National Institute for Metalworking Skills

DUTIES AND STANDARDS

FOR

INDUSTRIAL MAINTENANCE TECHNICIANS

(MECHATRONICS TECHNICIANS)

Level I

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INTRODUCTION TO DUTIES AND STANDARDS FOR INDUSTRIAL MAINTENANCE TECHNICIANS (MECHATRONIC TECHNICIANS) – LEVEL I

We are pleased to present the first of a series of National Skills Standards for industry to support the growing number of open jobs in industrial maintenance and the emerging field of mechatronics. The goal of this project is to establish world-class standards reflecting industry skill requirements. The standards will provide a method through certification and training for individual workers to receive recognition and validation for their abilities. The standards will help employers identify training needs and evaluate potential candidates.

The Duties and Standards for Industrial Maintenance and Mechatronics Technicians have been developed by National Technical Work Group and validated by Regional Validation Groups to incorporate the basic requirements for the majority of skilled industrial maintenance and mechatronic positions. This set of standards has been designed to support a selection of individual skills or groups of skills to be used as a foundation for many of the industrial maintenance and mechatronics disciplines.

OVERVIEW

In the spring of 2013, Ivy Tech Community College and the National Institute for Metalworking Skills (NIMS) launched an initiative to develop skills standards for the industrial maintenance and mechatronics industry. Skills standards refer to the major duties, knowledge and skills in which individuals must be proficient to meet performance requirements and expectations in the modern workplace. The national basis of these standards refers to the process followed in their development, namely that they be reviewed and reflect employer and employee opinions nationwide. The skills standards (once established) are intended to guide workforce development programs in the public and private sectors to build and sustain a premier workforce in the United States. They will also used by NIMS to develop credentials and certificates to assist in this process.

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I. DUTY AREA 1: MAINTENANCE OPERATIONS (MO)

A. DUTIES AND DUTY TITLES

Duty Title*:* 1.01 Adhere to safety, health and environmental rules and regulations
Duty: Adhere to safety, health and environmental rules and regulations to avoid workplace injury and maximize machine productivity

Duty Title: 1.02 Operate a machine
Duty: Perform machine operation, including startup, emergency and normal shutdown and manual functions to effectively and safely meet production and maintenance requirements (with operator present)

Duty Title: 1.03 Monitor a machine
Duty: Monitor machine operation and verify that performance meets production requirements

Duty Title*:* 1.04 Interpret machine operation and maintenance documentation
Duty: Locate, interpret and store machine operation and maintenance documentation

Duty Title*:* 1.05 Perform machine maintenance procedures
Duty: Perform planned and unscheduled machine maintenance procedures in accordance with a company-approved maintenance plan

Duty Title: 1.06 Perform preventative maintenance
Duty: Perform a preventive maintenance procedure for a given machine to extend machine life and minimize downtime

Duty Title: 1.07 Perform predictive maintenance
Duty: Perform predictive maintenance on a given machine to extend machine life and minimize downtime

Duty Title: 1.08 Technical drawings
Duty: Read and interpret technical drawings of parts and assemblies with tolerances and basic GD&T

Duty Title: 1.09 Selection and safe use of proper hand tool for a task
Duty: Use hand tools to inspect, adjust/tighten and assemble/disassemble equipment support preventive maintenance, inspection and troubleshooting activities

Duty Title: 1.10 Move, handle and store materials and equipment
Duty: Use hoists and other tools to safely handle and move parts and equipment

Duty Title*:* 1.11 Systems troubleshooting methodologies
Duty: Select and use troubleshooting methodologies to find malfunctions in machine systems to return the system to reliable, productive use in the shortest time possible

B. MAINTENANCE OPERATIONS: PERFORMANCE STANDARDS

Duty Title: 1.01. Adhere to safety, health and environmental rules and regulations (MO)

Duty: Adhere to safety, health and environmental rules and regulations to avoid workplace injury and maximize machine productivity

Performance Standard:

- Identify roles and responsibilities for safety, health and environment
- Adhere to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace
- Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)
- Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state
- Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job
- Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information
- List and select proper fall protection for working at heights and using ladders, scaffolding and lifts
- Identify and recognize 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)
- Describe the process used to perform a job safety analysis
- Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)
- Identify fuel source and selection of correct extinguisher class

KSAO	Duty Titles
KNOWLEDGE	**The attainment of facts and principles**
3. Customer Service	1.01, 1.04, 1.05
SKILLS	**Developed capabilities to work with given Knowledge**
1. Basic	Developed capacities that facilitate learning or the more rapid acquisition of knowledge
1.6 Operation Monitoring	1.01, 1.02, 1.03, 1.04, 1.05, 1.10
4. Social	Developed capacities used to work with people to achieve goals
4.2 Instructing	1.01, 1.02, 1.03, 1.04, 1.05
4.3 Perceptiveness	1.01, 1.02, 1.03, 1.07, 1.08

Duty Title: 1.02. Operate a machine (MO)

Duty: Perform machine operation, including startup, emergency and normal shutdown and manual functions to effectively and safely meet production and maintenance requirements (with operator present)

Performance Standard:

- Perform a safety checklist - Check equipment to make sure it is ready to come online - Check correct operation of safety devices - Check operation of machine interlocks
- Define machine malfunction
- Define standard operating procedures
- Work with operations to start and stop an operation
- Describe when a machine needs to be shut down
- Explain lockout process and perform

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
7	Production and Processing	1.02, 1.03, 1.05, 1.06, 1.07, 1.08
SKILLS		**Developed capabilities to work with given Knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.6	Operation Monitoring	1.01, 1.02, 1.03, 1.04, 1.05, 1.10
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	1.02, 1.03, 1.04, 1.05, 1.11
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.2	Time Management	1.02, 1.04, 1.05, 1.06, 1.07
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	1.02 thru 1.11
4.2	Instructing	1.01, 1.02, 1.03, 1.04, 1.05
4.3	Perceptiveness	1.01, 1.02, 1.03, 1.07, 1.08

5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	1.02, 1.04, 1.07, 1.08, 1.11
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	1.02, 1.03, 1.05, 1.06, 1.07, 1.09
6.5	Operational Analysis	1.02, 1.03, 1.04, 1.05, 1.08, 1.11
6.6	Operational Control	1.02, 1.05, 1.06
6.8	Quality Control	1.02, 1.03, 1.04, 1.05, 1.07, 1.11
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	1.02, 1.03, 1.05
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	1.02, 1.05, 1.09
3.3	Reaction Time	1.01, 1.02, 1.03
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	1.01, 1.02, 1.05
4.2	Speech Clarity	All
4.3	Speech Recognition	All

Duty Title: 1.03. Monitor a machine (MO)

Duty: Monitor machine operation and verify that performance meets production requirements

Performance Standard:

- Confirm with operator that machine is operating within specifications
- Use 5 senses to observe machine operation and vibration to determine if it is operating correctly and recognize symptoms of malfunctions
- Evaluate operator use of correct operation procedure
- Look for leaks, dirt and loose connections
- Read pressure gauges, flow meters, fluid levels, temperature gauges, voltages and current
- Use an HMI to monitor the machine
- Compare machine readings with machine documentation and performance specifications to determine if machine is performing within specifications
- Record machine operation history in a manual log or computer database

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
7	Production and Processing	1.02, 1.03, 1.05, 1.06, 1.07, 1.08
SKILLS		**Developed capabilities to work with given Knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.6	Operation Monitoring	1.01, 1.02, 1.03, 1.04, 1.05, 1.10
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	1.02, 1.03, 1.04, 1.05, 1.11
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	1.02 thru 1.11

4.2	Instructing	1.01, 1.02, 1.03, 1.04, 1.05
4.3	Perceptiveness	1.01, 1.02, 1.03, 1.07, 1.08
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	1.02, 1.03, 1.05, 1.06, 1.07, 1.09
6.5	Operational Analysis	1.02, 1.03, 1.04, 1.05, 1.08, 1.11
6.7	Programming	1.03, 1.04, 1.05, 1.06, 1.08
6.8	Quality Control	1.02, 1.03, 1.04, 1.05, 1.07, 1.11
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	1.02, 1.03, 1.05
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.3	Reaction Time	1.01, 1.02, 1.03
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	All
4.3	Speech Recognition	All

Duty Title: 1.04. Interpret machine operation and maintenance documentation (MO)

Duty: Locate, interpret and store machine operation and maintenance documentation

Performance Standard:

- Describe methods of storing machine operation and maintenance documentation so it is accessible to the maintenance technicians and operators
- Locate and interpret machine operation manuals, including identification of safety requirements and features, performance specifications, standard operating procedures, startup/shutdown procedures
- Locate and interpret spare parts lists, vendor sources and maintenance procedures for a given machine
- Locate and interpret machine maintenance logs, computer-based and manual, for a given machine
- Locate and interpret machine operation history logs, computer-based and manual, for a given machine
- Locate and interpret machine operation history from an HMI database for a given machine
- Locate and interpret machine lubrication and preventive maintenance schedules from company or machine manufacturer documentation

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
3	Customer Service	1.01, 1.04, 1.05
SKILLS		**Developed capabilities to work with given Knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.5	Mathematics	1.04, 1.05, 1.10, 1.11
1.6	Operation Monitoring	1.01, 1.02, 1.03, 1.04, 1.05, 1.10
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**

2.1	Problem Solving	1.02, 1.03, 1.04, 1.05, 1.11
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.2	Time Management	1.02, 1.04, 1.05, 1.06, 1.07
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	1.02 thru 1.11
4.2	Instructing	1.01, 1.02, 1.03, 1.04, 1.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	1.02, 1.04, 1.07, 1.08, 1.11
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.3	Installation Design	1.04 thru 1.11
6.5	Operational Analysis	1.02, 1.03, 1.04, 1.05, 1.08, 1.11
6.7	Programming	1.03, 1.04, 1.05, 1.06, 1.08
6.8	Quality Control	1.02, 1.03, 1.04, 1.05, 1.07, 1.11
6.10	Technology	1.04, 1.07, 1.11
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.4	Fluency	1.04, 1.05, 1.09, 1.11
1.11	Perceptual	1.04, 1.05, 1.07, 1.08, 1.09
1.12	Technical Design	1.04 thru 1.11
1.13	Time Sharing	1.01, 1.04, 1.05, 1.11
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	All
4.3	Speech Recognition	All

Duty Title: 1.05. Perform machine maintenance procedures (MO)

Duty: Perform planned and unscheduled machine maintenance procedures in accordance with a company-approved maintenance specifications

Performance Standard:

- Define concept of total productive maintenance (TPM) - combination of preventive, predictive and total company buy-in
- Explain benefits and limitations of preventive maintenance and predictive maintenance
- Identify and use company procedures to inform production personnel of maintenance to be done on a machine
- Describe use of CMMS (computer maintenance management system) system
- Determine when a work order is needed
- Identify and perform the steps to perform an unscheduled and planned maintenance procedure
- Describe the concept of autonomous maintenance - wherein operator performs cleaning, basic adjustments and preventive maintenance
- Describe elements of a comprehensive maintenance plan
- Describe methods of eliminating unplanned maintenance events
- Describe types of planned and unplanned maintenance procedures
- Explain how to read, interpret and resolve work order

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	1.05, 1.08, 1.09 1.10, 1.11
3	Customer Service	1.01, 1.04, 1.05
5	Mechanical	1.05 thru 1.11
7	Production and Processing	1.02, 1.03, 1.05, 1.06, 1.07, 1.08
SKILLS		**Developed capabilities to work with given Knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**

1.2	Application	1.05, 1.06, 1.09, 1.10, 1.11
1.5	Mathematics	1.04, 1.05, 1.10, 1.11
1.6	Operation Monitoring	1.01, 1.02, 1.03, 1.04, 1.05, 1.10
1.8	Science	1.05, 1.08, 1.11
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	1.02, 1.03, 1.04, 1.05, 1.11
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.2	Time Management	1.02, 1.04, 1.05, 1.06, 1.07
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	1.02 thru 1.11
4.2	Instructing	1.01, 1.02, 1.03, 1.04, 1.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.2	Decision Making	1.05, 1.07, 1.11
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	1.02, 1.03, 1.05, 1.06, 1.07, 1.09
6.2	Equipment Selection	1.05, 1.06, 1.08, 1.09
6.3	Installation Design	1.04 thru 1.11
6.4	Installation Technical	1.05, 1.06, 1.07, 1.09, 1.10,
6.5	Operational Analysis	1.02, 1.03, 1.04, 1.05, 1.08, 1.11
6.6	Operational Control	1.02, 1.05, 1.06
6.7	Programming	1.03, 1.04, 1.05, 1.06, 1.08
6.8	Quality Control	1.02, 1.03, 1.04, 1.05, 1.07, 1.11
6.9	Repair	1.05
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	1.02, 1.03, 1.05
1.4	Fluency	1.04, 1.05, 1.09, 1.11
1.10	Number Proficiency	1.05, 1.09
1.11	Perceptual	1.04, 1.05, 1.07, 1.08, 1.09

1.13	Time Sharing	1.01, 1.04, 1.05, 1.11
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	1.05, 1.09, 1.10
2.2	Strength	1.05, 1.09, 1.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	1.02, 1.05, 1.09
3.2	Dexterity	1.05, 1.09, 1.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	1.01, 1.02, 1.05
4.2	Speech Clarity	All
4.3	Speech Recognition	All
4.4	Visual Depth Perception	1.05, 1.09, 1.10

Duty Title: 1.06. Perform preventive maintenance (MO)

Duty: Perform a preventive maintenance procedure for a given machine to extend machine life and minimize downtime in accordance with company-approved maintenance specifications

Performance Standard:

- Describe a preventive maintenance procedure given machine documentation
- Identify types of preventive maintenance: changing oil, checking fluid levels, tightening machine, changing filters, checking gaskets and replacing certain components on a predetermined basis.
- Identify and remove sources of contamination, select best methods of cleaning machine based upon continuous improvement principle

