



# HEAVY INDUSTRIAL MAINTENANCE 47.0300.00

## TECHNICAL STANDARDS

An Industry Standards Validation Committee developed and approved these standards on March 26, 2024. The Arizona Career and Technical Education Quality Commission, the validating authority for the Arizona Technical Skills Assessment System, endorsed these technical standards on July 14, 2024.

Note: Arizona's Professional Skills are taught as an integral part of the Heavy Industrial Maintenance program.

**The Technical Skills Assessment for Heavy Industrial Maintenance is available SY2025-2026.**

Note: In this document i.e. explains or clarifies the content and e.g. provides examples of the content that must be taught.

### STANDARD 1.0 INVESTIGATE A CAREER AS A HEAVY INDUSTRIAL MAINTENANCE TECHNICIAN

- 1.1 Describe work performed by a heavy industrial maintenance technician (e.g., troubleshooting, repairing, and maintaining machinery and equipment )
- 1.2 Identify career opportunities for a heavy industrial maintenance technician (i.e., manufacturing maintenance technician, industrial mechanic, maintenance electrician, plant maintenance technician, heavy equipment mechanic, etc.)
- 1.3 Discuss technical skills needed by a heavy industrial maintenance technician (i.e., understanding mechanical electrical, pneumatic, and hydraulic systems; diagnosing problems, replacing parts, and making necessary adjustments; resolving equipment malfunctions, etc.)
- 1.4 Discuss personal characteristics needed by a heavy industrial maintenance technician (i.e., communication skills; time-management and organizational skills, attention to detail, computer and report writing skills)
- 1.5 Describe education and training requirements for a heavy industrial maintenance technician
- 1.6 Explain the purpose and objectives of an apprentice training program for a heavy industrial maintenance technician

### STANDARD 2.0 DEMONSTRATE SAFETY PRACTICES IN THE WORK ENVIRONMENT

- 2.1 Identify common shop hazards that can lead to serious accidents or injuries (e.g., unsafe practices, unsafe acts, and unsafe conditions)
- 2.2 Describe the use and care of personal protective equipment (PPE) (i.e., hard hats, eye and face protection, gloves, safety shoes, hearing protection, proper clothing, etc.)
- 2.3 Describe OSHA and other state and national regulations and programs designed to reduce safety risks and workplace injuries [i.e., proper use of fall protection equipment, proper use of respiratory protection, proper clothing and grooming, the HazCom programs (labels and SDS), etc.]
- 2.4 Identify methods used to establish work zone safety (i.e., danger signs, caution signs, information signs, safety instruction signs, barricades and barriers, etc.)
- 2.5 Describe safety precautions associated with various work areas (e.g., confined spaces, underground work, lockout/tagout procedure, and jobsite safeguards and emergency response procedures)
- 2.6 Maintain a clean work area
- 2.7 Conduct routine safety checks

### STANDARD 3.0 PERFORM BASIC MATH

- 3.1 Convert English to Metric and Metric to English
- 3.2 Use formulas to solve problems
- 3.3 Calculate surface area and volume
- 3.4 Use tables of weights and measurements
- 3.5 Identify and use measuring tools (i.e., tapes, calipers, dividers, gauges, etc.)
- 3.6 Demonstrate the proper and safe use of measuring tools

### STANDARD 4.0 READ AND INTERPRET DRAWINGS, SCHEMATICS, AND MANUALS

- 4.1 Explain the basic layout of a construction blueprint (e.g., title block, lines, abbreviations, and symbols)
- 4.2 Interpret mechanical drawings and electrical schematics
- 4.3 Read equipment manuals that provide instruction for installation, operation, and maintenance guidelines

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- 4.4 Read documents outlining safety procedures, precautions, and protective measures

