

COMPETENCY-BASED OCCUPATIONAL FRAMEWORK FOR REGISTERED APPRENTICESHIP

Industrial Maintenance Technician

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The nonprofit Urban Institute is dedicated to elevating the debate on social and economic policy. For nearly five decades, Urban scholars have conducted research and offered evidence-based solutions that improve lives and strengthen communities across a rapidly urbanizing world. Their objective research helps expand opportunities for all, reduce hardship among the most vulnerable, and strengthen the effectiveness of the public sector.

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Competency-Based Occupational Frameworks

The Urban Institute, under contract by the U.S. Department of Labor, has worked with employers, subject matter experts, labor unions, trade associations, credentialing organizations and academics to develop Competency-Based Occupational Frameworks (CBOF) for Registered Apprenticeship programs. These frameworks defined the **purpose** of an occupation, the **job functions** that are carried out to fulfill that purpose, the **competencies** that enable the apprentice to execute those job functions well, and the **performance criteria** that define the specific knowledge, skills and personal attributes associated with high performance in the workplace. This organizational hierarchy – Job Purpose – Job Functions – Competencies – Performance Criteria – is designed to illustrate that performing work well requires more than just acquiring discrete knowledge elements or developing a series of manual skills. To perform a job well, the employee must be able to assimilate knowledge and skills learned in various settings, recall and apply that information to the present situation, and carry out work activities using sound professional judgement, demonstrating an appropriate attitude or disposition, and achieving a level of speed and accuracy necessary to meet the employer’s business need.

The table below compares the terminology of Functional Analysis with that of traditional Occupational Task Analysis to illustrate the important similarities and differences. While both identify the key technical elements of an occupation, Functional Analysis includes the identification of behaviors, attributes and characteristics of workers necessary to meet an employer’s expectations.

Framework Terminology	Traditional Task Analysis Terminology
Job Function – the work activities that are carried out to fulfill the job purpose	Job Duties – roles and responsibilities associated with an occupation
Competency – the actions an individual takes and the attitudes he/she displays to complete those activities	Task – a unit of work or set of activities needed to produce some result
Performance Criteria – the specific knowledge, skills, dispositions, attributes, speed and accuracy associated with meeting the employer’s expectations	Sub Task – the independent actions taken to perform a unit of work or a work activity

Although designed for use in competency-based apprenticeship, these Competency-Based Occupational Frameworks also support time-based apprenticeship by defining more clearly and precisely apprentice is expected to learn and do during the allocated time-period.

CBOFs are comprehensive in to encompass the full range of jobs that may be performed by individuals in the same occupation. As employers or sponsors develop their individual apprenticeship programs, they can extract from or add to the framework to meet their unique organizational needs.

Components of the Competency-Based Occupational Framework

Occupational Overview: This section of the framework provides a description of the occupation including its purpose, the setting in which the job is performed and unique features of the occupation.

Work Process Schedule: This section includes the job functions and competencies that would likely be included in an apprenticeship sponsor’s application for registration. These frameworks provide a point of reference that has already been vetted by industry leaders so sponsors can develop new programs knowing that they will meet or exceed the consensus expectations of peers. Sponsors maintain the ability to customize their programs to meet their unique needs, but omission of a significant number of job functions or competencies should raise questions about whether or not the program has correctly identified the occupation of interest.

Cross-cutting Competencies: These competencies are common among all workers, and focus on the underlying knowledge, attitudes, personal attributes and interpersonal skills that are important regardless of the occupation. That said, while these competencies are important to all occupations, the relative importance of some versus is others may change from one occupation to the next. These relative differences are illustrated in this part of the CBOF and can be used to design pre-apprenticeship programs or design effective screening tools when recruiting apprentices to the program.

Detailed Job Function Analysis: This portion of the framework includes considerable detail and is designed to support curriculum designers and trainers in developing and administering the program. There is considerable detail in this section, which may be confusing to those seeking a more succinct, higher-level view of the program. For this reason, we recommend that the Work Process Schedule be the focus of program planning activities, leaving the detailed job function analysis sections to instructional designers as they engage in their development work.

- a. **Related Technical Instruction:** Under each job function appears a list of foundational knowledge, skills, tools and technologies that would likely be taught in the classroom to enable the apprentice’s on-the-job training safety and success.

- b. Performance Criteria: Under each competency, we provide recommended performance criteria that could be used to differentiate between minimally, moderately and highly competent apprentices. These performance criteria are generally skills-based rather than knowledge-based, but may also include dispositional and behavioral competencies.

Using the Competency-Based Occupational Framework to Develop a Registered Apprenticeship Program

When developing a registered apprenticeship program, the Work Process Schedule included in this CBOF provides an overview of the job functions and competencies an expert peer group deemed to be important to this occupation. The Work Process Schedule in this document can be used directly, or modified and used to describe your program content and design as part of your registration application.

The more detailed job function analysis sections of the framework may be shared with Related Technical Instruction providers and so that they can develop or identify courses that have learning objectives that support the foundational knowledge and skills upon which on-the-job competencies can be built. This section can also be useful to workplace trainers and evaluators since it provides additional detail about the performance criteria that could be used to both instruct apprentices and assess their level of competency throughout the program.

Industrial Maintenance Technician Occupational Overview

Occupational Purpose and Context

Industrial Maintenance Technicians work in the private sector and are critical to ensure the smooth and reliable operation of the industrial plants and equipment in their industry. They set out to maintain and repair manufacturing equipment. They help to ensure through the work that they do, that industrial machinery and equipment is maintained at the highest possible level, ensuring the productivity and safety of the entire production team.

Potential Job Titles

Electrical and Electronics Repairers; Commercial and Industrial Equipment Mechanics; Industrial Machinery Mechanics; Maintenance Workers, Machinery; Maintenance and Repair Workers, General; and Installation, Maintenance, and Repair Workers.

Attitudes and Behaviors

Industrial Maintenance Technicians should have well developed critical and autonomous thinking skills to solve problems quickly, strong interpersonal skills including good listening skills and cultural sensitivity, the ability to identify the important details to focus on, the ability to understand the implications of new information, the capability to problem solve and make decisions, the ability to execute tasks in a specific order to obtain an outcome, the ability to pay attention to specifics or details including documenting them and staying focused despite distractions, the ability to combine pieces of information to form general rules or conclusions, and the ability to arrange objects or actions in an order or pattern related to a specific rule or set of rules.

Apprenticeship Prerequisites

Some apprenticeship programs may require apprentices to pass drug testing prior to commencing the apprenticeships. Other programs may require apprentices to possess a driver’s license.

Occupational Pathways

Industrial Maintenance Technicians can enter a variety of high-tech jobs that include: maintaining, troubleshooting and improving complex machines and industrial systems, such as conveying systems, multi-axis machines, robotic welding arms, and hydraulic lifts.

Certifications, Licensure and Other Credential Requirements

CREDENTIAL	Offered By	Before, During or After Apprenticeship
Maintenance Operations		
Basic Mechanical Systems		
Basic Hydraulic Systems		
Basic Pneumatic Systems		
Electrical Systems		
Electronic Control Systems		
Process Control Systems		
Maintenance Welding		
Maintenance Piping		

Job Functions

JOB FUNCTIONS		Core or Optional
1.	Operates in the workplace in a safe and effective manner	Core
2.	Monitors, troubleshoots, installs, and repairs basic mechanical systems	Core
3.	Monitors, troubleshoots, installs, and repairs basic hydraulic systems	Core
4.	Monitors, troubleshoots, installs, and repairs basic pneumatic systems	Core
5.	Monitors, troubleshoots, installs, and repairs electrical systems	Core
6.	Monitors, troubleshoots, installs, and repairs electronic and process control systems	Core
7.	Performs maintenance welding to manufacture or repair parts, equipment, and other materials	Core
8.	Installs, removes, repairs, and replace piping systems	Core

Stackable Programs

This occupational framework is designed to link to the following additional framework(s) as part of a career laddering pathway.

Stackable Programs	Base or Higher Level	Stacks on top of
1.	Base Program	
2.		
3.		
4.		

Options and Specializations

The following options and specializations have been identified for this occupation. The Work Process Schedule and individual job function outlines indicate which job functions and competencies were deemed by industry advisors to be optional.

Options and Specializations	Option	Specialization
Electrical and Electronics Repairers		
Commercial and Industrial Equipment Mechanics		
Industrial Machinery Mechanics		
Machinery Maintenance Workers		
General Maintenance and Repair Workers		
Installation, Maintenance, and Repair Workers		

Levels

Industry advisors have indicated that individuals in this occupation may function at different levels, based on the nature of their work, the amount of time spent in an apprenticeship, the level of skills or knowledge mastery, and the degree of independence in performing the job or supervisory/management responsibilities.