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	1.06, 1.07, 1.08, 1.10, 1.11
5	Mechanical	1.05 thru 1.11
7	Production and Processing	1.02, 1.03, 1.05, 1.06, 1.07, 1.08
SKILLS		**Developed capabilities to work with given Knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	1.05, 1.06, 1.09, 1.10, 1.11
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.2	Time Management	1.02, 1.04, 1.05, 1.06, 1.07
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	1.02 thru 1.11
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	1.02, 1.03, 1.05, 1.06, 1.07, 1.09

6.2	Equipment Selection	1.05, 1.06, 1.08, 1.09
6.3	Installation Design	1.04 thru 1.11
6.4	Installation Technical	1.05, 1.06, 1.07, 1.09, 1.10,
6.6	Operational Control	1.02, 1.05, 1.06
6.7	Programming	1.03, 1.04, 1.05, 1.06, 1.08
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	1.04 thru 1.11
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	All
4.3	Speech Recognition	All

Duty Title: 1.07. Perform predictive maintenance (MO)

Duty: Perform predictive maintenance on a given machine to extend machine life and minimize downtime in accordance with company-approved specifications

Performance Standard:

- Describe basic elements and benefits of a predictive maintenance plan
- Identify types of predictive maintenance methods and their applications using basic senses (hearing, feeling, etc.) and inspection techniques: vibration analysis, thermography, oil analysis, acoustic analysis, motor current analysis
- Perform predictive maintenance

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	1.06, 1.07, 1.08, 1.10, 1.11
5	Mechanical	1.05 thru 1.11
7	Production and Processing	1.02, 1.03, 1.05, 1.06, 1.07, 1.08
SKILLS		**Developed capabilities to work with given Knowledge**
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.2	Time Management	1.02, 1.04, 1.05, 1.06, 1.07
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	1.02 thru 1.11
4.3	Perceptiveness	1.01, 1.02, 1.03, 1.07, 1.08
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.2	Decision Making	1.05, 1.07, 1.11
5.3	Evaluation	1.02, 1.04, 1.07, 1.08, 1.11
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving**

		application of machines or technological systems
6.1	Equipment Maintenance	1.02, 1.03, 1.05, 1.06, 1.07, 1.09
6.3	Installation Design	1.04 thru 1.11
6.4	Installation Technical	1.05, 1.06, 1.07, 1.09, 1.10,
6.8	Quality Control	1.02, 1.03, 1.04, 1.05, 1.07, 1.11
6.10	Technology	1.04, 1.07, 1.11
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.11	Perceptual	1.04, 1.05, 1.07, 1.08, 1.09
1.12	Technical Design	1.04 thru 1.11
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	All
4.3	Speech Recognition	All

Duty Title: 1.08. Introduction to technical drawings (MO)

Duty: Read and interpret technical drawings of parts and assemblies with tolerances and basic GD&T

Performance Standard:

- Read and interpret technical drawings of parts and assemblies with tolerances and basic GD&T
- Identify line types and basic symbology
- Identify multi-view drawings of cylindrical and prismatic-shaped parts
- Perform metric and English dimension conversions
- Identify dimension lines for linear, circular and angular dimensions
- Identify title blocks
- Identify feature sizes using a drawing scale
- Identify GD&T feature control frames
- Identify standard dimensional tolerance
- Identify GD&T tolerances for form orientation, location
- Identify assembly drawings
- Identify assembly tolerances, interference fit concept
- Identify maximum material condition symbols
- Identify sectional cutaway views
- Identify threaded and non-threaded fastener specifications
- Identify a type of fastener given a sample
- Identify and select a fastener for a given application
- Identify sizes and types of washers, pins, nuts, locking devices

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	1.05, 1.08, 1.09 1.10, 1.11
4	Mathematics	1.06, 1.07, 1.08, 1.10, 1.11
5	Mechanical	1.05 thru 1.11
6	Physics	1.08, 1.09, 1.10, 1.11
7	Production and Processing	1.02, 1.03, 1.05, 1.06, 1.07, 1.08
SKILLS		**Developed capabilities to work with given Knowledge**

1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.8	Science	1.05, 1.08, 1.11
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	1.08
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	1.02 thru 1.11
4.3	Perceptiveness	1.01, 1.02, 1.03, 1.07, 1.08
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	1.02, 1.04, 1.07, 1.08, 1.11
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	1.05, 1.06, 1.08, 1.09
6.3	Installation Design	1.04 thru 1.11
6.5	Operational Analysis	1.02, 1.03, 1.04, 1.05, 1.08, 1.11
6.7	Programming	1.03, 1.04, 1.05, 1.06, 1.08
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.11	Perceptual	1.04, 1.05, 1.07, 1.08, 1.09
1.12	Technical Design	1.04 thru 1.11
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	All
4.3	Speech Recognition	All

Duty Title: 1.09. Selection and safe use of proper hand tools for a task (MO)

Duty: Use hand tools to inspect, adjust, loosen/tighten and assemble/disassemble equipment support preventive maintenance, inspection and troubleshooting activities

Performance Standard:

- Describe basic hand tool safety rules and application for use as defined by OSHA standards
- Identify concepts of how a fastener works, force, torque, dynamic and static torques, press fits, assembly tolerances
- Identify proper fastener selection (select proper fasteners to assemble parts)
- Select and use screw and nut drivers, straight, Phillips and hex
- Select and use fixed wrenches: box, open end, etc.
- Select and use Allen/hex key wrenches
- Select and use ratchet wrenches
- Select and use a click-type torque wrench
- Select and proper use of pullers
- Select and use pliers, clamps and mallets
- Select and use pneumatic powered torque wrenches
- Select and use electric powered hand tools: drills, torque wrenches and screwdrivers
- Select and use methods to protect parts and components during handling and storage
- Assemble parts using threaded fasteners (bolts and machine screws), washers and nuts
- Assemble parts using pins (clevis, taper, dowel, spring, roll, shear)
- Assemble parts using keys, clips, snap rings and tie wraps
- Tighten parts using correct bolt pattern sequence

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	1.05, 1.08, 1.09 1.10, 1.11
5	Mechanical	1.05 thru 1.11
6	Physics	1.08, 1.09, 1.10, 1.11
SKILLS		**Developed capabilities to work with given Knowledge**

1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	1.05, 1.06, 1.09, 1.10, 1.11
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	1.02 thru 1.11
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	1.02, 1.03, 1.05, 1.06, 1.07, 1.09
6.2	Equipment Selection	1.05, 1.06, 1.08, 1.09
6.4	Installation Technical	1.05, 1.06, 1.07, 1.09, 1.10,
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.4	Fluency	1.04, 1.05, 1.09, 1.11
1.8	Mathematical Reasoning	1.09, 1.10, 1.11
1.10	Number Proficiency	1.05, 1.09
1.11	Perceptual	1.04, 1.05, 1.07, 1.08, 1.09
1.12	Technical Design	1.04 thru 1.11
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	1.05, 1.09, 1.10
2.2	Strength	1.05, 1.09, 1.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	1.02, 1.05, 1.09
3.2	Dexterity	1.05, 1.09, 1.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	All
4.3	Speech Recognition	All
4.4	Visual Depth Perception	1.05, 1.09, 1.10

Duty Title: 1.10. Move, handle and store materials and equipment (MO)

Duty: Use rigging techniques, hoists, slings and other tools to safely handle and move parts and equipment

Performance Standard:

- Describe and demonstrate rigging safety including load capacity
- Inspect a hoist and determine if it is safe to use
- Use manual and powered hoists using cantilevered and gantry configurations
- Determine and calculate center of gravity for load balance
- Determine proper use eyebolts for lifting parts
- Explain and use basic rigging techniques and types of slings, come-a-longs, blocking, chaining to lift a load
- Describe basic concepts of force, center of gravity, force vectors, rated load, crush force (load charts)
- Use a manual pry bar and truck to move a load
- Use a hydraulic jack to lift a load
- Use a dolly to move a load
- Use proper containment methods to store a component
- Handle parts using proper contamination prevention methods
- Inspect components for contamination and take corrective action

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	1.05, 1.08, 1.09 1.10, 1.11
4	Mathematics	1.06, 1.07, 1.08, 1.10, 1.11
5	Mechanical	1.05 thru 1.11
6	Physics	1.08, 1.09, 1.10, 1.11
SKILLS		**Developed capabilities to work with given Knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	1.05, 1.06, 1.09, 1.10, 1.11
1.5	Mathematics	1.04, 1.05, 1.10, 1.11

1.6	Operation Monitoring	1.01, 1.02, 1.03, 1.04, 1.05, 1.10
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	1.02 thru 1.11
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.3	Installation Design	1.04 thru 1.11
6.4	Installation Technical	1.05, 1.06, 1.07, 1.09, 1.10,
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	1.09, 1.10, 1.11
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	1.05, 1.09, 1.10
2.2	Strength	1.05, 1.09, 1.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	1.05, 1.09, 1.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	All
4.3	Speech Recognition	All
4.4	Visual Depth Perception	1.05, 1.09, 1.10

Duty Title: 1.11. Systems troubleshooting methodologies (MO)

Duty: Select and use troubleshooting methodologies to find malfunctions in a machine system to return the system to reliable, productive use in the shortest time possible

Performance Standard:

- Describe and apply methodologies to isolate problems to a particular sub-system; 5 why, fishbone, flow charts, half-split method, etc.
- Describe and apply effective interpersonal skills to interact with production personnel, vendors and colleagues
- Apply effective observation and interview strategies to validate the problem and determine the most effective troubleshooting strategy
- Analyze production information, maintenance and operation documents to assist in troubleshooting a malfunction

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	1.05, 1.08, 1.09 1.10, 1.11
4	Mathematics	1.06, 1.07, 1.08, 1.10, 1.11
5	Mechanical	1.05 thru 1.11
6	Physics	1.08, 1.09, 1.10, 1.11
SKILLS		**Developed capabilities to work with given Knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	1.05, 1.06, 1.09, 1.10, 1.11
1.5	Mathematics	1.04, 1.05, 1.10, 1.11
1.8	Science	1.05, 1.08, 1.11
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	1.02, 1.03, 1.04, 1.05, 1.11
4	**Social**	**Developed capacities used to work with people to achieve goals**

4.1	Coordination	1.02 thru 1.11
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	1.11
5.2	Decision Making	1.05, 1.07, 1.11
5.3	Evaluation	1.02, 1.04, 1.07, 1.08, 1.11
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.3	Installation Design	1.04 thru 1.11
6.5	Operational Analysis	1.02, 1.03, 1.04, 1.05, 1.08, 1.11
6.8	Quality Control	1.02, 1.03, 1.04, 1.05, 1.07, 1.11
6.10	Technology	1.04, 1.07, 1.11
6.11	Troubleshooting	1.11
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.4	Fluency	1.04, 1.05, 1.09, 1.11
1.8	Mathematical Reasoning	1.09, 1.10, 1.11
1.12	Technical Design	1.04 thru 1.11
1.13	Time Sharing	1.01, 1.04, 1.05, 1.11
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	All
4.3	Speech Recognition	All

IMT Level I – General: Knowledge, Skills, Abilities and Other Characteristics (KSAOs)

The performance standards for an Industrial Maintenance Technician (IMT) Level I consist of nine (9) Duty Areas:

- Duty Area 1: Maintenance Operations
- Duty Area 2: Basic Mechanical Systems
- Duty Area 3: Basic Hydraulic Systems
- Duty Area 4: Basic Pneumatic Systems
- Duty Area 5: Electrical Systems
- Duty Area 6: Electronic Control Systems
- Duty Area 7: Process Control Systems
- Duty Area 8: Maintenance Welding
- Duty Area 9: Maintenance Piping

The following KSAOs are held in common and apply to all nine areas and their corresponding Duty Titles

Inclusive KSAOs for IMT Level I	
KNOWLEDGE	**The attainment of facts and principles**
2. Communications	Knowledge of communication, dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, audial and visual media.
8. Public Safety and Security	Knowledge of relevant equipment, policies, procedures and strategies to promote effective local, state or national security operations for the protection of people, data, property and institutions.
SKILLS	**Developed capabilities to work with given knowledge**
1. Basic	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**

1.1 Active Learning and Listening	Understanding the implications of new information, utilizing in problem solving and decision making
1.3 Communication	Understanding the appropriate uses to convey and receive information
1.4 Effective Speaking and Writing	Communicating and conveying information verbally and in writing
1.7 Reading Comprehension	Understanding written material in work related documents
ABILITIES	**Attributes that influence performance**
1. Cognitive	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.2 Deductive Reasoning	Ability to apply general rules to specific problems
1.3 Expression	Ability to communicate information and ideas in writing and speaking so others can understand
1.5 Focus	Capability to pay attention to specifics or details with distractions
1.6 Inductive Reasoning	Ability to combined pieces of information to form general rules or conclusions
1.7 Information Organization	Ability to arrange objects or actions in an order or pattern related to a specific rule or set of rules
1.9 Memorization	Ability to remember information
OTHER CHARACTERISTICS	**Characteristics that may influence or have an effect towards work performance and influence occupational requirements**
1. Work Activities	**Performing specific functions or duties**
1.1. Controlling Machines and Processes	Utilizing mechanisms or direct physical activity to operate machines or processes
1.2. Drafting, Layout and Specification	Drawing, designing, detailing instructions or specifications for devices, parts, equipment for fabrication, assembly or maintaining
1.3. Handling and Moving Objects	Handling, installing, moving and positioning of materials
1.4. Inspection	Inspecting equipment, structures or materials to identify the cause of errors or other problems or defects
1.5. Monitoring	Monitor and review information from material, events, equipment or environment