## **STANDARD 5.0 USE TOOLS AND EQUIPMENT FOR MAINTENANCE AND REPAIR JOBS**

- 5.1 Identify common tools and their applications (i.e., wrenches; hand drivers, pliers, hammers, chisels and punches, files and deburring tools, power tools, drills and drivers, cutters and saws, etc.)
- 5.2 Explain and identify common taps and dies and their application (i.e., threading and cutting rods, pipes, etc.)
- 5.3 Tap holes by hand and cut threads with a die
- 5.4 Explain, set up, and use a pipe threader to join, form, or connect pipe
- 5.5 Explain, set up, and use a drill press
- 5.6 Explain the correct use of cutting fluids
- 5.7 Explain, set up, and use the pedestal grinder
- 5.8 Explain and use hand and hydraulic presses
- 5.9 Measure, cut, and fuse HDPE (high-density polyethylene) pipe
- 5.10 Use, maintain, and store hand tools, power tools, and equipment properly
- 5.11 Identify testing equipment and their application (e.g., tachometer, pyrometers, multimeters, automated diagnostics tools, voltage testers, and stroboscope)

## **STANDARD 6.0 INSTALL, SERVICE, AND MAINTAIN PUMPS**

- 6.1 Identify various pump types (e.g., centrifugal pumps, rotary pumps, reciprocating pumps, metering pumps, and vacuum pumps)
- 6.2 Use correct nomenclature for pump parts (e.g., shaft, casing, sealing, bearings, couplings, section muzzle, and discharge nozzle)
- 6.3 Explain the types and functions of impellers
- 6.4 Explain the types and functions of seals
- 6.5 Define and explain a volute case
- 6.6 Perform calculations required to use pumps safely and efficiently
- 6.7 Explain NPSHR, NPSHA, and efficiency curves
- 6.8 Identify types of pump gauges (e.g., pressure gauges, vacuum gauges, and mechanical pressure gauges)
- 6.9 Connect a pressure gauge for discharge
- 6.10 Connect a vacuum gauge for intake
- 6.11 Make an accurate reading of pump gauges
- 6.12 Use safe and efficient pump maintenance procedures

## **STANDARD 7.0 INSTALL, SERVICE, AND MAINTAIN VALVES**

- 7.1 Identify various types of valves and their associated piping systems (e.g., globe valves, butterfly valves, wafer valves, weir valves, needle valves, and ball valves)
- 7.2 Use correct nomenclature for valve parts (e.g., stem, actuator yoke, packing box, bonnet, cage, seat ring, plug, body, and gaskets)
- 7.3 Explain hand, air, and hydraulic operational methods
- 7.4 Explain the characteristics of flow in different valves (e.g., laminar flow, turbulent flow, and mixing)
- 7.5 Apply principles of proper valve selection for specific applications (e.g., determine fluid types, temperatures, viscosity, gravity, capacity of flow, system pressure, and pressure drop)
- 7.6 Use safe and efficient valve maintenance procedures (e.g., disassemble, inspect and evaluate, reassemble, and employ maintenance)

## **STANDARD 8.0 DEMONSTRATE MATERIAL HANDLING AND HAND RIGGING EQUIPMENT**

- 8.1 Identify common types of materials handling (e.g., manual material handling, mechanical material handling, and automated material handling)
- 8.2 Identify and describe the uses for common rigging hardware and equipment [i.e., jacks, block and tackle, chain hoists, come-alongs (wire rope hand ratchet puller), etc.]
- 8.3 Identify power transmission equipment (i.e., gear-box transmissions, fluid drives, chain drives, couplings, etc.)
- 8.4 Explain the operation and applications of motor-driven equipment used in industrial plants (i.e., portable generators, air compressors, aerial lifts, forklifts, mobile cranes, etc.)
- 8.5 Operate and perform preventive maintenance on portable generators, air compressors, and aerial lifts

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- 8.6 List types of friction (e.g., static, sliding, rolling, and fluid friction)
- 8.7 Compare types, properties, and classifications of lubricants
- 8.8 Identify and use lubrication equipment to apply lubricants
- 8.9 Read and interpret a lubrication chart
- 8.10 Explain OSHA hazard communication pertaining to lubrication