Level	Distinguishing Features	Added Competencies	Added Time Requirements
1	Operator/Technician		
2	Machinist		
3	Troubleshooter		
4	Supervisor		

Work Process Schedule

WORK PROCESS SCHEDULE		ONET Code: 49.9041.00	
Industrial Maintenance Technician		RAPIDS Code: 0308HY	
JOB TITLE: Industrial Maintenance Technician			
LEVEL:		SPECIALIZATION:	
STACKABLE PROGRAM <input type="checkbox"/> yes <input type="checkbox"/> no			
BASE OCCUPATION NAME:			
Company Contact: Name			
Address:		Phone	Email
Apprenticeship Type: <input type="checkbox"/> Competency-Based <input type="checkbox"/> Time-Based <input type="checkbox"/> Hybrid		Prerequisites	
JOB FUNCTION 1: Operates in the workplace in a safe and effective manner			
Competencies	Core or Optional	RTI	OJT
A. Adheres to safety, health, and environmental rules and regulations	Core		
B. Performs machine operation, including startup, emergency, and normal shutdown and manual functions to effectively and safely meet production and maintenance requirements (with operator present)	Core		
C. Monitors machine operation and verifies that performance meets production requirements	Core		
D. Locates, interprets, and stores machine operation and maintenance documentation	Core		
E. Performs planned and unscheduled machine maintenance procedures in accordance with a company-approved maintenance plan	Core		

JOB FUNCTION 2: Monitors, troubleshoots, installs, and repairs basic mechanical systems			
Competencies	Core or Optional	RTI	OJT
A. Adheres to mechanical power transmission safety rules	Core		
B. Uses dimensional measurement tools properly to inspect dimensions of shafts and other components	Core		
C. Safely examines, troubleshoots and repairs power transmission	Core		
D. Aligns and adjusts gear drives	Core		
E. Installs, aligns and adjusts a pillow block bearing	Core		
F. Lubricates equipment using correct lubricants and as recommended by manufacturer's guidance	Core		
G. Performs a preventive maintenance procedure for a given machine to extend machine life and minimize downtime	Core		
H. Performs predictive maintenance on a given machine to extend machine life and minimize downtime	Core		
I. Reads and interprets technical drawings of parts and assemblies with tolerances and basic GD&T	Core		
J. Uses hand tools to inspect, adjust/tighten and assemble/disassemble equipment and support preventive maintenance, inspection and troubleshooting activities	Core		
K. Uses hoists and other tools to safely handle and move parts and equipment	Core		
L. Selects and uses troubleshooting methodologies to find malfunctions in machine systems to return the system to reliable, productive use in the shortest time possible	Core		
JOB FUNCTION 3: Monitors, troubleshoots, installs, and repairs basic hydraulic systems			
Competencies	Core or Optional	RTI	OJT
A. Adheres to fluid power systems safety rules while understanding safety, health, and environmental rules and regulations	Core		
B. Interprets basic fluid power schematics and identifies schematic symbols, process flow and operation of the components and systems	Core		
C. Starts up and shuts down a hydraulic system and adjusts system pressure using a fixed displacement pump	Core		
D. Adjusts hydraulic actuator speed using a flow control valve	Core		
E. Services a hydraulic filter to maximize hydraulic fluid cleanliness	Core		

F. Adds, changes and properly disposes of waste hydraulic fluid	Core		
G. Installs hydraulic conductors	Core		
H. Installs and tests components in a basic hydraulic circuit	Core		
I. Troubleshoots a basic hydraulic circuit or rotary actuator circuit	Core		
JOB FUNCTION 4: Monitors, troubleshoots, installs, and repairs basic pneumatic systems			
Competencies	Core or Optional	RTI	OJT
A. Adheres to fluid power systems safety rules	Core		
B. Adjusts pneumatic system branch and actuator speed operating pressure using a regulator	Core		
C. Services a pneumatic filter through inspection, drainage, and changes	Core		
D. Services a pneumatic lubricator through inspection, fills, and adjustments	Core		
E. Installs, fills, and adjusts pneumatic conductors	Core		
F. Starts up and shuts down a reciprocating air compressor and adjusts operating pressure	Core		
G. Installs and tests the operation of components in a basic pneumatic linear or rotary circuit given a schematic	Core		
H. Installs and tests components in a pneumatic circuit that uses vacuum generators given a schematic	Core		
I. Troubleshoots a basic pneumatic circuit	Core		
JOB FUNCTION 5: Monitors, troubleshoots, and repairs electrical systems			
Competencies	Core or Optional	RTI	OJT
A. Adheres to electrical power and control systems safety rules for electrical power and control systems	Core		
B. Interprets electrical control and power schematics to ensure the operation of the components and system	Core		
C. Adjusts limit switches and electronic sensors	Core		
D. Measures voltage, current and resistance in an electrical circuit to verify system operation and power levels	Core		
E. Selects, installs, and tests fuses and circuit breakers	Core		
F. Installs and tests DC electric motors in a manual control circuit	Core		
G. Installs and tests AC electric motors in a manual control circuit	Core		

H. Installs and tests electrical relay control components and circuits	Core		
I. Installs and tests electro-fluid power components and circuits	Core		
J. Tests and repairs machine electrical ground	Core		
K. Troubleshoots an electrical motor relay control circuit	Core		
L. Troubleshoots a solenoid-operated fluid power relay control circuit	Core		
M. Replaces electrical control wiring using terminal attachment	Core		
N. Replaces electrical control wiring using solder attachment	Core		
O. Installs, examines, repairs, and replaces transformers	Core		
JOB FUNCTION 6: Monitors, troubleshoots, installs, and repairs electronic and process control systems			
Competencies	Core or Optional	RTI	OJT
A. Adheres to safety, health, and environmental rules and regulations for electronic power and control systems	Core		
B. Connects and tests a DC power supply to ensure proper operation	Core		
C. Installs and tests solid-state AC and DC discrete and analog relays	Core		
D. Installs and tests analog electronic sensors and signal conditioning equipment	Core		
E. Adjusts and repairs AC drive to control motor speed and torque	Core		
F. Transfers programs to programmable controller using a PC	Core		
G. Creates a basic PLC ladder-style program using internal and external contacts, timers, counters, non-retentive output coils, internal coils, subroutines, conditional commands and math commands	Core		
H. Installs and tests basic PLC components that uses a ladder logic program to interface to a hardware component	Core		
I. Performs basic troubleshooting of PLC and controlled components	Core		
JOB FUNCTION 7: Performs maintenance welding to manufacture or repair parts, equipment, and other materials			
Competencies	Core or Optional	RTI	OJT
A. Adheres to safety, health, and environmental rules and regulations for welding	Core		

B. Uses an acetylene torch properly while using appropriate safety equipment and precautions to cut steel parts	Core		
C. Performs basic welding and achieves necessary strength, resilience, shape and size requirements	Core		
D. Prepares parts to be welded including degreasing, cleaning, grinding and inspecting	Core		
E. Uses SMAW Welder to make basic welds on flat stock	Core		
F. Uses GMAW Welder to make basic welds on flat stock	Core		
G. Inspects welds for integrity and functionality	Core		
H. Uses plasma cutter to cut flat stock	Core		
JOB FUNCTION 8: Installs, removes, repairs, and replaces piping systems			
Competencies	Core or Optional	RTI	OJT
A. Adheres to safety, health and environmental rules and regulations for piping systems	Core		
B. Interprets basic piping schematics including specifications and fittings	Core		
C. Identifies and selects correct piping materials	Core		
D. Accurately measures, cuts and prepares piping for installation	Core		
E. Installs and tests piping systems	Core		

Related Technical Instruction Plan

COURSE NAME	Course Number
	Hours
LEARNING OBJECTIVES	
COURSE NAME	Course Number
	Hours
LEARNING OBJECTIVES	
COURSE NAME	Course Number
	Hours
LEARNING OBJECTIVES	
COURSE NAME	Course Number
	Hours
LEARNING OBJECTIVES	

LEARNING OBJECTIVES

Large empty grey rectangular area for entering learning objectives.

COURSE NAME

Course Number

Hours

LEARNING OBJECTIVES

Large empty grey rectangular area for entering learning objectives.

Cross-Cutting Competencies

COMPETENCY**		0	1	2	3	4	5	6	7	8
Personal Effectiveness	Interpersonal Skills	0	1	2	3	4	5	6	7	8
	Integrity	0	1	2	3	4	5	6	7	8
	Professionalism	0	1	2	3	4	5	6	7	8
	Initiative	0	1	2	3	4	5	6	7	8
	Dependability and Reliability	0	1	2	3	4	5	6	7	8
	Adaptability and Flexibility	0	1	2	3	4	5	6	7	8
	Lifelong Learning	0	1	2	3	4	5	6	7	8
Academic	Reading	0	1	2	3	4	5	6	7	8
	Writing	0	1	2	3	4	5	6	7	8
	Mathematics	0	1	2	3	4	5	6	7	8
	Science & Technology	0	1	2	3	4	5	6	7	8
	Communication	0	1	2	3	4	5	6	7	8
	Critical and Analytical Thinking	0	1	2	3	4	5	6	7	8
	Basic Computer Skills	0	1	2	3	4	5	6	7	8
Workplace	Teamwork	0	1	2	3	4	5	6	7	8
	Customer Focus	0	1	2	3	4	5	6	7	8
	Planning and Organization	0	1	2	3	4	5	6	7	8
	Creative Thinking	0	1	2	3	4	5	6	7	8
	Problem Solving & Decision Making	0	1	2	3	4	5	6	7	8
	Working with Tools & Technology	0	1	2	3	4	5	6	7	8
	Checking, Examining & Recording	0	1	2	3	4	5	6	7	8
	Business Fundamentals	0	1	2	3	4	5	6	7	8
	Sustainable	0	1	2	3	4	5	6	7	8
	Health & Safety	0	1	2	3	4	5	6	7	8

**Cross-cutting competencies are defined in the Competency Model Clearinghouse:

<https://www.careeronestop.org/CompetencyModel/competency-models/building-blocks-model.aspx>

Cross-Cutting Competencies identify transferable skills – sometimes called “soft skills” or “employability skills” – that are important for workplace success, regardless of a person’s occupation. Still, the relative importance of specific cross-cutting competencies differs from occupation to occupation. The Cross-Cutting Competencies table, above, provides information about which of these competencies is most important to be successful in a particular occupation. This information can be useful to employers or intermediaries in screening and selecting candidates for apprenticeship programs, or to pre-apprenticeship providers that seek to prepare individuals for successful entry into an apprenticeship program.