1.6. Organization and Decision Making	Organize, plan, prioritize, analyze and evaluate information
1.7. Repairing and Maintaining	Servicing, repairing, adjusting and testing machines, devices, moving parts and equipment
2. Work Interests	**Preferences to work environments**
2.1. Conventional	Work activities that follow procedures, rules and routines. Working with data and details. Working under a line of authority
2.2. Investigative	Working with ideas and an extensive amount of thinking. Exploring and searching for facts and figuring out problems mentally
2.3. Realistic	Work activities that include practical, hands-on problems and solutions. Working with materials like wood, tools and machinery. Working outside and indoors
3. Work Styles	**Personal characteristics that can affect job performance**
3.1. Adaptability	Open to change
3.2. Analytical Thinking	Using logic to address problems
3.3. Attention to Detail	Being careful about detail and thorough in completing tasks
3.4. Dependability	Being reliable, responsible and fulfilling obligations
3.5. Initiative	Willingness to take on responsibilities and challenges
3.6. Persistence	Being diligent in the face of obstacles
3.7. Self-control	Maintaining composure in difficult situations
3.8. Stress Tolerance	Accepting criticism and dealing effectively with high stress situations
4. Work Values	**Global aspects important to a person's satisfaction**
4.1. Achievement	Result oriented, use of strongest abilities, giving a feeling of accomplishment
4.2. Independence	Responsible, work on own and make decisions, giving a feeling of autonomy
4.3. Relationships	Provide services to others and work with co-workers in a friendly non-competitive environment, giving a feeling of worth

II. DUTY AREA 2: BASIC MECHANICAL SYSTEMS (BMS)

A. DUTIES AND DUTY TITLES

Duty Title: 2.01 Adhere to mechanical power transmission safety rules
Duty: Adhere to safety, health and environmental rules and regulations for mechanical power transmission systems

Duty Title: 2.02 Use dimensional measurement tools
Duty: Use measurement hand tools to inspect dimensions of shafts and other components

Duty Title: 2.03 Power transmission
Duty: Install and align a shaft couplings (types flexible, flange, grid and chain) using rim/face, feeler gauge and laser methods. Install, align and tension a belt drive, including single and multiple belts systems and using v-belts, timing and HTP types. Install, align and tension a chain drive, including single and multiple chain systems

Duty Title: 2.04 Alignment and adjustment of a gear drive
Duty: Install, align and adjust a spur gear drive and a right angle gear drive

Duty Title: 2.05 Install, align and adjust a pillow block bearing
Duty: Install, align and adjust a pillow and flange block bearing

Duty Title: 2.06 Equipment lubrication
Duty: Identify all lubrication points on a machine, select lubricant and apply lubricant to machine according to maintenance schedule

Duty Title: 2.07 Power transmissions troubleshooting
Duty: Apply troubleshooting techniques for shaft couplings (types flexible, flange, grid and chain) and belt drives, including single and multiple belts systems and using v-belts, timing and HTD type and chain drives, including single and multiple chain systems

B. BASIC MECHANICAL SYSTEMS: PERFORMANCE STANDARDS

Duty Title: 2.01. Adhere to mechanical power transmission system safety rules (BMS)

Duty: Adhere to safety, health and environmental rules and regulations for mechanical power transmission systems

Performance Standard:

- Identify roles and responsibilities for safety, health and environment
- Adhere to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace
- Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)
- Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state
- Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job
- Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information
- List and select proper fall protection for working at heights and using ladders, scaffolding and lifts
- Identify and recognize 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)
- Describe the process used to perform a job safety analysis
- Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)
- Identify fuel source and selection of correct extinguisher class

BMS-Specific:

- Explain the purpose of machine guarding for mechanical power transmission systems
- Identify required machine guarding for mechanical power transmission systems
- Describe how to safely store and dispose lubricants and maintenance chemicals

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
3	Customer Service	2.01, 2.07
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.6	Operation Monitoring	All
4	**Skills: Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	2.01
4.2	Instructing	2.01
4.3	Perceptiveness	2.01
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.3	Installation Design	All
6.4	Installation Technical	All
6.5	Operational Analysis	All
6.6	Operational Control	2.01, 2.03, 2.07
6.10	Technology	2.01, 2.03, 2.07
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.13	Time Sharing	2.01, 2.07
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.3	Reaction Time	2.01, 2.07
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.2	Speech Clarity	2.01
4.3	Speech Recognition	2.01

Duty Title: 2.02. Use dimensional measurement tools (BMS)

Duty: Use measurement hand tools to inspect dimensions of shafts and other components

Performance Standard:

- Use metric, decimal and inch fraction rules
- Apply English and metric units conversions of measurement
- Use digital calipers and dial calipers
- Use digital and vernier micrometers
- Recognize and explain the difference between Resolution, Repeatability, Accuracy
- Identify and select a measurement tool for a given task based on needed accuracy and feature to be measured
- Describe how to check calibration of a measurement tool - concept of a master
- Use a dial indicator or digital indicator to measure TIR (run out), flatness and other features
- Describe the concept of indirect measurement

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	2.02 thru 2.07
4	Mathematics	2.02 thru 2.07
5	Mechanical	2.02 thru 2.07
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	2.02 thru 2.07
1.5	Mathematics	2.02 thru 2.07
1.6	Operation Monitoring	All
1.8	Science	2.02 thru 2.07
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	2.02 thru 2.07
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**

5.3	Evaluation	2.02 thru 2.07
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	2.02 thru 2.07
6.3	Installation Design	All
6.4	Installation Technical	All
6.5	Operational Analysis	All
6.8	Quality Control	2.02 thru 2.07
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	2.02 thru 2.07
1.8	Mathematical Reasoning	2.02 thru 2.07
1.10	Number Proficiency	2.02 thru 2.07
1.11	Perceptual	2.02 thru 2.07
1.12	Technical Design	2.02 thru 2.07
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	2.02 thru 2.07
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All

Duty Title: 2.03. Power transmission (BMS)

Duty: Install and align a shaft couplings (types flexible, flange, grid and chain) using rim/face, feeler gauge and laser methods

Performance Standard:

- Describe how to mount a motor
- Describe how to correct for a soft foot on a motor
- Describe how to level motors and shaft
- Install flexible, flange, grid and chain couplings
- Identify couplings given a specification
- Use manufacturer's documentation to locate alignment specifications of a coupling
- Measure shaft speed using a tachometer
- Align a shaft using various equipment techniques; feeler gauge and straight edge, rim and face, dial indicators and laser aligning equipment
- Describe how to install a multiple v-belt drive onto a shaft with a bushing (define)
- Describe how to install a timing belt or HTD belt onto a shaft using a bushing
- Describe how to install split taper, QD and taper lock bushings
- Interpret specifications of sheaves and v-belts
- Identify v-belt drive components given a specification
- Align a v-belt drive using a straight edge
- Check tension of a v-belt drive using a tension tool
- Tension a v-belt drive by positioning the prime mover
- Interpret specifications of sprockets and chains given a specification
- Install a chain drive using proper tools
- Align a chain drive using a straight edge
- Check tension of a chain drive using a straight edge and rule
- Tension a chain drive by positioning the prime mover

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	2.02 thru 2.07
4	Mathematics	2.02 thru 2.07
5	Mechanical	2.02 thru 2.07
SKILLS		**Developed capabilities to work with given knowledge**

1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	2.02 thru 2.07
1.5	Mathematics	2.02 thru 2.07
1.6	Operation Monitoring	All
1.8	Science	2.02 thru 2.07
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	2.02 thru 2.07
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	2.02 thru 2.07
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	2.03, 2.06
6.2	Equipment Selection	2.02 thru 2.07
6.3	Installation Design	All
6.4	Installation Technical	All
6.5	Operational Analysis	All
6.6	Operational Control	2.01, 2.03, 2.07
6.8	Quality Control	2.02 thru 2.07
6.10	Technology	2.01, 2.03, 2.07
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	2.02 thru 2.07
1.8	Mathematical Reasoning	2.02 thru 2.07
1.10	Number Proficiency	2.02 thru 2.07
1.11	Perceptual	2.02 thru 2.07
1.12	Technical Design	2.02 thru 2.07
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	2.02 thru 2.07

4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All

Duty Title: 2.04. Alignment and adjustment of a gear drive (BMS)

Duty: Install, align and adjust a spur gear drive and a right angle gear drive

Performance Standard:

- Explain how gears are attached to shafts through keys and keyways
- Interpret specifications of gears
- Identify spur and right angle gear components given a specification
- Align a gear drive using a straight edge (define straight edge)
- Explain how to check backlash of gears using a dial indicator per specifications

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	2.02 thru 2.07
4	Mathematics	2.02 thru 2.07
5	Mechanical	2.02 thru 2.07
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	2.02 thru 2.07
1.5	Mathematics	2.02 thru 2.07
1.6	Operation Monitoring	All
1.8	Science	2.02 thru 2.07
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	2.02 thru 2.07
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	2.02 thru 2.07
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**

6.2	Equipment Selection	2.02 thru 2.07
6.3	Installation Design	All
6.4	Installation Technical	All
6.5	Operational Analysis	All
6.8	Quality Control	2.02 thru 2.07
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	2.02 thru 2.07
1.8	Mathematical Reasoning	2.02 thru 2.07
1.10	Number Proficiency	2.02 thru 2.07
1.11	Perceptual	2.02 thru 2.07
1.12	Technical Design	2.02 thru 2.07
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	2.02 thru 2.07
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All

Duty Title: 2.05. Install, align and adjust pillow block and flange bearings (BMS)

Duty: Install, align and adjust pillow block and flange bearings

Performance Standard:

- Interpret specifications of pillow block and flange bearings
- Identify pillow block bearings given a specification
- Install, align and adjust pillow block and flange bearings

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	2.02 thru 2.07
4	Mathematics	2.02 thru 2.07
5	Mechanical	2.02 thru 2.07
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	2.02 thru 2.07
1.5	Mathematics	2.02 thru 2.07
1.6	Operation Monitoring	All
1.8	Science	2.02 thru 2.07
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	2.02 thru 2.07
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	2.02 thru 2.07
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	2.02 thru 2.07
6.3	Installation Design	All
6.4	Installation Technical	All

6.5	Operational Analysis	All
6.8	Quality Control	2.02 thru 2.07
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	2.02 thru 2.07
1.8	Mathematical Reasoning	2.02 thru 2.07
1.10	Number Proficiency	2.02 thru 2.07
1.11	Perceptual	2.02 thru 2.07
1.12	Technical Design	2.02 thru 2.07
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	2.02 thru 2.07
3.2	Dexterity	2.07
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All

Duty Title: 2.06. Equipment lubrication (BMS)

Duty: Identify all lubrication points on a machine, select lubricant and apply lubricant to machine according to maintenance schedule

Performance Standard:

- Explain importance of a lubrication plan
- Identify all oil and grease lubrication points using the manual
- Identify/ select correct lubricant given a specification from the manual
- Describe the procedure for safe handling and storage of lubricants
- Lubricate bearings using Zerk fittings
- Use a grease gun to lubricate a bearing
- Fill an oil cup
- Inspect and fill automatic lubricators
- Explain what is a lubrication oil
- Explain what is a lubricating grease and what different grades are used for
- Explain the purpose of vent plugs
- Explain the purpose of additives and viscosity
- Explain the effects of over- and under-lubrication of bearings

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	2.02 thru 2.07
4	Mathematics	2.02 thru 2.07
5	Mechanical	2.02 thru 2.07
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	2.02 thru 2.07
1.5	Mathematics	2.02 thru 2.07
1.6	Operation Monitoring	All
1.8	Science	2.02 thru 2.07
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	2.02 thru 2.07

3.2	Time Management	2.06
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	2.02 thru 2.07
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	2.03, 2.06
6.2	Equipment Selection	2.02 thru 2.07
6.3	Installation Design	All
6.4	Installation Technical	All
6.5	Operational Analysis	All
6.8	Quality Control	2.02 thru 2.07
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	2.02 thru 2.07
1.8	Mathematical Reasoning	2.02 thru 2.07
1.10	Number Proficiency	2.02 thru 2.07
1.11	Perceptual	2.02 thru 2.07
1.12	Technical Design	2.02 thru 2.07
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	2.02 thru 2.07
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All

Duty Title: 2.07 Power transmissions troubleshooting (BMS)

Duty: Apply troubleshooting techniques for power transmissions

Performance Standard:

- Identify the cause of wear or malfunction of a flexible coupling through visual inspection
- Perform troubleshooting techniques to analyze the wear or malfunction of a V-belt drive
- Perform troubleshooting techniques to analyze the wear or malfunction of a chain drive
- Perform troubleshooting techniques to analyze the wear or malfunction of a gear drive
- Perform troubleshooting techniques to analyze the wear or malfunction of a pillow block bearing

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	2.02 thru 2.07
3	Customer Service	2.01, 2.07
4	Mathematics	2.02 thru 2.07
5	Mechanical	2.02 thru 2.07
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	2.02 thru 2.07
1.5	Mathematics	2.02 thru 2.07
1.6	Operation Monitoring	All
1.8	Science	2.02 thru 2.07
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	2.07
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**

3.1	Material Resources	2.02 thru 2.07
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	2.07
5.2	Decision Making	2.07
5.3	Evaluation	2.02 thru 2.07
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	2.02 thru 2.07
6.3	Installation Design	All
6.4	Installation Technical	All
6.5	Operational Analysis	All
6.6	Operational Control	2.01, 2.03, 2.07
6.8	Quality Control	2.02 thru 2.07
6.9	Repair	2.07
6.10	Technology	2.01, 2.03, 2.07
6.11	Troubleshooting	2.07
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	2.02 thru 2.07
1.4	Fluency	2.07
1.8	Mathematical Reasoning	2.02 thru 2.07
1.10	Number Proficiency	2.02 thru 2.07
1.11	Perceptual	2.02 thru 2.07
1.12	Technical Design	2.02 thru 2.07
1.13	Time Sharing	2.01, 2.07
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	2.07
2.2	Strength	2.07
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**

3.1	Control Precision	2.02 thru 2.07
3.2	Dexterity	2.07
3.3	Reaction Time	2.01, 2.07
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	2.07

IMT Level I – General:

Knowledge, Skills, Abilities and Other Characteristics (KSAOs)

The performance standards for an Industrial Maintenance Technician (IMT) Level I consists of nine (9) Duty Areas.

