr>
<tr>
<td>Maintain a safe working environment.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>Explain safe working practices around electrical hazards.</td>
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<tr>
<td>Identify emergency first aid procedures.</td>
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<tr>
<td>Identify the types of fires and the methods used to extinguish them.</td>
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<tr>
<td>Demonstrate the use of a fire extinguisher.</td>
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<tr>
<td>Identify personal protective equipment (PPE) requirements.</td>
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<tr>
<td>Describe ventilation requirements and regulations pertaining to</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>welding procedures and materials.</td>
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<tr>
<td>Inspect hand and power tools to ensure safety and usability.</td>
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<tr>
<td>Demonstrate lifting and carrying techniques.</td>
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<tr>
<td>Identify types of ladders.</td>
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<tr>
<td>Demonstrate safe laddering techniques for various types of ladders.</td>
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<tr>
<td>Describe safe scaffolding techniques.</td>
<td>English: 11.5, 12.5</td>
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<tr>
<td>Report injuries.</td>
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<tr>
<td>Report personal, environmental, and equipment safety violations to</td>
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<td>the appropriate authority.</td>
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<tr>
<td>Earn the OSHA 10 card.</td>
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<tr>
<td>Pass the safety exam.</td>
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<tr>
<td>Compare numbers and calculate ratios.</td>
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<tr>
<td>Perform algebraic equations.</td>
<td>Mathematics: A.4</td>
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<tr>
<td>Apply trigonometric functions.</td>
<td>Mathematics: T.8</td>
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<tr>
<td>Use a height gauge and surface plate to layout and measure parts.</td>
<td>Mathematics: A.3</td>
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<tr>
<td>Use inside micrometers and telescoping gauges.</td>
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<td>Cut internal and external threads with hand tools.</td>
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<td>Remove damaged screws with easy-outs.</td>
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<tr>
<td>Use reciprocating saws, circular saws, and chop saws.</td>
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<tr>
<td>Use power sheet metal shears.</td>
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<tr>
<td>Use a bench grinder to sharpen punches, chisels, drill bits, and</td>
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<td>other cutting tools.</td>
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<td>Demonstrate knowledge of hydraulic system operation.</td>
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</table>
Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- College and Work Readiness Assessment (CWRA+)
- Customer Service Examination
- Customer Service Specialist (CSS) Examination
- EPA Technician Examinations
- ICC Certificates of Completion Examinations
- Industrial Maintenance Mechanics Assessment
- Industrial Technology Maintenance - Level 1 Examinations
- Maintenance Operations Assessment
- Manufacturing Specialist Certification Examination
- Manufacturing Technician Level I Certification Examination
- National Career Readiness Certificate Assessment
- Pre-Manufacturing Technician I (PreMT1) Examination
- Professional Communications Certification Examination
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.

- Industrial Maintenance Technology I (8575/36 weeks, 140 hours)

Career Cluster: Manufacturing

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<td>Maintenance, Installation, and Repair</td>
<td>Safety Engineer</td>
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<td>Manufacturing Production Process Development</td>
<td>Millwright</td>
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<td>Production</td>
<td>Automated Manufacturing Technician</td>
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<tr>
<td>Quality Assurance</td>
<td>Welder</td>
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<td>Production</td>
<td>Quality Control Technician</td>
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