The names of the cross-cutting competencies come from the U.S. Department of Labor’s Competency Model Clearinghouse and definitions for each can be viewed at <https://www.careeronestop.org/CompetencyModel/competency-models/building-blocks-model.aspx>.

The scoring system utilized to evaluate the level of competency required in each cross cutting skill aligns with the recommendations of the Lumina Foundation’s Connecting Credentials Framework. The framework can be found at: <http://connectingcredentials.org/wp-content/uploads/2015/05/ConnectingCredentials-4-29-30.pdf>.

Detailed Job Functions

JOB FUNCTION 1: Operates in the workplace in a safe and effective manner

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> • OSHA safety requirements • NIOSH safety requirements • EPA safety regulations • Common industrial hazards and effective mitigation strategies • 6S Program for maintaining clean and safe workplace • Functions and specifications of equipment • Types of common equipment malfunctions • Total preventive maintenance techniques - predictive and preventive maintenance techniques • Lifting and moving devices such as hoists, carts, lifts, jacks and dollies • Functionality of fasteners, force, torque, dynamic and static torques, press fits, assembly tolerances • Basic physics - force, center of gravity, force vectors, rated load, crush force (load charts) 	<ul style="list-style-type: none"> • LOTO Practices • Job safety analysis • Troubleshooting using inductive and deductive reasoning • Interpreting technical drawings • Create predictive and preventive maintenance plan • Checking and changing fluids, filters, gaskets, etc. • English to metric conversions (and vice versa) 	<ul style="list-style-type: none"> • Personal protective devices • Material safety data sheets • Fire detectors and extinguishers • Pressure gauges • Flow meters • Human machine interface devices • Temperature gauges, voltage and current meters • Fasteners, washers, pins, nuts, locking devices • Hand tools - wrenches, screwdriver, drill, socket set, pliers, clamps

Competency A: Adheres to safety, health, and environmental rules and regulations	Core or Optional
PERFORMANCE CRITERIA	
1. Identifies roles and responsibilities for safety, health, and environment	Core
2. Adheres to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace	Core

3. Identifies and recognizes common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)	Core
4. Performs lockout/tagout (LOTO) process and tests to ensure a zero energy state	Core
5. Uses at all times appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears)	Core
6. Reviews material safety data sheets and follows appropriate use, storage, disposal and accidental exposure directions	Core
7. Uses proper fall protection strategies when working at heights and using ladders, scaffolding and lifts	Core
8. Employs preventive methods to prevent or remedy hazardous situations (includes following guidelines to prevent spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid)	Core
9. Performs job safety analyses, as needed	Optional
10. Employs 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety) to maintain cleanliness and safety of workplace	Core
11. Selects, installs and inspects fire extinguishers ensuring that grade aligns with materials in use	Core
Competency B: Performs machine operation, including startup, emergency and normal shutdown and manual functions to effectively and safely meet production and maintenance requirements (with operator present)	Core or Optional
PERFORMANCE CRITERIA	
1. Correctly uses safety checklist to make sure equipment is ready to come online, that safety devices are operation and that machine interlocks are functioning properly	Core
2. Correctly identifies machine malfunction	Core
3. Follows company's standard operating procedures	Core
4. Works with operations staff to start and stop an operation	Core
5. Properly shuts down machines during routine operations, when a malfunction occurs or in the event of an emergency	Core
6. Performs lock out process properly and reliably	Core
Competency C: Monitors machine operation and verifies that performance meets production requirements	Core or Optional
PERFORMANCE CRITERIA	
1. Confirms with operator that machine is operating within specifications	Core
2. Uses 5 senses to observe machine operation and vibration to determine if it is operating correctly and recognizes symptoms of malfunctions	Core

3. Evaluates operator use of correct operation procedure	Core
4. Looks for leaks, dirt, and loose connections	Core
5. Reads pressure gauges, flow meters, fluid levels, temperature gauges, voltages and current	Core
6. Uses an HMI to monitor the machine	Core
7. Compares machine readings with machine documentation and performance specifications to determine if machine is performing within specifications	Core
8. Records machine operation history in a manual log or computer database	Core
Competency D: Locates, interprets, and stores machine operation and maintenance documentation	Core or Optional
PERFORMANCE CRITERIA	
1. Properly stores machine operation and maintenance documents so it is accessible to the maintenance technicians and operators	Core
2. Uses and maintains machine operation manuals; follows standard operating procedures for identifying safety requirements and features, performance specifications and startup/shutdown procedures	Core
3. Maintains and references spare parts lists, vendor sources and maintenance procedures for a given machine	Core
4. Reviews maintenance logs, computer-based and manual, for a given machine	Core
5. Reviews machine operation history logs, computer-based and manual, for a given machine	Core
6. Reviews machine operation history from an HMI database for a given machine	Core
7. Tracks machine lubrication and preventive maintenance schedules from company or machine manufacturer documentation and performs service at recommended intervals	Core
Competency E: Performs planned and unscheduled machine maintenance procedures in accordance with a company-approved maintenance plan	Core or Optional
PERFORMANCE CRITERIA	
1. Applies concept of total productive maintenance (TPM) - combination of preventive, predictive, and total company buy-in	Core
2. Recognizes benefits and limitations of preventive maintenance and predictive maintenance	Core
3. Uses company procedures to inform production personnel of maintenance to be done on a machine	Core
4. Uses CMMS (computer maintenance management system) system	Core
5. Determines when a work order is needed	Core

6. Identifies and performs the steps to perform an unscheduled and planned maintenance procedure	Core
7. Applies the concept of autonomous maintenance - wherein operator performs cleaning, basic adjustments and preventive maintenance	Core
8. Applies elements of a comprehensive maintenance plan	Core
9. Applies methods to eliminate unplanned maintenance events	Core
10. Identifies and applies planned and unplanned maintenance procedures	Core
11. Explains how to read, interpret, and resolve work order	Core

JOB FUNCTION 2: Monitors, troubleshoots, installs, and repairs basic mechanical systems

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> • NIOSH safety requirements • EPA safety regulations • Common industrial hazards and effective mitigation strategies • Functions and specifications of equipment • Types of common equipment malfunctions • Total preventive maintenance techniques - predictive and preventive maintenance techniques • Computer maintenance management procedures • Lifting and moving devices such as hoists, carts, lifts, jacks and dollies • Functionality of fasteners, force, torque, dynamic and static torques, press fits, assembly tolerances • Proper use of lubricants, including of different grades, viscosities and other properties; use of additives • Functionality of gears and their attachment to shafts through keys and keyways • Definitions of Resolution, Repeatability, Accuracy • Basic physics - force, center of gravity, force vectors, rated load, crush force (load charts) 	<ul style="list-style-type: none"> • LOTO practices • Job safety analysis • Troubleshooting using inductive and deductive reasoning • Ability to identify and describe tasks and functions • English to metric conversions and vice versa 	<ul style="list-style-type: none"> • Calipers • V and HRD belts • Vernier micrometers • Shaft couplings • Straight edge

Competency A: Adheres to mechanical power transmission safety rules	Core or Optional
PERFORMANCE CRITERIA	
1. Adheres to roles and responsibilities for safety, health and environment	Core
2. Adheres to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace	Core

3. Identifies common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)	Core
4. Performs lockout/tagout (LOTO) process and tests to ensure a zero energy state	Core
5. Uses appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job	Core
6. Reviews material safety data sheets	Core
7. Uses proper fall protection strategies for working at heights and using ladders, scaffolding and lifts	Core
8. Employs preventative measures to prevent or remedy hazardous situations (includes following guidelines to prevent spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid)	Core
9. Performs a job safety analysis, as needed	Optional
10. Employs 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)	Core
11. Selects, installs, and inspects fire extinguishers ensuring that grade aligns with materials in use	Core
Competency B: Uses dimensional measurement tools properly to inspect dimensions of shafts and other components	Core or Optional
PERFORMANCE CRITERIA	
1. Uses metric, decimal and inch fraction rules	Core
2. Applies English and metric units conversions of measurement	Core
3. Uses digital calipers and dial calipers correctly	Core
4. Uses digital and vernier micrometers correctly	Core
5. Applies the difference between Resolution, Repeatability, Accuracy	Core
6. Selects a measurement tool for a given task based on needed accuracy and feature to be measured	Core
7. Checks calibration of a measurement tool	Core
8. Uses a dial indicator or digital indicator to measure TIR (run out), flatness, and other features	Core
9. Applies indirect measurement, as needed	Optional
Competency C: Safely examines, troubleshoots, and repairs power transmission	Core or Optional
PERFORMANCE CRITERIA	
1. Installs and aligns shaft couplings (types flexible, flange, grid and chain) using rim/face, feeler gauge and laser methods. Installs, aligns and tensions a belt drive, including single and multiple belts systems and using v-belts, timing and HTP types	Core