## **STANDARD 9.0 CONDUCT ELECTRICAL MAINTENANCE**

- 9.1 Explain the difference between conductors and insulators
- 9.2 Define the types of measurement (e.g., volt, amps, Ohms, and watts)
- 9.3 Explain the relationship between voltage, current, and resistance
- 9.4 Explain basic characteristics of series and parallel circuits
- 9.5 Use Kirchhoff's Current Law (KCL) to calculate the total and unknown currents in parallel and series-parallel circuits
- 9.6 Use the formula for Ohm's law to calculate voltage, current, and resistance
- 9.7 Identify electricity maintenance tasks (i.e., install wiring, check power plugs and cables, repair or replace damaged equipment, inspect electrical systems for safety, etc.)
- 9.8 Identify electrical equipment and machines (e.g., control panels, electrical control systems, and motors to perform repairs, installations, and maintenance)
- 9.9 Identify electrical tools and equipment test instruments (e.g., battery testers, voltage testers, wire tracers, outlet testers, circuit testers, multimeters, oscilloscopes, and generators)
- 9.10 Install, repair, maintain, and dismantle electrical instruments and equipment
- 9.11 Maintain and properly store electrical tools (e.g., cool down heated tools, clean regularly, lubricate, sharpen bits and blades, calibrate, replace worn parts, and battery care)

## **STANDARD 10.0 ANALYZE INDUSTRIAL HYDRAULICS**

- 10.1 Identify the principles of hydraulics (e.g., pressure, force, and area)
- 10.2 Identify the components of a hydraulic system and explain their function (i.e., reservoir, hydraulic pump, hydraulic valve, actuators, filters, accumulator, etc.)
- 10.3 Review a hydraulic schematic drawing
- 10.4 Identify problems related to hydraulic systems (e.g., noise, elevated temperature, and slow or erratic operation)
- 10.5 Identify common causes of hydraulic problems (e.g., air and water contamination, fluid level, and temperature issues)
- 10.6 Identify examples of common industrial applications of hydraulics (e.g., cranes, forklifts, jacks, and pumps)
- 10.7 Install and maintain tubing and hose systems
- 10.8 Install and maintain valves and piping system protection
- 10.9 Perform hydraulics calculations (e.g., force, piston area, pipe requirements, horsepower and torque, and velocity and flow)
- 10.10 Explain hydraulics safety

## **STANDARD 11.0 ANALYZE PNEUMATIC SYSTEMS**

- 11.1 Explain a pneumatic system and how it works (e.g., uses gas or pressurized air to move cylinders and motors or other mechanical parts)
- 11.2 Explain the physical characteristics of gases
- 11.3 Explain compressing gases
- 11.4 Explain the pneumatic transmission of energy
- 11.5 Explain the principles of compressor operation
- 11.6 Explain compressed-air treatment
- 11.7 Identify and explain pneumatic system components and symbols
- 11.8 Explain pneumatic system safety

## **STANDARD 12.0 PERFORM WELDING REPAIR AND FABRICATION**

- 12.1 Explain welding as part of the fabrication process
- 12.2 Identify and explain welding/cutting processes [e.g., Metal Arc Welding (MIG), Gas Tungsten Arc Welding (TIG), and Shielded Metal Arc Welding SMAW]
- 12.3 Identify and explain welding/joining processes (e.g., welding, riveting, bolting, brazing, and soldering)
- 12.4 Identify and explain types of welding positions (e.g., flat, horizontal, vertical, and overhead)

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- 12.5 Identify and explain welding joints used in welding repair (e.g., butt joint, lap joint, T-joint, edge joint, and corner joint)
- 12.6 Identify measuring and layout tools used by welders (e.g., framing square, carpenter's square, cabinet maker's square, combination square, torpedo level, and builder's level)
- 12.7 Explain the oxyacetylene gas welding process
- 12.8 Explain how to perform a tensile stress test of a weld
- 12.9 Complete a welding cut (e.g., measure welding cut, set up equipment, produce cut, test accuracy of cut, and shutdown equipment)
- 12.10 Demonstrate a welding joint (e.g., set up equipment, produce weld, evaluate bead disposition, and cut a tensile test sample and evaluate results)
- 12.11 Explain welding safety practices, including PPE

## **STANDARD 13.0 PERFORM MACHINERY MAINTENANCE AND TROUBLESHOOTING**

- 13.1 Use resources to understand equipment
- 13.2 Use maintenance history to understand equipment
- 13.3 Define operation requirements for mechanical equipment
- 13.4 Use root cause analysis to analyze mechanical failure
- 13.5 Schedule preventative maintenance
- 13.6 Prepare and submit maintenance reports