Duty Area 1: Maintenance Operations
Duty Area 2: Basic Mechanical Systems
Duty Area 3: Basic Hydraulic Systems
Duty Area 4: Basic Pneumatic Systems
Duty Area 5: Electrical Systems
Duty Area 6: Electronic Control Systems
Duty Area 7: Process Control Systems
Duty Area 8: Maintenance Welding
Duty Area 9: Maintenance Piping

The following KSAOs are held in common and apply to all nine areas and their corresponding Duty Titles.

Inclusive KSAOs for IMT Level I	
KNOWLEDGE	**The attainment of facts and principles**
2. Communications	Knowledge of communication, dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, audial and visual media.
8. Public Safety and Security	Knowledge of relevant equipment, policies, procedures and strategies to promote effective local, state or national security operations for the protection of people, data, property and institutions.
SKILLS	**Developed capabilities to work with given knowledge**
1. Basic	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.1 Active Learning and Listening	Understanding the implications of new information, utilizing in problem solving and decision making
1.3 Communication	Understanding the appropriate uses to convey and receive information
1.4 Effective Speaking and Writing	Communicating and conveying information verbally and in writing
1.7 Reading Comprehension	Understanding written material in work related documents

ABILITIES	**Attributes that influence performance**
1. Cognitive	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.2 Deductive Reasoning	Ability to apply general rules to specific problems
1.3 Expression	Ability to communicate information and ideas in writing and speaking so others can understand
1.5 Focus	Capability to pay attention to specifics or details with distractions
1.6 Inductive Reasoning	Ability to combined pieces of information to form general rules or conclusions
1.7 Information Organization	Ability to arrange objects or actions in an order or pattern related to a specific rule or set of rules
1.9 Memorization	Ability to remember information
OTHER CHARACTERISTICS	**Characteristics that may influence or have an effect towards work performance and influence occupational requirements**
5. Work Activities	**Performing specific functions or duties**
5.1. Controlling Machines and Processes	Utilizing mechanisms or direct physical activity to operate machines or processes
5.2. Drafting, Layout and Specification	Drawing, designing, detailing instructions or specifications for devices, parts, equipment for fabrication, assembly or maintaining
5.3. Handling and Moving Objects	Handling, installing, moving and positioning of materials
5.4. Inspection	Inspecting equipment, structures or materials to identify the cause of errors or other problems or defects
5.5. Monitoring	Monitor and review information from material, events, equipment or environment
5.6. Organization and Decision Making	Organize, plan, prioritize, analyze and evaluate information
5.7. Repairing and Maintaining	Servicing, repairing, adjusting and testing machines, devices, moving parts and equipment
6. Work Interests	**Preferences to work environments**
6.1. Conventional	Work activities that follow procedures, rules and routines. Working with data and details. Working under a line of authority
6.2. Investigative	Working with ideas and an extensive amount of thinking. Exploring and searching for facts and figuring out problems mentally

6.3. Realistic	Work activities that include practical, hands-on problems and solutions. Working with materials like wood, tools and machinery. Working outside and indoors
7. Work Styles	**Personal characteristics that can affect job performance**
7.1. Adaptability	Open to change
7.2. Analytical Thinking	Using logic to address problems
7.3. Attention to Detail	Being careful about detail and thorough in completing tasks
7.4. Dependability	Being reliable, responsible and fulfilling obligations
7.5. Initiative	Willingness to take on responsibilities and challenges
7.6. Persistence	Being diligent in the face of obstacles
7.7. Self-control	Maintaining composure in difficult situations
7.8. Stress Tolerance	Accepting criticism and dealing effectively with high stress situations
8. Work Values	**Global aspects important to a person's satisfaction**
8.1. Achievement	Result oriented, use of strongest abilities, giving a feeling of accomplishment
8.2. Independence	Responsible, work on own and make decisions, giving a feeling of autonomy
8.3. Relationships	Provide services to others and work with co-workers in a friendly non-competitive environment, giving a feeling of worth

III. DUTY AREA 3: BASIC HYDRAULIC SYSTEMS (HS)

A. DUTIES AND DUTY TITLES

Duty Title: 3.01 Adhere to fluid power systems safety rules
Duty: Adhere to safety, health and environmental rules and regulations for fluid power systems

Duty Title: 3.02 Interpret basic fluid power schematics
Duty: Read and interpret basic fluid power schematics including identifying schematic symbols, process flow and operation of the components and systems

Duty Title: 3.03 Start up and shut down a hydraulic system and adjust system pressure
Duty: Start up and shut down a hydraulic system and adjust hydraulic pressure control valves in a system that uses a fixed displacement pump

Duty Title: 3.04 Adjust hydraulic actuator speed using a flow control valve
Duty: Select and adjust hydraulic actuator speed using a flow control valve

Duty Title: 3.05 Service a hydraulic filter
Duty: Inspect and change a hydraulic filter to maximize hydraulic fluid cleanliness

Duty Title: 3.06 Service hydraulic fluid
Duty: Inspect, add and change a hydraulic fluid

Duty Title: 3.07 Install hydraulic conductors
Duty: Connect, adjust and disconnect flexible and rigid hydraulic conductors

Duty Title: 3.08 Install and test components in a basic hydraulic circuit
Duty: Install and test the operation of components in a basic hydraulic linear or rotary actuator circuit given a schematic

Duty Title: 3.09 Troubleshoot a basic hydraulic circuit
Duty: Troubleshoot a basic hydraulic linear or rotary actuator circuit

B. BASIC HYDRAULIC SYSTEMS: PERFORMANCE STANDARDS

Duty Title: 3.01. Adhere to fluid power systems safety rules (HS)

Duty: Adhere to safety, health and environmental rules and regulations for fluid power systems

Performance Standard:

- Identify roles and responsibilities for safety, health and environment
- Adhere to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace
- Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)
- Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state
- Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job
- Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information
- List and select proper fall protection for working at heights and using ladders, scaffolding and lifts
- Identify and recognize 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)
- Describe the process used to perform a job safety analysis
- Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)
- Identify fuel source and selection of correct extinguisher class

HS Specific:

- Identify required machine guarding for fluid power systems
- Describe safe procedures for removing stored hydraulic or pneumatic energy, including systems with accumulators and compressed air reservoirs, perform zero energy verification
- Describe procedures for safe handling and disposal of lubricants, hydraulic oil and other hydraulic/pneumatic components
- Describe dangers of personal contact with pressurized hydraulic or pneumatic streams
- Define procedures to avoid oil fire hazards
- Adhere to guidelines to avoid contact with hot surfaces in fluid power system

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
3	Customer Service	3.01
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	3.01, 3.03, 3.04, 3.05
4.2	Instructing	3.01
4.3	Perceptiveness	3.01
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.6	Operational Control	All
6.10	Technology	3.01, 3.07, 3.08, 3.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.13	Time Sharing	3.01, 3.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.3	Reaction Time	3.01, 3.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.2	Speech Clarity	3.01
4.3	Speech Recognition	3.01

Duty Title: 3.02. Interpret basic fluid power schematics (HS)

Duty: Read and interpret basic fluid power schematics, including identifying schematic symbols, process flow and operation of the components and system

Performance Standard:

- Identify and describe the basic hydraulic components given their NFPA/ ISO schematic symbol
    - Directional control valves, pressure control valve, flow control valves, cylinders, motors, instrumentation, pumps, various types of operators, filters
- Describe the operation of circuits using 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
- Describe the operation of hydraulic circuits that use accumulators, pump uploading, remote pressure control, rapid traverse slow feed and pilot-operated check valves
- Interpret hydraulic line types on a schematic
- Interpret the operation of a basic hydraulic circuit given a schematic
- Identify and describe the basic pneumatic components given their NFPA/ ISO schematic symbol
    - Directional control valves, pressure control valves, flow control valves, cylinders, motors, instrumentation, compressors, various types of operators, filters
- Interpret pneumatic line types on a schematic
- Interpret the operation of a basic pneumatic circuit given a schematic

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	3.02 thru 3.09
5	Mechanical	3.02 thru 3.09
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.5	Mathematics	3.02 thru 3.09

1.6	Operation Monitoring	3.02 thru 3.09
1.8	Science	3.02, 3.03, 3.04, 3.05, 3.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	3.02 thru 3.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.3	Installation Design	3.02 thru 3.09
6.5	Operational Analysis	3.02 thru 3.09
6.6	Operational Control	All
6.8	Quality Control	3.02 thru 3.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	3.02 thru 3.09
1.10	Number Proficiency	3.02 thru 3.09
1.11	Perceptual	3.02 thru 3.09
1.12	Technical Design	3.02 thru 3.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All

Duty Title: 3.03. Start up and shut down a hydraulic system and adjust system pressure (HS)

Duty: Start up and shut down a hydraulic system and adjust hydraulic pressure control valves in a system that uses a fixed displacement pump

Performance Standard:

- Safely start up a hydraulic power system including pre-start inspection
- Safely shut down a hydraulic power system
- Use manufacturer's documentation per specific application to determine correct operating pressure
- Read a pressure gauge
- Adjust the system operating pressure using a relief valve
- Operate manual valves to direct system flow
- Adjust the pressure of a pressure reducing valve
- Adjust the system operating pressure
- Describe the pressure-flow characteristics of types of relief valves, direct and pilot operated
- Describe the operation of a double acting cylinder, motor, hydraulic sequence valve and pressure reducing valve
- Describe the pressure-flow characteristics of fixed and variable displacement pumps
- Describe how to do pressure checks and charge accumulators
- Describe the pressure vs. force/torque output characteristics of cylinders and motors
- Describe Pascal's law and its importance in reading system pressure

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	3.02 thru 3.09
5	Mechanical	3.02 thru 3.09
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**

1.2	Application	3.03 thru 3.09
1.5	Mathematics	3.02 thru 3.09
1.6	Operation Monitoring	3.02 thru 3.09
1.8	Science	3.02, 3.03, 3.04, 3.05, 3.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	3.02 thru 3.18
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	3.01, 3.03, 3.04, 3.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	3.03 thru 3.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	3.03 thru 3.09
6.2	Equipment Selection	3.03 thru 3.09
6.3	Installation Design	3.02 thru 3.09
6.4	Installation Technical	3.03 thru 3.09
6.5	Operational Analysis	3.02 thru 3.09
6.6	Operational Control	All
6.8	Quality Control	3.02 thru 3.09
6.9	Repair	3.03 thru 3.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	3.03 thru 3.09

1.8	Mathematical Reasoning	3.02 thru 3.09
1.10	Number Proficiency	3.02 thru 3.09
1.11	Perceptual	3.02 thru 3.09
1.12	Technical Design	3.02 thru 3.09
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	3.03 thru 3.09
2.2	Strength	3.03 thru 3.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	3.03 thru 3.09
3.2	Dexterity	3.03 thru 3.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	3.03 thru 3.09

Duty Title: 3.04. Adjust hydraulic actuator speed using a flow control valve (HS)

Duty: Select and adjust hydraulic actuator speed using a flow control valve

Performance Standard:

- Adjust actuator speed using a needle valve
- Adjust actuator speed using non-compensated and compensated flow control valves
- Adjust flow control valves in meter-in and meter-out configurations
- Measure actuator speed
- Describe the operation of a needle valve, flow control valve, compensated flow control valve and meter-in and meter-out circuits
- Describe the flow vs. speed characteristics of a hydraulic cylinder and a motor
- Calculate pump flow rate requirements given actuator speeds and sizes
- Calculate pump flow rate given pump size and speed

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	3.02 thru 3.09
5	Mechanical	3.02 thru 3.09
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	3.03 thru 3.09
1.5	Mathematics	3.02 thru 3.09
1.6	Operation Monitoring	3.02 thru 3.09
1.8	Science	3.02, 3.03, 3.04, 3.05, 3.09
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**

2.1	Problem Solving	3.04, 3.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	3.02 thru 3.09
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	3.01, 3.03, 3.04, 3.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	3.03 thru 3.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	3.03 thru 3.09
6.2	Equipment Selection	3.03 thru 3.09
6.3	Installation Design	3.02 thru 3.09
6.4	Installation Technical	3.03 thru 3.09
6.5	Operational Analysis	3.02 thru 3.09
6.6	Operational Control	All
6.8	Quality Control	3.02 thru 3.09
6.9	Repair	3.03 thru 3.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	3.03 thru 3.09
1.8	Mathematical Reasoning	3.02 thru 3.09
1.10	Number Proficiency	3.02 thru 3.09
1.11	Perceptual	3.02 thru 3.09

1.12	Technical Design	3.02 thru 3.09
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	3.03 thru 3.09
2.2	Strength	3.03 thru 3.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	3.03 thru 3.09
3.2	Dexterity	3.03 thru 3.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	3.03 thru 3.09

Duty Title: 3.05. Service a hydraulic filter (HS)

Duty: Inspect and change a hydraulic filter to maximize hydraulic fluid cleanliness

Performance Standard:

- Interpret filter specifications and models to determine correct filter
- Use manufacturer's documentation to determine frequency of change
- Determine when to replace a filter base on pressure differential across the filter
- Measure pressure differential across a filter
- Replace a spin-on filter
- Replace a cartridge filter
- Define or describe symptoms of a required strainer
- Replace a strainer

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	3.02 thru 3.09
5	Mechanical	3.02 thru 3.09
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	3.03 thru 3.09
1.5	Mathematics	3.02 thru 3.09
1.6	Operation Monitoring	3.02 thru 3.09
1.8	Science	3.02, 3.03, 3.04, 3.05, 3.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	3.02 thru 3.09

3.2	Time Management	3.05, 3.06,
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	3.01, 3.03, 3.04, 3.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	3.03 thru 3.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	3.03 thru 3.09
6.2	Equipment Selection	3.03 thru 3.09
6.3	Installation Design	3.02 thru 3.09
6.4	Installation Technical	3.03 thru 3.09
6.5	Operational Analysis	3.02 thru 3.09
6.6	Operational Control	All
6.8	Quality Control	3.02 thru 3.09
6.9	Repair	3.03 thru 3.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	3.03 thru 3.09
1.8	Mathematical Reasoning	3.02 thru 3.09
1.10	Number Proficiency	3.02 thru 3.09
1.11	Perceptual	3.02 thru 3.09
1.12	Technical Design	3.02 thru 3.09
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**