2. Installs, aligns, and tensions a chain drive, including single and multiple chain systems	Core
3. Uses proper mount a motor	Core
4. Selects and uses correct soft foot on a motor	Core
5. Properly levels motors and shaft	Core
6. Installs flexible, flange, grid, and chain couplings	Core
7. Identifies couplings given specifications	Core
8. Uses manufacturer's documentation to locate alignment specifications of a coupling	Core
9. Measures shaft speed using a tachometer	Core
10. Aligns a shaft using various equipment techniques; feeler gauge and straight edge, rim and face, dial indicators and laser aligning equipment	Core
11. Properly installs a multiple v-belt drive onto a shaft with a bushing	Core
12. Properly installs timing belt or HTD belt onto a shaft using a bushing	Core
13. Properly installs split taper, QD and taper lock bushings	Core
14. Interprets specifications of sheaves and v-belts	Core
15. Identifies v-belt drive components given a specification	Core
16. Aligns a v-belt drive using a straight edge	Core
17. Checks tension of a v-belt drive using a tension tool	Core
18. Tensions a v-belt drive by positioning the prime mover	Core
19. Interprets specifications of sprockets and chains given a specification	Core
20. Installs a chain drive using proper tools	Core
21. Aligns a chain drive using a straight edge	Core
22. Checks tension of a chain drive using a straight edge and rule	Core
23. Tensions a chain drive by positioning the prime mover	Core
Competency D: Aligns and adjusts gear drives	Core or Optional
PERFORMANCE CRITERIA	
1. Installs, aligns and adjusts a spur gear drive and a right angle gear drive	Core
2. Inspects gears to ensure proper attachment to shafts through keys and keyways	Core
3. Interprets specifications of gears	Core
4. Identifies spur and right angle gear components given a specification	Core
5. Aligns a gear drive using a straight edge	Core
6. Checks backlash of gears using a dial indicator per specifications	Core

Competency E: Installs, aligns, and adjusts a pillow block bearing	Core or Optional
PERFORMANCE CRITERIA	
1. Installs, aligns, and adjusts a pillow and flange block bearing	Core
2. Interprets specifications of pillow block and flange bearings	Core
3. Identifies pillow block bearings given specifications	Core
4. Installs, aligns, and adjusts pillow block and flange bearings	Core
Competency F: Lubricates equipment using correct lubricants and as recommended by manufacturer's guidance	Core or Optional
PERFORMANCE CRITERIA	
1. Selects lubricant and applies lubricant to all lubrication points on a machine according to maintenance schedule	Core
2. Develops and/or implements an equipment lubrication plan	Core
3. Selects correct lubricant given a specification from the manual	Core
4. Handles and stores lubricants correctly	Core
5. Lubricates bearings using Zerk fittings	Core
6. Uses a grease gun to lubricate a bearing	Core
7. Fills an oil cup	Core
8. Inspects and fills automatic lubricators	Core
9. Selects appropriate grade of lubricating grease based on the application	Core
10. Properly uses and checks vent plugs	Core
11. Avoids over- or under-lubrication	Core
Competency G: Performs a preventive maintenance procedure for a given machine to extend machine life and minimize downtime	Core or Optional
PERFORMANCE CRITERIA	
1. Follows preventive maintenance procedures and adheres to recommended schedule	Core
2. Performs preventive maintenance according to manufacturer's instructions and schedule: changes oil, checks fluid levels, tightens machine, changes filters, checks gaskets and replaces certain components on a predetermined basis	Core
3. Identifies and removes sources of contamination, selects best methods of cleaning machine based upon continuous improvement principle	Core

Competency H: Performs predictive maintenance on a given machine to extend machine life and minimize downtime	Core or Optional
PERFORMANCE CRITERIA	
1. Develops and implements predictive maintenance plans	Core
2. Employs predictive maintenance methods using basic senses (hearing, feeling, etc.) and inspection techniques: vibration analysis, thermography, oil analysis, acoustic analysis, motor current analysis	Core
3. Performs predictive maintenance according to manufacturer's instructions	Core
Competency I: Reads and interprets technical drawings of parts and assemblies with tolerances and basic GD&T	Core or Optional
PERFORMANCE CRITERIA	
1. Reads and interprets technical drawings of parts and assemblies with tolerances and basic GD&T	Core
2. Correctly interprets line types and basic symbology	Core
3. Identifies and interprets multi-view drawings of cylindrical and prismatic-shaped parts	Core
4. Performs metric and English dimension conversions correctly	Core
5. Identifies and follows dimension lines for linear, circular and angular dimensions	Core
6. Identifies and properly interprets title blocks	Core
7. Identifies feature sizes using a drawing scale and converts to actual measurements	Core
8. Adheres to GD&T feature control frames	Core
9. Identifies standard dimensional tolerance	Core
10. Identifies GD&T tolerances for form orientation, location	Core
11. Follows assembly drawings to repair and assemble equipment	Core
12. Identifies assembly tolerances, interference fit concept	Core
13. Identifies and interprets maximum material condition symbols	Core
14. Properly interprets sectional cutaway views	Core
15. Identifies and adheres to threaded and non-threaded fastener specifications	Core
16. Properly identifies and locates new fasteners based on a sample fastener	Core
17. Identifies and selects a fastener for a given application	Core
18. Identifies and uses washers, pins, nuts, locking devices of appropriate sizes and types	Core

Competency J: Uses hand tools to inspect, adjust/tighten and assemble/disassemble equipment and support preventive maintenance, inspection and troubleshooting activities	Core or Optional
PERFORMANCE CRITERIA	
1. Uses hand tools to inspect, adjust/tighten and assemble/disassemble equipment support preventive maintenance, inspection and troubleshooting activities	Core
2. Uses and tightens to appropriate levels fasteners and parts	Core
3. Assembles fasteners properly	Core
4. Selects and uses screw and nut drivers, straight, Phillips and hex	Core
5. Selects and uses fixed wrenches: box, open end, etc.	Core
6. Selects and uses Allen/hex key wrenches	Core
7. Selects and uses ratchet wrenches	Core
8. Selects and uses a click-type torque wrench	Core
9. Selects and properly uses pullers	Core
10. Selects and uses pliers, clamps and mallets	Core
11. Selects and uses pneumatic powered torque wrenches	Core
12. Selects and uses electric powered hand tools: drills, torque wrenches and screwdrivers	Core
13. Selects and uses methods to protect parts and components during handling and storage	Core
14. Assembles parts using threaded fasteners (bolts and machine screws), washers and nuts	Core
15. Assembles parts using pins (clevis, taper, dowel, spring, roll, shear)	Core
16. Assembles parts using keys, clips, snap rings and tie wraps	Core
17. Tightens parts using correct bolt pattern sequence	Core

Competency K: Uses hoists and other tools to safely handle and move parts and equipment	Core or Optional
PERFORMANCE CRITERIA	
1. Uses proper rigging to safely load and move materials/equipment	Core
2. Inspects hoists to determine if they are safe to use	Core
3. Uses manual and powered hoists using cantilevered and gantry configurations	Core
4. Determines and calculates center of gravity for load balance	Core
5. Determines proper use eyebolts for lifting parts	Core
6. Uses basic rigging techniques and types of slings, come-a-longs, blocking, chaining to lift a load	Core
7. Uses a manual pry bar and truck to move a load	Core
8. Uses a hydraulic jack to lift a load	Core
9. Uses a dolly to move a load	Core
10. Uses proper containment methods to store a component	Core
11. Handles parts using proper contamination prevention methods	Core
12. Inspects components for contamination and takes corrective action	Core
Competency L: Selects and uses troubleshooting methodologies to find malfunctions in machine systems to return the system to reliable, productive use in the shortest time possible	Core or Optional
PERFORMANCE CRITERIA	
1. Applies methodologies to isolate problems in a particular subsystem; 5 why, fishbone, flow charts, half-split method, etc.	Core
2. Uses good interpersonal communication skills to interact with production personnel, vendors and colleagues	Core
3. Applies effective observation and interview strategies to validate errors or problems and determine the most effective troubleshooting strategy	Core
4. Analyzes production information, maintenance, and operation documents to assist in troubleshooting a malfunction	Core

JOB FUNCTION 3: Monitors, troubleshoots, installs, and repairs basic hydraulic systems

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> • OSHA safety requirements • NIOSH safety requirements • EPA safety regulations • Purpose and use of material safety data sheets • Use and functionality of control valves and pressure valves • Components of pumps and signs of component failure • Methods for preventing the spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid. • Pascal's law and its importance in reading system pressure • Pressure-flow characteristics, types of relief valves (direct and pilot operated) • Pressure vs. force/torque output characteristics of cylinders and motors • Flow vs. speed characteristics of a hydraulic cylinder and a motor • Pressure checks and charge accumulators 	<ul style="list-style-type: none"> • LOTO practices • Reading schematic diagrams • Install, troubleshoot, repair and test pumps and their component parts 	<ul style="list-style-type: none"> • Hydraulic circuits • Displacement pumps • Personal protective devices • Fire extinguishers • Components - o-ring

Competency A: Adheres to fluid power systems safety rules while understanding safety, health, and environmental rules and regulations	Core or Optional
PERFORMANCE CRITERIA	
1. Adheres to safety, health, and environmental rules and regulations for fluid power systems	Core
2. Identifies roles and responsibilities for safety, health, and environment	Core
3. Adheres to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace	Core
4. Identifies, responds to, alerts others to and/or mitigates common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)	Core
5. Performs lockout/tagout (LOTO) process and tests to ensure a zero energy state	Core
6. Uses at all times appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears)	Core
7. Reviews material safety data sheets	Core
8. Utilizes proper fall protection for working at heights and using ladders, scaffolding and lifts	Core
9. Employs preventive methods to prevent or remedy hazardous situations (includes following guidelines to prevent spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid)	Core
10. Performs job safety analysis, as needed	Optional
11. Employs 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)	Core
12. Selects, installs, and inspects fire extinguishers ensuring that grade aligns with materials in use	Core

Competency B: Interprets basic fluid power schematics and identifies schematic symbols, process flow and operation of the components and systems	Core or Optional
PERFORMANCE CRITERIA	
1. Reads and interprets basic fluid power schematics including identifying schematic symbols, process flow and operation of the components and systems	Core
2. Identifies the basic hydraulic components given their NFPA/ ISO schematic symbol	Core
3. Installs, uses, and inspects directional control valves, pressure control valve, flow control valves, cylinders, motors, instrumentation, pumps, various types of operators, filters	Core
4. Properly uses single stage and two stage hydraulic directional control valves with manual and electrical operators, various types of spool centers, 2-position/3-position and 2/3/4 way designs	Core
5. Describes the operation of hydraulic circuits that use accumulators, pump unloading, remote pressure control, rapid traverse slow feed and pilot-operated check valves	Core
6. Interprets hydraulic line types on a schematic	Core
7. Interprets and properly traces the operation of a basic hydraulic circuit given a schematic	Core
8. Identifies and describes the basic pneumatic components given their NFPA/ ISO schematic symbol	Core
9. Interprets pneumatic line types from a schematic	Core
10. Properly traces pneumatic circuit based on a schematic	Core

Competency C: Starts up and shuts down a hydraulic system and adjusts system pressure using a fixed displacement pump		Core or Optional
PERFORMANCE CRITERIA		
1. Starts up and shuts down a hydraulic system and adjust hydraulic pressure control valves in a system that uses a fixed displacement pump		Core
2. Safely starts up a hydraulic power system including pre-start inspection		Core
3. Safely shuts down a hydraulic power system		Core
4. Uses manufacturer's documentation per specific application to determine correct operating pressure		Core
5. Reads a pressure gauge		Core
6. Adjusts the system operating pressure using a relief valve		Core
7. Operates manual valves to direct system flow		Core
8. Adjusts the pressure of a pressure reducing valve		Core
9. Adjusts the system operating pressure		Core
10. Properly selects, aligns and adjusts types of relief valves, direct and pilot operated		Core
11. Identifies correct pressure-flow characteristics of fixed and variable displacement pumps		Core
Competency D: Adjusts hydraulic actuator speed using a flow control valve		Core or Optional
PERFORMANCE CRITERIA		
1. Selects and adjusts hydraulic actuator speed using a flow control valve		Core
2. Adjusts actuator speed using a needle valve		Core
3. Adjusts actuator speed using non-compensated and compensated flow control valves		Core
4. Adjusts flow control valves in meter-in and meter-out configurations		Core
5. Measures actuator speed		Core
6. Properly installs or operates a needle valve, flow control valve, compensated flow control valve and meter-in and meter-out circuits		Core
7. Properly adjusts flow and speed characteristics of a hydraulic cylinder and a motor		Core
8. Calculates pump flow rate requirements given actuator speeds and sizes		Core
9. Calculates pump flow rate given pump size and speed		Core

Competency E: Services a hydraulic filter to maximize hydraulic fluid cleanliness	Core or Optional
PERFORMANCE CRITERIA	
1. Inspects and changes a hydraulic filter to maximize hydraulic fluid cleanliness	Core
2. Adjusts actuator speed using a needle valve	Core
3. Adjusts sactuator speed using non-compensated and compensated flow control valves	Core
4. Adjusts flow control valves in meter-in and meter-out configurations	Core
5. Properly measures actuator speed	Core
6. Properly operates a needle valve, flow control valve, compensated flow control valve and meter-in and meter-out circuits	Core
7. Adjusts the appropriate flow and speed characteristics of a hydraulic cylinder and a motor	Core
8. Calculates pump flow rate requirements given actuator speeds and sizes	Core
9. Calculates pump flow rate given pump size and speed	Core
Competency F: Adds, changes, and properly disposes of waste hydraulic fluid	Core or Optional
PERFORMANCE CRITERIA	
1. Inspects, adds, and changes a hydraulic fluid	Core
2. Inspects fluid levels through level gauge and determines when to add fluid	Core
3. Adds fluid to a hydraulic system	Core
4. Replaces hydraulic fluid using a filter cart	Core
5. Inspects fluid through sight, touch, and smell to determine if it should be replaced	Core
6. Inspects fluid for water and visible contaminants	Core
7. Removes water and contaminants from a hydraulic system including but not limited to flushing and refilling system	Core
8. Interprets oil specifications to determine if an oil meets the specifications specified by the machine manufacturer	Core
9. Uses manufacturer's documentation to determine the correct oil to use in a hydraulic system	Core
10. Takes a fluid sample and prepares for submittal to a testing lab	Core

Competency G: Installs hydraulic conductors	Core or Optional
PERFORMANCE CRITERIA	
1. Connects, adjusts, and disconnects flexible and rigid hydraulic conductors	Core
2. Interprets pipe, hose, and tubing specifications	Core
3. Identifies type and size of hose, tubing, and hydraulic fittings given a sample	Core
4. Uses safety procedures to make sure pressure is removed before disconnecting conductors	Core
5. Properly tightens fittings and avoids over-tightening	Core
6. Attaches and tightens hydraulic steel tubing using wrenches and ferrule fittings	Core
7. Attaches and tightens hydraulic fittings to components with threaded ports using wrenches and applicable thread sealant	Core
8. Attaches and tightens hydraulic hose using wrenches and swivel fittings	Core
9. Attaches and tightens hydraulic hose using wrenches and straight thread o-ring fittings	Core
10. Adjusts the position and alignment of conductors for proper operation	Core
11. Makes hydraulic hose using proper fittings	Core
12. Properly installs o-rings	Core

Competency H: Installs and tests components in a basic hydraulic circuit	Core or Optional
PERFORMANCE CRITERIA	
1. Installs and tests the operation of components in a basic hydraulic linear or rotary actuator circuit given a schematic	Core
2. Installs and connects hydraulic components in basic functional circuit given a schematic	Core
3. Replaces subplate-mounted directional, flow and pressure control valves in a hydraulic system	Core
4. Replaces a threaded port valve	Core
5. Mounts and aligns a hydraulic cylinder or a motor	Core
6. Identifies types of cylinder and motor mounting methods and their applications	Core
7. Operates a hydraulic system to determine that it is performing correctly	Core
8. Follows proper bleeding procedures of a hydraulic system after component replacement	Core
Competency I: Troubleshoots a basic hydraulic circuit or rotary actuator circuit	Core or Optional
PERFORMANCE CRITERIA	
1. Troubleshoots a basic hydraulic linear or rotary actuator circuit	Core
2. Troubleshoots basic components (cylinder, motor, directional valve, relief valve, pressure reducing valve, sequence valve, flow control valve, fixed/variable pump and check valve) in a hydraulic circuit using in-circuit tests	Core
3. Uses flow and pressure instruments to take hydraulic circuit readings during in-circuit testing	Core
4. Identifies the flow vs. pressure drop characteristics of components and conductors and their impact on system operation	Core
5. Uses systematic methodologies to troubleshoot basic hydraulic circuits with linear and rotary actuators with these symptoms: <ul style="list-style-type: none"> • Actuator will not move • Actuator moves at incorrect speed • Actuator moves erratically • No or low system pressure 	Core
6. Identifies types of failures of basic hydraulic component	Core

JOB FUNCTION 4: Monitors, troubleshoots, installs, and repairs basic pneumatic systems

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> • OSHA safety requirements • NIOSH safety requirements • EPA Safety Regulations • Job Safety Analysis • 6s program • Purpose and use of material safety data sheets • Use and functionality of control valves and pressure valves • Pascal's law and its importance in reading system pressure • Actuator speeds • Pneumatic filters and circuits • Flow vs. speed characteristics of a hydraulic cylinder and a motor • Pressure checks and charge accumulators 	<ul style="list-style-type: none"> • LOTO practices • Troubleshooting using inductive and deductive reasoning • Understanding and using basic installation functions • Adjusting systems using different techniques • Servicing equipment effectively 	<ul style="list-style-type: none"> • Hydraulic circuits • Pneumatic systems • Personal protective devices • Air compressors