2.1	Flexibility	3.03 thru 3.09
2.2	Strength	3.03 thru 3.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	3.03 thru 3.09
3.2	Dexterity	3.03 thru 3.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	3.03 thru 3.09

Duty Title: 3.06. Service hydraulic fluid (HS)

Duty: Inspect, add and change a hydraulic fluid

Performance Standard:

- Inspect fluid levels through level gauge and determine when to add fluid
- Add fluid to a hydraulic system
- Replace hydraulic fluid using a filter cart
- Inspect fluid through sight, touch and smell to determine if it should be replaced
- Inspect fluid for water and visible contaminants
- Remove water and contaminants from a hydraulic system including but not limited to flushing and refilling system
- Interpret oil specifications to determine if an oil meets the specifications specified by the machine manufacturer
- Use manufacturer's documentation to determine the correct oil to use in a hydraulic system
- Take a fluid sample and prepare for submittal to a testing lab

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
3	Customer Service	3.01
4	Mathematics	3.02 thru 3.09
5	Mechanical	3.02 thru 3.09
6	Physics	All
7	Production and Processing	3.09, 3.18
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	3.03 thru 3.09
1.5	Mathematics	3.02 thru 3.09

1.6	Operation Monitoring	3.02 thru 3.09
1.8	Science	3.02, 3.03, 3.04, 3.05, 3.09
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	3.04, 3.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	3.02 thru 3.09
3.2	Time Management	3.05, 3.06
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	3.01, 3.03, 3.04, 3.05
4.2	Instructing	3.01
4.3	Perceptiveness	3.01
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	3.09, 3.09
5.2	Decision Making	3.09, 3.09
5.3	Evaluation	3.03 thru 3.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	3.03 thru 3.09
6.2	Equipment Selection	3.03 thru 3.09
6.3	Installation Design	3.02 thru 3.09
6.4	Installation Technical	3.03 thru 3.09
6.5	Operational Analysis	3.02 thru 3.09
6.6	Operational Control	All
6.8	Quality Control	3.02 thru 3.09
6.9	Repair	3.03 thru 3.09

6.10	Technology	3.01, 3.07, 3.08, 3.09
6.11	Troubleshooting	3.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	3.03 thru 3.09
1.4	Fluency	3.09, 3.09
1.8	Mathematical Reasoning	3.02 thru 3.09
1.10	Number Proficiency	3.02 thru 3.09
1.11	Perceptual	3.02 thru 3.09
1.12	Technical Design	3.02 thru 3.09
1.13	Time Sharing	3.01, 3.09
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	3.03 thru 3.09
2.2	Strength	3.03 thru 3.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	3.03 thru 3.09
3.2	Dexterity	3.03 thru 3.09
3.3	Reaction Time	3.01, 3.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.2	Speech Clarity	3.01
4.3	Speech Recognition	3.01
4.4	Visual Depth Perception	3.03 thru 3.09

Duty Title: 3.07. Install hydraulic conductors (HS)

Duty: Connect, adjust and disconnect flexible and rigid hydraulic conductors

Performance Standard:

- Interpret pipe, hose and tubing specifications
- Identify type and size of hose, tubing and hydraulic fittings given a sample
- Use safety procedures to make sure pressure is removed before disconnecting conductors
- Describe proper fitting tightening and describe the consequences of over-tightening
- Attach and tighten hydraulic steel tubing using wrenches and ferrule fittings
- Attach and tighten hydraulic fittings to components with threaded ports using wrenches and applicable thread sealant
- Attach and tighten hydraulic hose using wrenches and swivel fittings
- Attach and tighten hydraulic hose using wrenches and straight thread o-ring fittings
- Adjust the position and alignment of conductors for proper operation
- Describe how to make hydraulic hose using proper fittings
- Describe the operation of an o-ring
- Install an o-ring
- Describe how o-rings are specified

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	3.02 thru 3.09
5	Mechanical	3.02 thru 3.09
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	3.03 thru 3.09
1.5	Mathematics	3.02 thru 3.09
1.6	Operation Monitoring	3.02 thru 3.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**

3.1	Material Resources	3.02 thru 3.09
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	3.03 thru 3.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	3.03 thru 3.09
6.2	Equipment Selection	3.03 thru 3.09
6.3	Installation Design	3.02 thru 3.09
6.4	Installation Technical	3.03 thru 3.09
6.5	Operational Analysis	3.02 thru 3.09
6.6	Operational Control	All
6.8	Quality Control	3.02 thru 3.09
6.9	Repair	3.03 thru 3.09
6.10	Technology	3.01, 3.07, 3.08, 3.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	3.03 thru 3.09
1.8	Mathematical Reasoning	3.02 thru 3.09
1.10	Number Proficiency	3.02 thru 3.09
1.11	Perceptual	3.02 thru 3.09
1.12	Technical Design	3.02 thru 3.09
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	3.03 thru 3.09

2.2	Strength	3.03 thru 3.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	3.03 thru 3.09
3.2	Dexterity	3.03 thru 3.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	3.03 thru 3.09

Duty Title: 3.08. Install and test components in a basic hydraulic circuit (HS)

Duty: Install and test the operation of components in a basic hydraulic linear or rotary actuator circuit given a schematic

Performance Standard:

- Install and connect hydraulic components in basic functional circuit given a schematic
- Replace subplate-mounted directional, flow and pressure control valves in a hydraulic system
- Replace a threaded port valve
- Mount and align a hydraulic cylinder or a motor
- Describe types of cylinder and motor mounting methods and their applications
- Operate a hydraulic system to determine that it is performing correctly
- Follow proper bleeding procedures of a hydraulic system after component replacement

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	3.02 thru 3.09
5	Mechanical	3.02 thru 3.09
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	3.03 thru 3.09
1.5	Mathematics	3.02 thru 3.09
1.6	Operation Monitoring	3.02 thru 3.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	3.02 thru 3.09

5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	3.03 thru 3.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	3.03 thru 3.09
6.2	Equipment Selection	3.03 thru 3.09
6.3	Installation Design	3.02 thru 3.09
6.4	Installation Technical	3.03 thru 3.09
6.5	Operational Analysis	3.02 thru 3.09
6.6	Operational Control	All
6.8	Quality Control	3.02 thru 3.09
6.9	Repair	3.03 thru 3.09
6.10	Technology	3.01, 3.07, 3.08, 3.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	3.03 thru 3.09
1.8	Mathematical Reasoning	3.02 thru 3.09
1.10	Number Proficiency	3.02 thru 3.09
1.11	Perceptual	3.02 thru 3.09
1.12	Technical Design	3.02 thru 3.09
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	3.03 thru 3.09
2.2	Strength	3.03 thru 3.09

3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	3.03 thru 3.09
3.2	Dexterity	3.03 thru 3.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	3.03 thru 3.09

Duty Title: 3.09. Troubleshoot a basic hydraulic circuit (HS)

Duty: Troubleshoot a basic hydraulic linear or rotary actuator circuit

Performance Standard:

- Troubleshoot 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
- Use flow and pressure instruments to take hydraulic circuit readings during in-circuit testing
- Describe the flow vs. pressure drop characteristics of components and conductors and their impact on system operation
- Use systematic methodologies to troubleshoot basic hydraulic circuits with linear and rotary actuators with these symptoms:
    - Actuator will not move
    - Actuator moves at incorrect speed
    - Actuator moves erratically
    - No or low system pressure
- Describe types of failures of basic hydraulic component

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	3.02 thru 3.09
5	Mechanical	3.02 thru 3.09
6	Physics	All
7	Production and Processing	3.09
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	3.03 thru 3.09
1.5	Mathematics	3.02 thru 3.09
1.6	Operation Monitoring	3.02 thru 3.09
1.8	Science	3.02, 3.03, 3.04, 3.05, 3.09

2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	3.04, 3.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	3.02 thru 3.09
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	3.09, 3.09
5.2	Decision Making	3.09, 3.09
5.3	Evaluation	3.03 thru 3.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	3.03 thru 3.09
6.2	Equipment Selection	3.03 thru 3.09
6.3	Installation Design	3.02 thru 3.09
6.4	Installation Technical	3.03 thru 3.09
6.5	Operational Analysis	3.02 thru 3.09
6.6	Operational Control	All
6.8	Quality Control	3.02 thru 3.09
6.9	Repair	3.03 thru 3.09
6.10	Technology	3.01, 3.07, 3.08, 3.09
6.11	Troubleshooting	3.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	3.03 thru 3.09
1.4	Fluency	3.09

1.8	Mathematical Reasoning	3.02 thru 3.09
1.10	Number Proficiency	3.02 thru 3.09
1.11	Perceptual	3.02 thru 3.09
1.12	Technical Design	3.02 thru 3.09
1.13	Time Sharing	3.01, 3.09
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	3.03 thru 3.09
2.2	Strength	3.03 thru 3.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	3.03 thru 3.09
3.2	Dexterity	3.03 thru 3.09
3.3	Reaction Time	3.01, 3.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	3.03 thru 3.09

IMT Level I – General: Knowledge, Skills, Abilities and Other Characteristics (KSAOs)

The performance standards for an Industrial Maintenance Technician (IMT) Level I consists of nine (9) Duty Areas.

Duty Area 1: Maintenance Operations
Duty Area 2: Basic Mechanical Systems
Duty Area 3: Basic Hydraulic Systems
Duty Area 4: Basic Pneumatic Systems
Duty Area 5: Electrical Systems
Duty Area 6: Electronic Control Systems
Duty Area 7: Process Control Systems
Duty Area 8: Maintenance Welding
Duty Area 9: Maintenance Piping

The following KSAOs are held in common and apply to all nine areas and their corresponding Duty Titles.

Inclusive KSAOs for IMT Level I	
KNOWLEDGE	**The attainment of facts and principles**
2. Communications	Knowledge of communication, dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, audial and visual media.
8. Public Safety and Security	Knowledge of relevant equipment, policies, procedures and strategies to promote effective local, state or national security operations for the protection of people, data, property and institutions.
SKILLS	**Developed capabilities to work with given knowledge**
1. Basic	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.1 Active Learning and Listening	Understanding the implications of new information, utilizing in problem solving and decision making
1.3 Communication	Understanding the appropriate uses to convey and receive information

1.4 Effective Speaking and Writing	Communicating and conveying information verbally and in writing
1.7 Reading Comprehension	Understanding written material in work related documents
ABILITIES	**Attributes that influence performance**
1. Cognitive	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.2 Deductive Reasoning	Ability to apply general rules to specific problems
1.3 Expression	Ability to communicate information and ideas in writing and speaking so others can understand
1.5 Focus	Capability to pay attention to specifics or details with distractions
1.6 Inductive Reasoning	Ability to combined pieces of information to form general rules or conclusions
1.7 Information Organization	Ability to arrange objects or actions in an order or pattern related to a specific rule or set of rules
1.9 Memorization	Ability to remember information
OTHER CHARACTERISTICS	**Characteristics that may influence or have an effect towards work performance and influence occupational requirements**
1. Work Activities	**Performing specific functions or duties**
1.1. Controlling Machines and Processes	Utilizing mechanisms or direct physical activity to operate machines or processes
1.2. Drafting, Layout and Specification	Drawing, designing, detailing instructions or specifications for devices, parts, equipment for fabrication, assembly or maintaining
1.3. Handling and Moving Objects	Handling, installing, moving and positioning of materials
1.4. Inspection	Inspecting equipment, structures or materials to identify the cause of errors or other problems or defects
1.5. Monitoring	Monitor and review information from material, events, equipment or environment
1.6. Organization and Decision Making	Organize, plan, prioritize, analyze and evaluate information

1.7. Repairing and Maintaining	Servicing, repairing, adjusting and testing machines, devices, moving parts and equipment
2. Work Interests	**Preferences to work environments**
2.1. Conventional	Work activities that follow procedures, rules and routines. Working with data and details. Working under a line of authority
2.2. Investigative	Working with ideas and an extensive amount of thinking. Exploring and searching for facts and figuring out problems mentally
2.3. Realistic	Work activities that include practical, hands-on problems and solutions. Working with materials like wood, tools and machinery. Working outside and indoors
3. Work Styles	**Personal characteristics that can affect job performance**
3.1. Adaptability	Open to change
3.2. Analytical Thinking	Using logic to address problems
3.3. Attention to Detail	Being careful about detail and thorough in completing tasks
3.4. Dependability	Being reliable, responsible and fulfilling obligations
3.5. Initiative	Willingness to take on responsibilities and challenges
3.6. Persistence	Being diligent in the face of obstacles
3.7. Self-control	Maintaining composure in difficult situations
3.8. Stress Tolerance	Accepting criticism and dealing effectively with high stress situations
4. Work Values	**Global aspects important to a person's satisfaction**
4.1. Achievement	Result oriented, use of strongest abilities, giving a feeling of accomplishment
4.2. Independence	Responsible, work on own and make decisions, giving a feeling of autonomy
4.3. Relationships	Provide services to others and work with co-workers in a friendly non-competitive environment, giving a feeling of worth

IV. DUTY AREA 4: PNEUMATIC SYSTEMS (PS)

A.DUTIES AND DUTY TITLES

Duty Title: 4.01 Adhere to fluid power systems safety rules
Duty: Adhere to safety, health and environmental rules and regulations for fluid power systems

Duty Title: 4.02 Adjust pneumatic system branch operating pressure using a regulator
Duty: Determine and adjust pneumatic system operating pressure using a regulator

Duty Title: 4.03 Adjust pneumatic actuator speed using a flow control valve
Duty: Select and adjust pneumatic actuator speed using a flow control valve

Duty Title: 4.04 Service a pneumatic filter
Duty: Inspect, drain and change a pneumatic filter

Duty Title: 4.05 Service a pneumatic lubricator
Duty: Inspect, fill and adjust a pneumatic lubricator

Duty Title: 4.06 Install pneumatic conductors
Duty: Connect, adjust and disconnect flexible and rigid pneumatic conductors

Duty Title: 4.07 Start up and shut down a reciprocating air compressor and adjust operating pressure
Duty: Startup and shutdown a reciprocating air compressor and adjust operating pressure using a pressure switch