Competency A: Adheres to fluid power systems safety rules	Core or Optional
PERFORMANCE CRITERIA	
1. Adheres to safety, health and environmental rules and regulations for fluid power systems	Core
2. Identifies roles and responsibilities for safety, health and environment	Core
3. Adheres to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace	Core
4. Identifies and recognizes common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)	Core
5. Performs lockout/tagout (LOTO) process and tests to ensure a zero energy state	Core

6. Selects the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job	Core
7. Reviews material safety data sheets	Core
8. Uses proper fall protection for working at heights and using ladders, scaffolding, and lifts	Core
9. Employs preventive methods to prevent or remedy hazardous situations (includes following guidelines to prevent spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid)	Core
10. Performs a job safety analysis, as needed	Optional
11. Employs 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)	Core
12. Selects, installs, and inspects fire extinguishers ensuring that grade aligns with materials in use	Core
Competency B: Adjusts pneumatic system branch operating pressure using a regulator	Core or Optional
PERFORMANCE CRITERIA	
1. Determines and adjusts pneumatic system operating pressure using a regulator	Core
2. Identifies operation of relieving and non-relieving pneumatic regulators	Core
3. Identifies the pressure vs. force/ torque output characteristics of cylinders and motors	Core
4. Applies fundamentals of Pascal's law when reading system pressure	Core
5. Interprets and converts between air pressure units of measurement (psi, psia, psig, kPa, bar)	Core
6. Identifies compressibility characteristics of air and their impact on system operation	Core
7. Identifies the operation of circuits using pneumatic directional control valves with manual and electrical operators, various types of spool centers, 2-position/3-position, pilot operated, cam-operated and 2/3/4/5 way designs	Core
8. Reads a pressure gauge	Core
9. Uses manufacturer's documentation to determine correct operating pressure	Core
10. Adjusts pneumatic regulator pressure	Core
11. Operates a branch shutoff valve to enable flow to a system branch	Core

Competency C: Services a pneumatic filter through inspection, drainage, and changes	Core or Optional
PERFORMANCE CRITERIA	
1. Inspects, drains, and changes a pneumatic filter	Core
2. Replaces a cartridge filter	Core
3. Determines when to replace a filter based on inspection and pressure differential and manufacturer's recommendations	Core
4. Interprets filter specifications and models to determine correct filter	Core
5. Uses manufacturer's documentation to determine frequency of change	Core
6. Recognizes symptoms of excessive water in a compressed air system	Core
Competency D: Services a pneumatic lubricator through inspection, fills, and adjustments	Core or Optional
PERFORMANCE CRITERIA	
1. Inspects, fills and adjusts a pneumatic lubricator	Core
2. Uses manufacturer's documentation to determine correct lubricant	Core
3. Defines proper lubricating media	Core
4. Inspects fluid level in a lubricator	Core
5. Adds lubricating oil to a lubricator	Core
6. Sets lubrication rate on a lubricator	Core
Competency E: Installs, fills, and adjusts pneumatic conductors	Core or Optional
PERFORMANCE CRITERIA	
1. Connects, adjusts, and disconnects flexible and rigid pneumatic conductors	Core
2. Uses safety procedures to make sure pressure is removed before disconnecting conductors	Core
3. Attaches and tightens pneumatic steel tubing using wrenches and ferrule fittings	Core
4. Attaches and tightens pneumatic fittings to components with threaded ports using wrenches and thread sealant when appropriate	Core
5. Attaches and tightens pneumatic hose using wrenches and straight-thread, barb, ferrule and push-on fittings	Core
6. Adjusts the position and alignment of conductors for proper operation	Core
7. Interprets pipe, hose, and tubing specifications	Core

Competency F: Starts up and shuts down a reciprocating air compressor and adjusts operating pressure	Core or Optional
PERFORMANCE CRITERIA	
1. Starts up and shuts down a reciprocating air compressor and adjusts operating pressure using a pressure switch	Core
2. Calculates air consumption from a receiver given a pressure change	Core
3. Interprets and converts between air flow rate units (scfm, cfm, fcfm, etc.)	Core
4. Safely starts up an air compressor system, including pre-start inspection	Core
5. Safely shuts down and drains a reciprocating air compressor system	Core
6. Operates manual valves to direct system flow	Core
7. Uses manufacturer's documentation to determine correct operating pressure	Core
8. Adjusts the system operating pressure using a pressure switch	Core
9. Adjusts working pressure with a regulator	Core
Competency G: Installs and tests the operation of components in a basic pneumatic linear or rotary circuit given a schematic	Core or Optional
PERFORMANCE CRITERIA	
1. Installs and tests components in a basic pneumatic circuit	Core
2. Installs and connects pneumatic components in basic functional circuit given a schematic	Core
3. Replaces a sub plate-mounted directional valve in a pneumatic system	Core
4. Replaces a threaded port valve	Core
5. Mounts and aligns a pneumatic cylinder or a motor	Core
6. Operates a pneumatic system to determine that it is performing correctly	Core

Competency H: Installs and tests components in a pneumatic circuit that uses vacuum generators given a schematic	Core or Optional
PERFORMANCE CRITERIA	
1. Installs and tests the operation of components in a basic pneumatic circuit that uses vacuum generators given a Schematic	Core
2. Installs and connects pneumatic components in basic functional circuit given a schematic	Core
3. Replaces a sub plate-mounted directional valve in a pneumatic system	Core
4. Replaces a threaded port valve	Core
5. Mounts and aligns a pneumatic cylinder or a motor	Core
6. Operates a pneumatic system to determine that it is performing correctly	Core
7. Identifies types of cylinder and motor mounting methods and their applications	Core
Competency I: Troubleshoots a basic pneumatic circuit	Core or Optional
PERFORMANCE CRITERIA	
1. Troubleshoots a basic pneumatic linear or rotary actuator circuit	Core
2. Troubleshoots basic components (cylinder, motor, directional valve, relief valve, pressure regulator valve, flow control valve, vacuum generator, suction cup and check valve) in a pneumatic circuit using in-circuit tests	Core
3. Uses flow and pressure instruments to take pneumatic circuit readings during in-circuit testing	Core
4. Describes the flow vs. pressure drop characteristics of pneumatic components and conductors and their impact on system operation	Core
5. Uses systematic methodologies to troubleshoot basic pneumatic circuits with linear and rotary actuators with these symptoms: <ul style="list-style-type: none"> • Actuator will not move • Actuator moves at incorrect speed • Actuator moves erratically • No or low system pressure 	Core
6. Identifies types of failures of basic pneumatic components	Core

JOB FUNCTION 5: Monitors, troubleshoots, and repairs electrical systems

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> • OSHA safety requirements • NIOSH safety requirements • EPA Safety Regulations • Job Safety Analysis • 6s program • Purpose and use of material safety data sheets • Use and functionality of control valves and pressure valves • Pascal's law and its importance in reading system pressure • Actuator speeds • Electronic control and power schematics • Circuit breakers • Transformers • Pneumatic filters and circuits • Flow vs. speed characteristics of a hydraulic cylinder and a motor 	<ul style="list-style-type: none"> • LOTO practices • Troubleshooting using inductive and deductive reasoning • Understanding and using basic installation functions • Adjusting systems using different techniques • Servicing equipment effectively • Installing and testing systems • Measuring and making adjustments when necessary 	<ul style="list-style-type: none"> • Hydraulic circuits • Pneumatic systems • Personal protective devices • Air compressors • Transformers • Circuit breakers

Competency A: Adheres to electrical power and control systems safety rules for electrical power and control systems	Core or Optional
PERFORMANCE CRITERIA	
1. Adheres to safety, health and environmental rules and regulations for electrical power and control systems	Core
2. Identifies roles and responsibilities for safety, health and environment	Core
3. Adheres to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace	Core
4. Identifies and recognizes common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)	Core

5. Performs lockout-tagout (LOTO) process and tests to ensure a zero energy state	Core
6. Uses at all times appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job	Core
7. Reviews material safety data sheets	Core
8. Uses proper fall protection for working at heights and using ladders, scaffolding and lifts	Core
9. Employs preventative methods to prevent or remedy hazardous situations (includes following guidelines to prevent spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid)	Core
10. Performs a job safety analysis, as needed	Optional
11. Employs 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)	Core
12. Selects, installs, and inspects fire extinguishers ensuring that grade aligns with materials in use	Core
Competency B: Interprets electrical control and power schematics to ensure the operation of the components and system	Core or Optional
PERFORMANCE CRITERIA	
1. Reads and interprets electrical motor control and programmable controller system schematics, including identifying schematic symbols, signal flow and operation of the components and system	Core
2. Identifies electrical components given their NEC/ISO schematic symbol	Core
3. Interprets electrical control and power line types on a schematic	Core
4. Interprets the operation of a basic electrical power and control circuits given a schematic (N.O. and N.C. contacts)	Core
5. Follows signal flow on an electrical control or power schematic	Core
6. Interprets control schematics given a ladder logic diagram	Core
7. Interprets power diagrams associated with a PLC and all related input/output devices	Core

Competency C: Adjusts limit switches and electronic sensors	Core or Optional
PERFORMANCE CRITERIA	
1. Adjusts and tests limit switches, pressure switches, float switches and electronic proximity sensors	Core
2. Adjusts and tests the trip point of a limit switch, float switch and pressure switch	Core
3. Adjusts and tests the trip point of a capacitive sensor, inductive sensor, photoelectric sensor, hall effect sensor, fiber optic, magnetic reed sensor, light curtain switches	Core
Competency D: Measures voltage, current and resistance in an electrical circuit to verify system operation and power levels	Core or Optional
PERFORMANCE CRITERIA	
1. Uses a multimeter to measure incoming voltage and current to an electrical circuit	Core
2. Uses a multimeter to measure voltage and current in an electrical circuit	Core
3. Uses a multimeter to measure resistance in an electrical circuit	Core
4. Uses a multimeter to perform a continuity check in an electrical circuit	Core
5. Uses an amp meter (clamp-on)	Core
6. Calculates power in an electrical circuit given current and voltage	Core
Competency E: Selects, installs, and tests fuses and circuit breakers	Core or Optional
PERFORMANCE CRITERIA	
1. Sizes fuses and circuit breakers in accordance with NEC requirements for a given power draw in an electrical circuit with consideration to ampacity of wiring in that circuit	Core
2. Sizes fuses and circuit breakers in accordance with NEC requirements for a given power draw in an electrical circuit with consideration to ampacity of wiring in that circuit	Core
3. Tests fuses	Core
4. Inspects circuit breakers to determine if tripped	Core
5. Resets circuit breakers	Core

Competency F: Installs and tests DC electric motors in a manual control circuit	Core or Optional
PERFORMANCE CRITERIA	
1. Installs and connects DC electric motors to a manual switch given a power schematic	Core
2. Uses a multimeter and mega-ohmmeter (megger) to test a DC motor	Core
3. Interprets a DC motor name plate	Core
Competency G: Installs and tests AC electric motors in a manual control circuit	Core or Optional
PERFORMANCE CRITERIA	
1. Installs and connects AC single-phase electric motors to a manual motor starter given a power schematic	Core
2. Installs and connects AC 3-phase electric motors to a manual motor starter given a schematic	Core
3. Interprets AC single phase and 3-phase motor specifications	Core
4. Uses a multimeter and mega-ohmmeter (megger) to test an AC motor	Core
5. Interprets an AC motor name plate	Core
6. Selects an AC motor overload	Core
Competency H: Installs and tests electrical relay control components and circuits	Core or Optional
PERFORMANCE CRITERIA	
1. Installs and connects NEMA/ IEC relay control components in a control circuit given a wiring diagram or schematic	Core
2. Installs wiring between components in a control cabinet using raceways	Core
3. Installs wiring between components located in different enclosures via conduit	Core
4. Replaces failed relay contacts and coils	Core

Competency I: Installs and tests electro-fluid power components and circuits	Core or Optional
PERFORMANCE CRITERIA	
1. Installs and connects solenoid-operated hydraulic and pneumatic valves in a control circuit given a wiring diagram or schematic	Core
2. Uses manual overrides to test operation and Describes the potential negative effects or consequences	Core
Competency J: Tests and repairs machine electrical ground	Core or Optional
PERFORMANCE CRITERIA	
1. Applies methods of grounding and bonding machines per NEC code and their respective applications	Core
2. Operates a grounding conductor	Core
3. Tests a machine ground to verify its correct operation	Core
Competency K: Troubleshoots an electrical motor relay control circuit	Core or Optional
PERFORMANCE CRITERIA	
1. Troubleshoots basic electrical components (resistors, control transformers, potentiometers, pushbutton switches, selector switches, control relays, magnetic motor starters, overloads, indicator lamps, drum switches and disconnect switches) in an electrical relay control circuit using in-circuit tests	Core
2. Uses a multimeter to take electrical circuit readings during in-circuit testing	Core
3. Uses systematic methodologies to troubleshoot electrical relay control circuits with AC and DC motors with these symptoms: <ul style="list-style-type: none"> • Motor will not run • Motor turns in wrong direction • Motor runs erratically • Motor is hot • Motor runs high current 	Core

Competency L: Troubleshoots a solenoid-operated fluid power relay control circuit	Core or Optional
PERFORMANCE CRITERIA	
1. Troubleshoots solenoid-operated hydraulic and pneumatic directional control valves using in-circuit tests	Core
2. Uses systematic methodologies to troubleshoot electro-fluid power relay control circuits with these symptoms: <ul style="list-style-type: none"> • Actuator will not move • Actuator moves in wrong direction • Actuator moves erratically 	Core
Competency M: Replaces electrical control wiring using terminal attachment	Core or Optional
PERFORMANCE CRITERIA	
1. Performs a continuity test on wiring connected via all types of terminals	Core
2. Sizes wiring for a control circuit given voltage and current requirements and NEC code	Core
3. Interprets wiring specifications including standard color coding	Core
4. Strips wire	Core
5. Attaches wires to terminals	Core
6. Describes types of wire and their application	Core
Competency N: Replaces electrical control wiring using solder attachment	Core or Optional
PERFORMANCE CRITERIA	
1. Performs a continuity test on wiring connected via soldering	Core
2. Prepares wire for soldering	Core
3. Solders wire to terminals	Core
4. Tests and inspects a solder joint for integrity	Core

Competency O: Installs, examines, repairs, and replaces transformers	Core or Optional
PERFORMANCE CRITERIA	
1. Tests different types of transformer	Core
2. Disconnects and reconnects primary and secondary transformers	Core
3. Replaces primary and secondary transformers	Core

JOB FUNCTION 6: Monitors, troubleshoots, installs, and repairs electronic and process control systems

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> • OSHA safety requirements • NIOSH safety requirements • EPA Safety Regulations • Job Safety Analysis • 6s program • Purpose and use of material safety data sheets • Use and functionality of control valves and pressure valves • DC power supply • AC variables • Circuit breakers • Working with PMIs • Understanding PLC Components 	<ul style="list-style-type: none"> • LOTO practices • Troubleshooting using inductive and deductive reasoning • Understanding and using basic installation functions • Adjusting systems using different techniques • Servicing equipment effectively • Installing and testing systems • Measuring and making adjustments when necessary • Interpreting PLC systems 	<ul style="list-style-type: none"> • AC variables • Circuit breakers • PLC Components • PMIs

Competency A: Adheres to safety, health, and environmental rules and regulations for electronic power and control systems	Core or Optional
PERFORMANCE CRITERIA	
1. Identifies roles and responsibilities for safety, health and environment	Core
2. Adheres to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace	Core
3. Identifies and recognizes common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)	Core
4. Performs lockout-tagout (LOTO) process and tests to ensure a zero energy state	Core
5. Uses at all times appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears)	Core
6. Reviews material safety data sheets	Core
7. Uses proper fall protection for working at heights and using ladders, scaffolding and lifts	Core

8. Employs preventative methods to prevent or remedy hazardous situations and applies proper procedures (includes following guidelines to prevent spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid)	Core
9. Performs a job safety analysis, as needed	Optional
10. Employs 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)	Core
11. Selects, installs, and inspects fire extinguishers ensuring that grade aligns with materials in use	Core
Competency B: Connects and tests a DC power supply to ensure proper operation	Core or Optional
PERFORMANCE CRITERIA	
1. Measures output from a DC power supply (to determine noise or quality of filtering)	Core
2. Connects and tests linear and switching DC power supplies	Core
Competency C: Installs and tests a solid-state AC and DC discrete and analog relays	Core or Optional
PERFORMANCE CRITERIA	
1. Interprets solid-state relay schematic symbols	Core
2. Interprets solid-state relay specifications	Core
3. Installs solid-state relays in an electrical circuit given a schematic	Core
4. Troubleshoots types of failures of solid-state relays	Core
5. Uses a multimeter to test a solid-state relay	Core
Competency D: Installs and tests analog electronic sensors and signal conditioning equipment	Core or Optional
PERFORMANCE CRITERIA	
1. Interprets specifications for analog sensors	Core
2. Connects and tests sensors and associated signal conditioner	Core
3. Troubleshoots types of failures of analog sensors	Core
4. Adjusts the range and zero point of an analog signal conditioner	Core

Competency E: Adjusts and repairs AC drive to control motor speed and torque	Core or Optional
PERFORMANCE CRITERIA	
1. Connects and operates an AC variable frequency drive (VFD) with an AC motor and relay control circuit	Core
2. Manually operates an AC VFD using an onboard HMI, as needed	Core
3. Views and edits parameters in an AC VFD using an onboard HMI	Core
Competency F: Transfers programs to programmable controller using a PC	Core or Optional
PERFORMANCE CRITERIA	
1. Changes PLC modes	Core
2. Connects and transfers programs between a PC and a programmable controller via a serial, USB or Ethernet connection	Core
Competency G: Creates a basic PLC ladder-style program using internal and external contacts, timers, counters, non-retentive output coils, internal coils, subroutines, conditional commands and math commands	
PERFORMANCE CRITERIA	
1. Uses PC software to open a PLC program and review the files	Core
2. Interprets PLC programs with internal and external contacts, timers, counters, non-retentive output coils, internal coils, subroutines, conditional commands and math commands.	Core
3. Interprets PLC programs that control and sequence electric motors and fluid power systems	Core
4. Interprets a PLC I/O Diagram	Core
5. Identifies an I/O device given a memory address	Core