Duty Title: 4.08 Install and test components in a basic pneumatic circuit
Duty: Install and test the operation of components in a basic pneumatic linear or rotary circuit given a schematic

Duty Title: 4.09 Install and test components in a pneumatic circuit
Duty: Install and test the operation of components in a basic pneumatic circuit that uses vacuum generators given a Schematic

Duty Title: 4.10 Troubleshoot a basic pneumatic circuit
Duty: Troubleshoot a basic pneumatic linear or rotary actuator circuit

B. BASIC PNEUMATIC SYSTEMS: PERFORMANCE STANDARDS

Duty Title: 4.01. Adhere to safety, health and environmental rules and regulations for fluid pneumatic systems (PS)

Duty: Adhere to safety, health and environmental rules and regulations for pneumatic systems

Performance Standard:

- Identify roles and responsibilities for safety, health and environment
- Adhere to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace
- Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)
- Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state
- Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job
- Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information
- List and select proper fall protection for working at heights and using ladders, scaffolding and lifts
- Identify and recognize 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)
- Describe the process used to perform a job safety analysis
- Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)
- Identify fuel source and selection of correct extinguisher class

Duty Title: 4.02. Adjust pneumatic system branch operating pressure using a regulator (PS)

Duty: Determine and adjust pneumatic system operating pressure using a regulator

Performance Standard:

- Describe the operation of relieving and non-relieving pneumatic regulators
- Describe the pressure vs. force/ torque output characteristics of cylinders and motors
- Describe Pascal's law and its importance in reading system pressure
- Interpret and convert between air pressure units of measurement (psi, psia, psig, kPa, bar)
- Describe the compressibility characteristics of air and their impact on system operation
- Describe 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
- Read a pressure gauge
- Use manufacturer's documentation to determine correct operating pressure
- Adjust pneumatic regulator pressure
- Operate a branch shutoff valve to enable flow to a system branch

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	4.02 thru 4.10
5	Mechanical	4.02 thru 4.10
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	4.03 thru 4.10
1.5	Mathematics	4.02 thru 4.10
1.6	Operation Monitoring	4.02 thru 4.10

1.8	Science	4.02, 4.03, 4.04, 4.05, 4.09, 4.10
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	4.02 thru 4.10
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	4.01, 4.03, 4.04, 4.05, 4.10
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	4.03 thru 4.10
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	4.03 thru 4.10
6.2	Equipment Selection	4.03 thru 4.10
6.3	Installation Design	4.02 thru 4.10
6.4	Installation Technical	4.03 thru 4.10
6.5	Operational Analysis	4.02 thru 4.10
6.6	Operational Control	All
6.8	Quality Control	4.02 thru 4.10
6.9	Repair	4.03 thru 4.10
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	4.03 thru 4.10
1.8	Mathematical Reasoning	4.02 thru 4.10
1.10	Number Proficiency	4.02 thru 4.10
1.11	Perceptual	4.02 thru 4.10

1.12	Technical Design	4.02 thru 4.10
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	4.03 thru 4.10
2.2	Strength	4.03 thru 4.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	4.03 thru 4.10
3.2	Dexterity	4.03 thru 4.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	4.03 thru 4.10

Duty Title: 4.03. Adjust pneumatic actuator speed using a flow control valve (PS)

Duty: Select and adjust pneumatic actuator speed using a flow control valve

Performance Standard:

- Describe the operation of a needle valve, flow control valve and meter-in and meter-out circuits
- Describe the flow vs. speed characteristics of a pneumatic cylinder and a motor
- Describe the effect of system pressure on pneumatic actuator speed
- Adjust actuator speed using a needle valve
- Adjust actuator speed using a flow control valve
- Adjust actuator speed using manifold mounted flow control valves
- Adjust flow control valves in meter-in and meter-out configurations
- Measure actuator speed

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	4.02 thru 4.10
5	Mechanical	4.02 thru 4.10
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	4.03 thru 4.10
1.5	Mathematics	4.02 thru 4.10
1.6	Operation Monitoring	4.02 thru 4.10
1.8	Science	4.02, 4.03, 4.04, 4.05, 4.09, 4.10,
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	4.02 thru 4.10

4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	4.01, 4.03, 4.04, 4.05, 4.10
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	4.03 thru 4.10
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	4.03 thru 4.10
6.2	Equipment Selection	4.03 thru 4.10
6.3	Installation Design	4.02 thru 4.10
6.4	Installation Technical	4.03 thru 4.10
6.5	Operational Analysis	4.02 thru 4.10
6.6	Operational Control	All
6.8	Quality Control	4.02 thru 4.10
6.9	Repair	4.03 thru 4.10
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	4.03 thru 4.10
1.8	Mathematical Reasoning	4.02 thru 4.10
1.10	Number Proficiency	4.02 thru 4.10
1.11	Perceptual	4.02 thru 4.10
1.12	Technical Design	4.02 thru 4.10
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	4.03 thru 4.10

2.2	Strength	4.03 thru 4.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	4.03 thru 4.10
3.2	Dexterity	4.03 thru 4.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	4.03 thru 4.10

Duty Title: 4.04. Service a pneumatic filter (PS)

Duty: Inspect, drain and change a pneumatic filter

Performance Standard:

- Replace a cartridge filter
- Determine when to replace a filter based on inspection and pressure differential and manufacturer's recommendations
- Interpret filter specifications and models to determine correct filter
- Use manufacturer's documentation to determine frequency of change
- Operate the drain on a pneumatic filter
- Operate water removal systems on a pneumatic filter
- Recognize symptoms of excessive water in a compressed air system

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	4.02 thru 4.18
5	Mechanical	4.02 thru 4.18
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	4.03 thru 4.18
1.5	Mathematics	4.02 thru 4.18
1.6	Operation Monitoring	4.02 thru 4.18
1.8	Science	4.02, 4.03, 4.04, 4.05, 4.09, 4.10
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	4.02 thru 4.18
3.2	Time Management	4.05, 4.06

4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	4.01, 4.03, 4.04, 4.05, 4.10
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	4.03 thru 4.10
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	4.03 thru 4.10
6.2	Equipment Selection	4.03 thru 4.10
6.3	Installation Design	4.02 thru 4.10
6.4	Installation Technical	4.03 thru 4.10
6.5	Operational Analysis	4.02 thru 4.10
6.6	Operational Control	All
6.8	Quality Control	4.02 thru 4.10
6.9	Repair	4.03 thru 4.10
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	4.03 thru 4.10
1.8	Mathematical Reasoning	4.02 thru 4.10
1.10	Number Proficiency	4.02 thru 4.10
1.11	Perceptual	4.02 thru 4.10
1.12	Technical Design	4.02 thru 4.10
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	4.03 thru 4.10

2.2	Strength	4.03 thru 4.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	4.03 thru 4.10
3.2	Dexterity	4.03 thru 4.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	4.03 thru 4.10

Duty Title: 4.05. Service a pneumatic lubricator (PS)

Duty: Inspect, fill and adjust a pneumatic lubricator

Performance Standard:

- Use manufacturer's documentation to determine correct lubricant
- Define proper lubricating media
- Inspect fluid level in a lubricator
- Add lubricating oil to a lubricator
- Set lubrication rate on a lubricator

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	4.02 thru 4.10
5	Mechanical	4.02 thru 4.10
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	4.03 thru 4.10
1.5	Mathematics	4.02 thru 4.10
1.6	Operation Monitoring	4.02 thru 4.10
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	4.02 thru 4.10
3.2	Time Management	4.05, 4.06
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	4.03 thru 4.10

6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	4.03 thru 4.10
6.2	Equipment Selection	4.03 thru 4.10
6.3	Installation Design	4.02 thru 4.10
6.4	Installation Technical	4.03 thru 4.10
6.5	Operational Analysis	4.02 thru 4.10
6.6	Operational Control	All
6.8	Quality Control	4.02 thru 4.10
6.9	Repair	4.03 thru 4.10
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	4.03 thru 4.10
1.8	Mathematical Reasoning	4.02 thru 4.10
1.10	Number Proficiency	4.02 thru 4.10
1.11	Perceptual	4.02 thru 4.10
1.12	Technical Design	4.02 thru 4.10
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	4.03 thru 4.10
2.2	Strength	4.03 thru 4.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	4.03 thru 4.10
3.2	Dexterity	4.03 thru 4.10

4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	4.03 thru 4.10

Duty Title: 4.06. Install pneumatic conductors (PS)

Duty: Connect, adjust and disconnect flexible and rigid pneumatic conductors

Performance Standard:

- Use safety procedures to make sure pressure is removed before disconnecting conductors
- Attach and tighten pneumatic steel tubing using wrenches and ferrule fittings
- Attach and tighten pneumatic fittings to components with threaded ports using wrenches and thread sealant when appropriate
- Attach and tighten pneumatic hose using wrenches and straight-thread, barb, ferrule and push-on fittings
- Adjust the position and alignment of conductors for proper operation
- Interpret pipe, hose and tubing specifications
- Identify type and size of hose, tubing and fittings given a sample
- Identify fittings and application given a sample and explain limitations for use of each

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	4.02 thru 4.10
5	Mechanical	4.02 thru 4.10
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	4.03 thru 4.10
1.5	Mathematics	4.02 thru 4.10
1.6	Operation Monitoring	4.02 thru 4.10
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	4.02 thru 4.10

5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	4.03 thru 4.10
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	4.03 thru 4.10
6.2	Equipment Selection	4.03 thru 4.10
6.3	Installation Design	4.02 thru 4.10
6.4	Installation Technical	4.03 thru 4.10
6.5	Operational Analysis	4.02 thru 4.10
6.6	Operational Control	All
6.8	Quality Control	4.02 thru 4.10
6.9	Repair	4.03 thru 4.10
6.10	Technology	4.01, 4.07, 4.08, 4.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	4.03 thru 4.10
1.8	Mathematical Reasoning	4.02 thru 4.10
1.10	Number Proficiency	4.02 thru 4.10
1.11	Perceptual	4.02 thru 4.10
1.12	Technical Design	4.02 thru 4.10
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	4.03 thru 4.10
2.2	Strength	4.03 thru 4.10

3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	4.03 thru 4.10
3.2	Dexterity	4.03 thru 4.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	4.03 thru 4.10

Duty Title: 4.07. Start up and shut down an air compressor and adjust operating pressure (PS)

Duty: Start up and shut down an air compressor and adjust operating pressure

Performance Standard:

- Calculate air consumption from a receiver given a pressure change
- Interpret and convert between air flow rate units (scfm, cfm, fcfm, etc.)
- Safely start up an air compressor system, including pre-start inspection
- Safely shut down and drain a reciprocating air compressor system
- Operate manual valves to direct system flow
- Use manufacturer's documentation to determine correct operating pressure
- Adjust the system operating pressure using a pressure switch
- Adjust working pressure with a regulator

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	4.02 thru 4.10
5	Mechanical	4.02 thru 4.10
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	4.03 thru 4.10
1.5	Mathematics	4.02 thru 4.10
1.6	Operation Monitoring	4.02 thru 4.10
1.8	Science	4.02, 4.03, 4.04, 4.05, 4.09, 4.10
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	4.02 thru 4.10

4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	4.01, 4.03, 4.04, 4.05, 4.10
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	4.03 thru 4.10
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	4.03 thru 4.10
6.2	Equipment Selection	4.03 thru 4.10
6.3	Installation Design	4.02 thru 4.10
6.4	Installation Technical	4.03 thru 4.10
6.5	Operational Analysis	4.02 thru 4.10
6.6	Operational Control	All
6.8	Quality Control	4.02 thru 4.10
6.9	Repair	4.03 thru 4.10
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	3.03 thru 3.18
1.8	Mathematical Reasoning	3.02 thru 3.18
1.10	Number Proficiency	3.02 thru 3.18
1.11	Perceptual	3.02 thru 3.18
1.12	Technical Design	3.02 thru 3.18
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	3.03 thru 3.18

2.2	Strength	4.03 thru 4.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	4.03 thru 4.10
3.2	Dexterity	4.03 thru 4.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	4.03 thru 4.10

Duty Title: 4.08. Install and test components in a basic pneumatic circuit (PS)

Duty: Install and test the operation of components in a basic pneumatic linear or rotary actuator circuit given a schematic

Performance Standard:

- Install and connect pneumatic components in basic functional circuit given a schematic
- Replace a sub plate-mounted directional valve in a pneumatic system
- Replace a threaded port valve
- Mount and align a pneumatic cylinder or a motor
- Operate a pneumatic system to determine that it is performing correctly
- Describe types of cylinder and motor mounting methods and their applications

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	4.02 thru 4.10
5	Mechanical	4.02 thru 4.10
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	4.03 thru 4.10
1.5	Mathematics	4.02 thru 4.10
1.6	Operation Monitoring	4.02 thru 4.10
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	4.02 thru 4.10
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**

5.3	Evaluation	4.03 thru 4.10
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	4.03 thru 4.10
6.2	Equipment Selection	4.03 thru 4.10
6.3	Installation Design	4.02 thru 4.10
6.4	Installation Technical	4.03 thru 4.10
6.5	Operational Analysis	4.02 thru 4.10
6.6	Operational Control	All
6.8	Quality Control	4.02 thru 4.10
6.9	Repair	4.03 thru 4.10
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	4.03 thru 4.10
1.8	Mathematical Reasoning	4.02 thru 4.10
1.10	Number Proficiency	4.02 thru 4.10
1.11	Perceptual	4.02 thru 4.10
1.12	Technical Design	4.02 thru 4.10
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	4.03 thru 4.10
2.2	Strength	4.03 thru 4.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	4.03 thru 4.10

3.2	Dexterity	4.03 thru 4.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	4.03 thru 4.10

Duty Title: 4.09. Install and test components in a pneumatic vacuum generator circuit (PS)

Duty: Install and test the operation of components in a basic pneumatic circuit that uses vacuum generators given a schematic

Performance Standard:

- Interpret vacuum units of measurement
- Describe Pascal's law in relation to vacuum
- Calculate lifting force of a vacuum cup given vacuum level and manufacturer's data
- Describe common hose types, fittings & sealants used in vacuum applications
- Identify vacuum system and safeguards
- Install and connect a vacuum generator and vacuum cups

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	4.02 thru 4.10
5	Mechanical	4.02 thru 4.10
6	Physics	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	4.03 thru 4.10
1.5	Mathematics	4.02 thru 4.10
1.6	Operation Monitoring	4.02 thru 4.10
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	4.02 thru 4.10
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	4.03 thru 4.10

6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	4.03 thru 4.10
6.2	Equipment Selection	4.03 thru 4.10
6.3	Installation Design	4.02 thru 4.10
6.4	Installation Technical	4.03 thru 4.10
6.5	Operational Analysis	4.02 thru 4.10
6.6	Operational Control	All
6.8	Quality Control	4.02 thru 4.10
6.9	Repair	4.03 thru 4.10
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	4.03 thru 4.10
1.4	Fluency	4.09, 4.10
1.8	Mathematical Reasoning	4.02 thru 4.10
1.10	Number Proficiency	4.02 thru 4.10
1.11	Perceptual	4.02 thru 4.10
1.12	Technical Design	4.02 thru 4.10
1.13	Time Sharing	4.01, 4.09, 4.10
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	4.03 thru 4.10
2.2	Strength	4.03 thru 4.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	4.03 thru 4.10

3.2	Dexterity	4.03 thru 4.10
3.3	Reaction Time	4.01, 4.09, 4.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	3.03 thru 3.18

Duty Title: 4.10. Troubleshoot a basic pneumatic circuit (PS)

Duty*:* Troubleshoot a basic pneumatic linear or rotary actuator circuit

Performance Standard:

- Troubleshoot 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
- Use flow and pressure instruments to take pneumatic circuit readings during in-circuit testing
- Describe the flow vs. pressure drop characteristics of pneumatic components and conductors and their impact on system operation
- Use systematic methodologies to troubleshoot basic pneumatic circuits with linear and rotary actuators with these symptoms:
    - Actuator will not move
    - Actuator moves at incorrect speed
    - Actuator moves erratically
    - No or low system pressure
- Describe types of failures of basic pneumatic components

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	4.02 thru 4.10
5	Mechanical	4.02 thru 4.10
6	Physics	All
7	Production and Processing	4.09, 4.10
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	4.03 thru 4.10
1.5	Mathematics	4.02 thru 4.10

1.6	Operation Monitoring	4.02 thru 4.10
1.8	Science	4.02, 4.03, 4.04, 4.05, 4.09, 4.10
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	4.04, 4.09, 4.10
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	4.02 thru 4.10
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	4.09, 4.10
5.2	Decision Making	4.09, 4.10
5.3	Evaluation	4.03 thru 4.10
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	4.03 thru 4.10
6.2	Equipment Selection	4.03 thru 4.10
6.3	Installation Design	4.02 thru 4.10
6.4	Installation Technical	4.03 thru 4.10
6.5	Operational Analysis	4.02 thru 4.10
6.6	Operational Control	All
6.8	Quality Control	4.02 thru 4.10
6.9	Repair	4.03 thru 4.10
6.11	Troubleshooting	4.09, 4.10
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	4.03 thru 4.10

1.4	Fluency	4.09, 4.10
1.8	Mathematical Reasoning	4.02 thru 4.10
1.10	Number Proficiency	4.02 thru 4.10
1.11	Perceptual	4.02 thru 4.10
1.12	Technical Design	4.02 thru 4.10
1.13	Time Sharing	4.01, 4.09, 4.10
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	4.03 thru 4.10
2.2	Strength	4.03 thru 4.10
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	4.03 thru 4.10
3.2	Dexterity	4.03 thru 4.10
3.3	Reaction Time	4.01, 3.09, 4.10
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	All
4.4	Visual Depth Perception	4.03 thru 4.10

IMT Level I – General: Knowledge, Skills, Abilities and Other Characteristics (KSAOs)

The performance standards for an Industrial Maintenance Technician (IMT) Level I consists of nine (9) Duty Areas.

Duty Area 1: Maintenance Operations
Duty Area 2: Basic Mechanical Systems
Duty Area 3: Basic Hydraulic Systems
Duty Area 4: Basic Pneumatic Systems
Duty Area 5: Electrical Systems
Duty Area 6: Electronic Control Systems
Duty Area 7: Process Control Systems
Duty Area 8: Maintenance Welding
Duty Area 9: Maintenance Piping

The following KSAOs are held in common and apply to all nine areas and their corresponding Duty Titles.

Inclusive KSAOs for IMT Level I	
KNOWLEDGE	**The attainment of facts and principles**
2. Communications	Knowledge of communication, dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, audial and visual media.
8. Public Safety and Security	Knowledge of relevant equipment, policies, procedures and strategies to promote effective local, state or national security operations for the protection of people, data, property and institutions.
SKILLS	**Developed capabilities to work with given knowledge**
1. Basic	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.1 Active Learning and Listening	Understanding the implications of new information, utilizing in problem solving and decision making
1.3 Communication	Understanding the appropriate uses to convey and receive information

1.4 Effective Speaking and Writing	Communicating and conveying information verbally and in writing
1.7 Reading Comprehension	Understanding written material in work related documents
ABILITIES	**Attributes that influence performance**
1. Cognitive	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.2 Deductive Reasoning	Ability to apply general rules to specific problems
1.3 Expression	Ability to communicate information and ideas in writing and speaking so others can understand
1.5 Focus	Capability to pay attention to specifics or details with distractions
1.6 Inductive Reasoning	Ability to combined pieces of information to form general rules or conclusions
1.7 Information Organization	Ability to arrange objects or actions in an order or pattern related to a specific rule or set of rules
1.9 Memorization	Ability to remember information
OTHER CHARACTERISTICS	**Characteristics that may influence or have an effect towards work performance and influence occupational requirements**
1. Work Activities	**Performing specific functions or duties**
1.1. Controlling Machines and Processes	Utilizing mechanisms or direct physical activity to operate machines or processes
1.2. Drafting, Layout and Specification	Drawing, designing, detailing instructions or specifications for devices, parts, equipment for fabrication, assembly or maintaining
1.3. Handling and Moving Objects	Handling, installing, moving and positioning of materials
1.4. Inspection	Inspecting equipment, structures or materials to identify the cause of errors or other problems or defects
1.5. Monitoring	Monitor and review information from material, events, equipment or environment
1.6. Organization and Decision Making	Organize, plan, prioritize, analyze and evaluate information

1.7. Repairing and Maintaining	Servicing, repairing, adjusting and testing machines, devices, moving parts and equipment
2. Work Interests	**Preferences to work environments**
2.1. Conventional	Work activities that follow procedures, rules and routines. Working with data and details. Working under a line of authority
2.2. Investigative	Working with ideas and an extensive amount of thinking. Exploring and searching for facts and figuring out problems mentally
2.3. Realistic	Work activities that include practical, hands-on problems and solutions. Working with materials like wood, tools and machinery. Working outside and indoors
3. Work Styles	**Personal characteristics that can affect job performance**
3.1. Adaptability	Open to change
3.2. Analytical Thinking	Using logic to address problems
3.3. Attention to Detail	Being careful about detail and thorough in completing tasks
3.4. Dependability	Being reliable, responsible and fulfilling obligations
3.5. Initiative	Willingness to take on responsibilities and challenges
3.6. Persistence	Being diligent in the face of obstacles
3.7. Self-control	Maintaining composure in difficult situations
3.8. Stress Tolerance	Accepting criticism and dealing effectively with high stress situations
4. Work Values	**Global aspects important to a person's satisfaction**
4.1. Achievement	Result oriented, use of strongest abilities, giving a feeling of accomplishment
4.2. Independence	Responsible, work on own and make decisions, giving a feeling of autonomy
4.3. Relationships	Provide services to others and work with co-workers in a friendly non-competitive environment, giving a feeling of worth

V. DUTY AREA 5: ELECTRICAL SYSTEMS (ES)

A. DUTIES AND DUTY TITLES

Duty Title: 5.01 Adhere to electrical power and control systems safety rules
Duty: Adhere to safety, health and environmental rules and regulations for electrical power and control systems

Duty Title: 5.02 Interpret electrical control and power schematics
Duty: Read and interpret electrical motor control and programmable controller system schematics, including identifying schematic symbols, signal flow and operation of the components and system

Duty Title: 5.03 Adjust limit switches and electronic sensors
Duty: Adjust and test limit switches, pressure switches, float switches and electronic proximity sensors

Duty Title: 5.04 Measure voltage, current and resistance in an electrical circuit
Duty: Use a multimeter to measure voltage, current and resistance in an electrical circuit to verify system operation and power levels

Duty Title: 5.05 Select, install and test fuses and circuit breakers
Duty: Select, install and test fuses and circuit breakers

Duty Title: 5.06 Install and test DC electric motors
Duty: Install and test DC electric motors in a manual motor control circuit

Duty Title: 5.07 Install and test AC electric motors
Duty: Install and test single and 3-phase AC electric motors in a manual motor control circuit

Duty Title: 5.08 Install and test electrical relay control components and circuits
Duty: Install and test electrical relay control components in control system

Duty Title: 5.09 Install and test electro-fluid power components and circuits
Duty: Install and test electro-fluid power components and circuits

Duty Title: 5.10 Test and repair machine electrical ground
Duty: Test and repair machine electrical ground

Duty Title: 5.11 Troubleshoot an electrical motor relay control circuit
Duty: Troubleshoot an electrical motor relay control circuit

Duty Title: 5.12 Troubleshoot a solenoid-operated fluid power relay control circuit
Duty: Troubleshoot a solenoid-operated fluid power relay control circuit

Duty Title: 5.13 Replace electrical control wiring using terminal attachment
Duty: Test and replace electrical control wiring using terminal attachment

Duty Title: 5.14 Replace electrical control wiring using solder attachment
Duty: Test and replace electrical control wiring using solder attachment

Duty Title: 5.15 Transformers
Duty: Test and replace transformers

B. ELECTRICAL SYSTEMS: PERFORMANCE STANDARDS

Duty Title: 5.01. Adhere to electrical power and control systems safety rules (ES)

Duty: Adhere to safety, health and environmental rules and regulations for electrical power and control systems

Performance Standard:

- Identify roles and responsibilities for safety, health and environment
- Adhere to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace
- Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)
- Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state
- Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job
- Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information
- List and select proper fall protection for working at heights and using ladders, scaffolding and lifts
- Identify and recognize 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)
- Describe the process used to perform a job safety analysis
- Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)
- Identify fuel source and selection of correct extinguisher class

ES Specific:

- Adhere to NEC safety regulations
- Describe safety procedures for tightening, disconnecting or connecting electrical conductors and components
- Define the hazards and how to avoid personal contact with live electrical systems
- Describe the guidelines on the safe approach distances while working on electrical systems

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
3	Customer Service	5.01
SKILLS		**Developed capabilities to work with given knowledge**
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	5.01
4.2	Instructing	5.01, 5.04
4.3	Perceptiveness	5.01
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.13	Time Sharing	5.01, 5.09, 5.11, 5.12
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.3	Reaction Time	5.01, 5.03, 5.11, 5.12
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	5.01
4.3	Speech Recognition	5.01

Duty Title: 5.02. Interpret electrical control and power schematics (ES)

Duty: Read and interpret electrical motor control and programmable controller system schematics, including identifying schematic symbols, signal flow and operation of the components and system.

Performance Standard:

- Identify electrical components given their NEC/ISO schematic symbol
  - Resistors, potentiometers, inductors, capacitors, fuses, circuit breakers, pushbutton switches, selector switches, power supplies, transformers, lamps, motors, buzzers, control relays, motor starters, overloads, limit switches, pressure switches, level switches, electronic sensors and solenoids
- Interpret electrical control and power line types on a schematic
- Interpret the operation of a basic electrical power and control circuits given a schematic (N.O. and N.C. contacts)
- Follow signal flow on an electrical control or power schematic
- Interpret control schematics given a ladder logic diagram
- Interpret power diagrams associated with a PLC and all related input/output devices

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
5	Mechanical	5.02, thru 5.09, 5.14
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.8	Science	5.02, 5.04 thru 5.09, 5.11, 5.12, 5.15
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	5.02, 5.03, 5.11, 5.12
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	5.02 thru 5.15

6.3	Installation Design	5.02 thru 5.15
6.7	Programming	5.02, 5.06, 5.07, 5.08, 5.09, 5.11, 5.12
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
1.12	Technical Design	5.02 thru 5.15

Duty Title: 5.03. Adjust limit switches and electronic sensors (ES)

Duty: Adjust and test limit switches, pressure switches, float switches and electronic proximity sensors

Performance Standard:

- Adjust and test the trip point of a limit switch, float switch and pressure switch
- Adjust and test the trip point of a capacitive sensor, inductive sensor, photoelectric sensor, hall effect sensor, fiber optic, magnetic reed sensor, light curtain switches
- Describe the operation of limit, float and pressure switches
- Describe the operation of capacitive sensors, inductive sensors, photoelectric sensors, hall effect sensors, fiber optic sensors and magnetic reed sensors

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
5	Mechanical	5.02, thru 5.09, 5.14
6	Physics	5.03, 5.05, 5.09, 5.11, 5.12, 5.15
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
1.6	Operation Monitoring	5.03 thru 5.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	4.02, 4.03, 4.11, 4.12
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**

6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 4.14, 4.15
6.5	Operational Analysis	5.03 thru 5.15
6.6	Operational Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.8	Quality Control	5.03, 5.05 thru 5.09, 5.11, 5.12
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	5.03, 5.05 thru 5.09, 5.11, 5.12
1.10	Number Proficiency	5.03, 5.05 thru 5.09, 5.11, 5.12
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
1.12	Technical Design	5.02 thru 5.15
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	5.03, 5.05 thru 5.09, 5.11, 5.12,
3.2	Dexterity	5.03 thru 5.15
3.3	Reaction Time	5.01, 5.03, 5.11, 5.12
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.04. Measure voltage, current and resistance in an electrical circuit (ES)