Competency H: Installs and tests basic PLC components that uses a ladder logic program to interface a hardware component	Core or Optional
PERFORMANCE CRITERIA	
1. Connects and configures a HMI to a PLC via a network or direct connection	Core
2. Installs and configures a PLC and its components	Core
3. Powers up a HMI	Core
4. Views data from a HMI panel	Core
5. Navigates HMI screens using touchscreen and function keys	Core
6. Interprets the operation of a PLC program that uses a ladder logic program to interface to a hardware component	Core
Competency I: Performs basic troubleshooting of PLC and controlled components	Core or Optional
PERFORMANCE CRITERIA	
1. Uses a PLC troubleshooting flow chart to troubleshoot a PLC system	Core
2. Uses PLC program history to troubleshoot a PLC system	Core
3. Uses systematic methodologies to troubleshoot a basic PLC-controlled machine or system and its components	Core
4. Uses a HMI to troubleshoot a PLC-controlled machine	Core
5. Troubleshoots a HMI on a PLC-controlled machine	Core
6. Makes mechanical, electrical and software adjustments to tune the performance of a PLC-controlled machine	Core
7. Uses team skills to install, troubleshoot and optimize systems	Core

JOB FUNCTION 7: Performs maintenance welding to manufacture or repair parts, equipment and other materials

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> • OSHA safety requirements • NIOSH safety requirements • EPA Safety Regulations • Job Safety Analysis • 6s program • Purpose and use of material safety data sheets • Basic welding • Preparing metal parts for welding • Cutting flat stock • Methods for preventing the spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid. 	<ul style="list-style-type: none"> • LOTO practices • Troubleshooting using inductive and deductive reasoning • Understanding and using basic installation functions • Adjusting systems using different techniques • Servicing equipment effectively • Basic welding 	<ul style="list-style-type: none"> • Acetyne torch • GMAW welder • Plasma cutter

Competency A: Adheres to safety, health and environmental rules and regulations for welding	Core or Optional
PERFORMANCE CRITERIA	
1. Identifies roles and responsibilities for safety, health and environment	Core
2. Adheres to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace	Core
3. Identifies and recognizes common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)	Core
4. Performs lockout/tagout (LOTO) process and tests to ensure a zero energy state	Core
5. Uses at all times appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job	Core
6. Reviews material safety data sheets	Core

7. Uses proper fall protection for working at heights and using ladders, scaffolding and lifts	Core
8. Identifies and recognizes hazardous situations and apply proper procedures (includes following guidelines to prevent spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid)	Core
9. Performs a job safety analysis, as needed	Optional
10. Employs 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)	Core
11. Selects, installs, and inspects fire extinguishers ensuring that grade aligns with materials in use	Core
Competency B: Uses an acetylene torch properly while using appropriate safety equipment and precautions to cut steel parts	Core or Optional
PERFORMANCE CRITERIA	
1. Sets up a torch and tanks for operation	Core
2. Selects correct tips for thickness of metal	Core
3. Cares for torch tips	Core
4. Selects/Chooses proper PPE	Core
5. Uses a torch to perform a straight cut on various thickness of metals up to ½" thick	Core
6. Properly transports and stores regulators, pressure adjustments, and tanks	Core
Competency C: Performs basic welding and achieves necessary strength, resilience, shape and size requirements	Core or Optional
PERFORMANCE CRITERIA	
1. Selects correct welding equipment	Core
2. Uses a torch to perform a straight cut on various thickness of metals up to ½" thick	Core
Competency D: Prepares parts to be welded including degreasing, cleaning, grinding and inspecting	Core or Optional
PERFORMANCE CRITERIA	
1. Selects correct parts for welding	Core
2. Degreases, cleans, grinds, and inspects part before welding	Core

Competency E: Uses SMAW Welder to make basic welds on flat stock	Core or Optional
PERFORMANCE CRITERIA	
1. Chooses proper PPE for SMAW welding	Core
2. Chooses SMAW Welding wire for metal being used and thickness	Core
3. Sets up a SMAW Welder for operation and make basic welds	Core
4. Identifies and select proper gasses for SMAW welding	Core
5. Set up part to be welded using a clamp, vise, or fixture	Core
6. Explains need for proper selection of nozzles and tips in the GMAW process	Core
7. Performs basic welds using a GMAW Welder including: tack, butt joint, lap joint, T-joint corner joint and groove joint in various positions	Core
8. Cleans weld	Core
Competency F: Uses GMAW Welder to make basic welds on flat stock	Core or Optional
PERFORMANCE CRITERIA	
1. Chooses proper PPE for GMAW Welding	Core
2. Cleans weld	Core
3. Chooses GMAW Welding wire for metal being used and thickness	Core
4. Sets up a GMAW Welder for operation and make basic welds	Core
5. Identifies and select proper gasses for GMAW Welding	Core
6. Sets up part to be welded using a clamp, vise, or fixture	Core
7. Selects proper nozzles and tips in the GMAW process	Core
8. Performs basic welds using a GMAW Welder including: tack, butt joint, lap joint, T-joint corner joint and groove joint in various position	Core

Competency G: Inspects welds for integrity and functionality	Core or Optional
PERFORMANCE CRITERIA	
1. Visually inspects welds to identify common weld defects, including porosity, undercuts, inclusions, poor penetration, burn through, and cold lapping	Core
2. Identifies proper welding sizing-including shape form and length	Core
3. Troubleshoots and applies countermeasures for common defects	Core
Competency H: Uses plasma cutter to cut flat stock	Core or Optional
PERFORMANCE CRITERIA	
1. Chooses proper PPE for plasma cutting	Core
2. Chooses proper plasma cutter tip/cup and electrode for the process and thickness	Core
3. Sets up and adjusts a plasma cutter properly to cut metal	Core
4. Sets proper air pressure for cutting metal using a plasma cutter	Core
5. Uses a plasma cutter to perform a straight cut on various metals up to ½" thick	Core

JOB FUNCTION 8: Installs, removes, repairs, and replaces piping systems

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> • OSHA safety requirements • NIOSH safety requirements • EPA Safety Regulations • Job Safety Analysis • 6s program • Purpose and use of material safety data sheets • Installing, measuring, and preparing pipes • Methods for preventing the spread of blood borne pathogens, spill control, proper storage, handling, protection of equipment, first aid. 	<ul style="list-style-type: none"> • LOTO practices • Troubleshooting using inductive and deductive reasoning • Understanding and using basic installation functions • Understanding and using basic installation functions • Adjusting systems using different techniques • Servicing equipment effectively • Interpreting piping schematics 	<ul style="list-style-type: none"> • PVC, CPVC pipes • Tubing

Competency A: Adheres to safety, health, and environmental rules and regulations for piping systems	Core or Optional
PERFORMANCE CRITERIA	
1. Identifies roles and responsibilities for safety, health and environment	Core
2. Adheres to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace	Core
3. Identifies and recognizes common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)	Core
4. Performs lockout/tagout (LOTO) process and tests to ensure a zero energy state	Core
5. Uses at all times appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job	Core
6. Reviews material safety data sheets	Core
7. Uses proper fall protection for working at heights and using ladders, scaffolding and lifts	Core
8. Employs preventative methods to prevent or remedy hazardous situations and applies proper procedures (includes following guidelines to prevent spread of blood	Core

borne pathogens, spill control, proper storage, handling, protection of equipment, first aid)	
9. Performs a job safety analysis, as needed	Optional
10. Employs 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)	Core
11. Selects, installs, and inspects fire extinguishers ensuring that grade aligns with materials in use	Core
Competency B: Interprets basic piping schematics including specifications and fittings	Core or Optional
PERFORMANCE CRITERIA	
1. Interprets piping line types and symbols on a schematic	Core
2. Interprets the operation of a basic piping systems given a schematic	Core
Competency C: Identifies and selects correct piping materials	Core or Optional
PERFORMANCE CRITERIA	
1. Selects the proper tools to use with piping system	Core
2. Identifies and select correct materials for process/medium compatibility <ul style="list-style-type: none"> • Fitting, connections, • Pipe or tubing • Hoses • Hangers • Sealants, gaskets or solder/weld 	Core
Competency D: Accurately measures, cuts and prepares piping for installation	Core or Optional
PERFORMANCE CRITERIA	
1. Interprets or details the appropriate measurement of materials for cutting or bending	Core
2. Calculates pipe length required for installation or repair	Core
3. Uses threading machines, tubing benders and cutting devices to prepare pipe and tubing	Core
4. Performs surface preparation for all types of connections	Core
5. Measures, cuts and prepares iron pipe for installation or replacement	Core
6. Measures, cuts and prepares PVC, CPVC pipe for installation	Core
7. Measures, cuts and prepares tubing for installation	Core

Competency E: Installs and tests piping systems	Core or Optional
PERFORMANCE CRITERIA	
1. Removes, installs, and tests threaded pipe and fittings	Core
2. Removes, installs, and tests tubing and fittings	Core
3. Removes, installs, and tests PVC and CPVC pipe and fittings	Core
4. Removes, installs, and tests bolted piping flanges	Core

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