Duty: Use a multimeter to measure voltage, current and resistance in an electrical circuit to verify system operation and power levels

Performance Standard:

- Use a multimeter to measure incoming voltage and current to an electrical circuit
- Use a multimeter to measure voltage and current in an electrical circuit
- Use a multimeter to measure resistance in an electrical circuit
- Use a multimeter to perform an continuity check in an electrical circuit
- Describe the concepts of resistance, voltage, current and power
- Use an amp meter (clamp-on)
- Describe the application of a multimeter to measure continuity, resistance, voltage and current
- Define Ohm's law and use it to determine power flow in electrical circuits
- Calculate power in an electrical circuit given current and voltage
- Describe the operation of parallel and series electrical circuits

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
5	Mechanical	5.02, thru 5.09, 5.14
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.6	Operation Monitoring	5.03 thru 5.09
1.8	Science	5.02, 5.04 thru 5.09, 5.11, 5.12, 5.15
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.2	Instructing	5.01, 5.04

6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.5	Operational Analysis	5.03 thru 5.15
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	5.02 thru 5.15
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.05. Select, install and test fuses and circuit breakers

Duty*:* Select, install and test fuses and circuit breakers

Performance Standard:

- Size 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
- Install fuses and circuit breakers in electrical circuits
- Describe procedure to test fuses
- Inspect circuit breakers to determine if tripped
- Reset circuit breakers
- Describe the operation of fuses, circuit breakers, GFCI
- Identify fuse types and their use

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
5	Mechanical	5.02, thru 5.09, 4.14
6	Physics	5.03, 5.05, 5.09, 4.11, 4.12, 4.15
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
1.6	Operation Monitoring	5.03 thru 5.09
1.8	Science	5.02, 5.04 thru 5.09, 5.11, 5.12, 5.15
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	5.05 thru 5.09

6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 5.14, 5.15
6.5	Operational Analysis	5.03 thru 5.15
6.6	Operational Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.8	Quality Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.10	Technology	5.05, 5.11, 5.12
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	5.03, 5.05 thru 5.09, 5.11, 5.12
1.10	Number Proficiency	5.03, 5.05 thru 5.09, 5.11, 5.12
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
1.12	Technical Design	5.02 thru 5.15
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	5.05 thru 5.09, 5.11, 5.12, 5.13, 5.14,
2.2	Strength	5.05 thru 5.09, 5.11, 5.12
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	5.03, 5.05 thru 5.09, 5.11, 5.12,
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.06. Install and test DC electric motors (ES)

Duty: Install and test DC electric motors in a manual motor control circuit

Performance Standard:

- Install and connect DC electric motors to a manual switch given a power schematic
- Describe the operation of DC electric motor (speed/direction)
- Describe the operation of DC motor configurations: compound, series and shunt
- Interpret DC motor specifications
- Use a multimeter and mega-ohmmeter (megger) to test a DC motor
- Describe the operation of a DC speed controller and its function/purpose
- Interpret a DC motor name plate

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
5	Mechanical	5.02, thru 5.09, 5.14
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
1.6	Operation Monitoring	5.03 thru 5.09
1.8	Science	5.02, 5.04 thru 5.09, 5.11, 5.12, 5.15
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	5.05 thru 5.09
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15

6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 5.14, 5.15
6.5	Operational Analysis	5.03 thru 5.15
6.6	Operational Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.7	Programming	5.02, 5.06, 5.07, 5.08, 5.09, 5.11, 5.12
6.8	Quality Control	5.03, 5.05 thru 5.09, 5.11, 5.12
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	5.03, 5.05 thru 5.09, 5.11, 5.12
1.10	Number Proficiency	5.03, 5.05 thru 5.09, 5.11, 5.12
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
1.12	Technical Design	5.02 thru 5.15
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	5.05 thru 5.09, 5.11, 5.12, 5.13, 5.14,
2.2	Strength	5.05 thru 5.09, 5.11, 5.12
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	5.03, 5.05 thru 5.09, 5.11, 5.12,
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.07. Install and test AC electric motors (ES)

Duty: Install and test single and 3-phase AC electric motors in a manual motor control circuit

Performance Standard:

- Install and connect AC single-phase electric motors to a manual motor starter given a power schematic
- Install and connect AC 3-phase electric motors to a manual motor starter given a schematic
- Describe the operation of single-phase electric motor: capacitor start, capacitor start/run and split capacitor
- Interpret AC single phase and 3-phase motor specifications
- Use a multimeter and mega-ohmmeter (megger) to test an AC motor
- Describe the operation of a manual motor starter
- Describe the operation of a 3-phase motor – i.e., multispeed motor (speed/direction)
- Describe the operation and function of a bearing grounding ring
- Explain the function of a motor brake
- Interpret an AC motor name plate
- Explain how to select an AC motor overload

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
5	Mechanical	5.02, thru 5.09, 5.14
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
1.6	Operation Monitoring	5.03 thru 5.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15

6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	5.05 thru 5.09
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 5.14, 5.15
6.5	Operational Analysis	5.03 thru 5.15
6.6	Operational Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.7	Programming	5.02, 5.06, 5.07, 5.08, 5.09, 5.11, 5.12
6.8	Quality Control	5.03, 5.05 thru 5.09, 5.11, 5.12
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	5.03, 5.05 thru 5.09, 5.11, 5.12
1.10	Number Proficiency	5.03, 5.05 thru 5.09, 5.11, 5.12
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
1.12	Technical Design	5.02 thru 5.15
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	5.05 thru 5.09, 5.11, 5.12, 5.13, 5.14,
2.2	Strength	5.05 thru 5.09, 5.11, 5.12
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	5.03, 5.05 thru 5.09, 5.11, 5.12,
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.08. Install and test electrical relay control components and circuits (ES)

Duty: Install and test electrical relay control components in a control system

Performance Standard:

- Describe the operation of control transformers, pushbutton switches, selector switches, control relays, magnetic motor starters, overloads, indicator lamps, electronic sensors, drum switches, solenoid operated fluid power valves, capacitors, resistors and disconnect switches
- Describe the operation of basic single direction and reversing direction motor control circuits with interlocks and sensors
- Install and connect NEMA/ IEC relay control components in a control circuit given a wiring diagram or schematic
- Install wiring between components in a control cabinet using raceways
- Install wiring between components located in different enclosures via conduit
- Replace failed relay contacts and coils

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
5	Mechanical	5.02, thru 5.09, 5.14
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
1.6	Operation Monitoring	5.03 thru 5.09
1.8	Science	5.02, 5.04 thru 5.09, 5.11, 5.12, 5.15
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**

6.1	Equipment Maintenance	5.05 thru 5.09
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 5.14, 5.15
6.5	Operational Analysis	5.03 thru 5.15
6.6	Operational Control	5.03, 5.05 thru 4.09, 4.11, 4.12
6.7	Programming	5.02, 5.06, 5.07, 5.08, 5.09, 5.11, 5.12
6.8	Quality Control	5.03, 5.05 thru 5.09, 5.11, 5.12
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	5.03, 5.05 thru 5.09, 5.11, 5.12
1.10	Number Proficiency	5.03, 5.05 thru 5.09, 5.11, 5.12
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
1.12	Technical Design	5.02 thru 5.15
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	5.05 thru 5.09, 5.11, 5.12, 5.13, 5.14,
2.2	Strength	5.05 thru 5.09, 5.11, 5.12
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	5.03, 5.05 thru 5.09, 5.11, 5.12,
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.09. Install and test electro-fluid power components and circuits (ES)

Duty*:* Install and test electro-fluid power components and circuits

Performance Standard:

- Describe the operation of solenoid-operated hydraulic and pneumatic valves
- Describe the operation of relay-controlled sequence fluid power circuits
- Install and connect solenoid-operated hydraulic and pneumatic valves in a control circuit given a wiring diagram or schematic
- Use manual overrides to test operation and describe the potential negative effects or consequences

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
5	Mechanical	5.02, thru 5.09, 5.14
6	Physics	5.03, 5.05, 5.09, 5.11, 5.12, 5.15
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
1.6	Operation Monitoring	5.03 thru 5.09
1.8	Science	5.02, 5.04 thru 5.09, 5.11, 5.12, 5.15
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	5.05 thru 5.09
6.2	Equipment Selection	5.02 thru 5.15

6.3	Installation Design	5.02 thru 5.15
6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 5.14, 5.15
6.5	Operational Analysis	5.03 thru 5.15
6.6	Operational Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.7	Programming	5.02, 5.06, 5.07, 5.08, 5.09, 5.11, 5.12
6.8	Quality Control	5.03, 5.05 thru 5.09, 5.11, 5.12
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	5.03, 5.05 thru 5.09, 5.11, 5.12
1.10	Number Proficiency	5.03, 5.05 thru 5.09, 5.11, 5.12
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	5.05 thru 5.09, 5.11, 5.12, 5.13, 5.14,
2.2	Strength	5.05 thru 5.09, 5.11, 5.12
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	5.03, 5.05 thru 5.09, 5.11, 5.12,
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.10. Test and repair machine electrical ground (ES)

Duty: Test and repair a machine electrical ground

Performance Standard:

- Describe methods of grounding and bonding machines per NEC code and their respective applications
- Describe the operation of electric motor grounding rings
- Identify types of machine grounds
- Describe the operation of a grounding conductor
- Test a machine ground to verify its correct operation
- Repair a machine ground

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 5.14, 5.15
6.5	Operational Analysis	5.03 thru 5.15
ABILITIES		**Attributes that influence performance**

1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
1.12	Technical Design	5.02 thru 5.15
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.11. Troubleshoot an electrical motor relay control circuit (ES)

Duty: Troubleshoot electrical motor relay control circuits

Performance Standard:

- Describe types of failures of basic electrical relay components and electric motors
- Troubleshoot 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 (define)
- Use a multimeter to take electrical circuit readings during in-circuit testing
- Use systematic methodologies to troubleshoot electrical relay control circuits with AC and DC motors with these symptoms:
    - Motor will not run
    - Motor turns in wrong direction
    - Motor runs erratically
    - Motor is hot
    - Motor runs high current

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
6	Physics	5.03, 5.05, 5.09, 5.11, 5.12, 5.15
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
1.8	Science	5.02, 5.04 thru 5.09, 5.11, 5.12, 5.15
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	5.11, 5.12
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**

3.1	Material Resources	5.03 thru 5.15
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	5.11, 5.12
5.2	Decision Making	5.11, 5.12
5.3	Evaluation	5.02, 5.03, 5.11, 5.12
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.5	Operational Analysis	5.03 thru 5.15
6.6	Operational Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.7	Programming	5.02, 5.06, 5.07, 5.08, 5.09, 5.11, 5.12
6.8	Quality Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.9	Repair	5.11, 5.12
6.10	Technology	5.05, 5.11, 5.12
6.11	Troubleshooting	5.11, 5.12
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	5.11, 5.12
1.4	Fluency	5.11, 5.12
1.8	Mathematical Reasoning	5.03, 5.05 thru 5.09, 5.11, 5.12
1.10	Number Proficiency	5.03, 5.05 thru 5.09, 5.11, 5.12
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
1.12	Technical Design	5.02 thru 5.15
1.13	Time Sharing	5.01, 5.09, 5.11, 5.12
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	5.05 thru 5.09, 5.11, 5.12, 5.13, 5.14,
2.2	Strength	5.05 thru 5.09, 5.11, 5.12

3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	5.03, 5.05 thru 5.09, 5.11, 5.12,
3.2	Dexterity	5.03 thru 5.15
3.3	Reaction Time	5.01, 5.03, 5.11, 5.12
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	5.11, 5.12
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.12. Troubleshoot a solenoid-operated fluid power valve relay control circuit (ES)

Duty: Troubleshoot a solenoid-operated fluid power relay control circuit

Performance Standard:

- Describe types of failures of solenoid-operated valves
- Troubleshoot solenoid-operated hydraulic and pneumatic directional control valves using in-circuit tests
- Use systematic methodologies to troubleshoot electro-fluid power relay control circuits with these symptoms:
  - Actuator will not move
  - Actuator moves in wrong direction
  - Actuator moves erratically

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
6	Physics	5.03, 5.05, 5.09, 5.11, 5.12, 5.15
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
1.8	Science	5.02, 5.04 thru 5.09, 5.11, 5.12, 5.15
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	5.11, 5.12
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
4	**Social**	**Developed capacities used to work with people to achieve goals**

5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	5.11, 5.12
5.2	Decision Making	5.11, 5.12
5.3	Evaluation	5.02, 5.03, 4.11, 4.12
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.5	Operational Analysis	5.03 thru 5.15
6.6	Operational Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.7	Programming	5.02, 5.06, 5.07, 5.08, 5.09, 5.11, 5.12
6.8	Quality Control	5.03, 5.05 thru 5.09, 5.11, 5.12
6.9	Repair	5.11, 5.12
6.10	Technology	5.05, 5.11, 5.12
6.11	Troubleshooting	5.11, 5.12
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	5.11, 5.12
1.4	Fluency	5.11, 5.12
1.8	Mathematical Reasoning	5.03, 5.05 thru 5.09, 5.11, 5.12
1.10	Number Proficiency	5.03, 5.05 thru 5.09, 5.11, 5.12
1.11	Perceptual	5.02, 5.03, 5.05 thru 5.12
1.12	Technical Design	5.02 thru 5.15
1.13	Time Sharing	5.01, 5.09, 5.11, 5.12
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	5.05 thru 5.09, 5.11, 5.12, 5.13, 5.14,
2.2	Strength	5.05 thru 5.09, 5.11, 5.12
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**

3.1	Control Precision	5.03, 5.05 thru 5.09, 5.11, 5.12,
3.2	Dexterity	5.03 thru 5.15
3.3	Reaction Time	5.01, 5.03, 5.11, 5.12
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	5.11, 5.12
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.13. Replace electrical control wiring using terminal attachment (ES)

Duty: Test and replace electrical control wiring using terminal attachment

Performance Standard:

- Perform a continuity test on wiring connected via all types of terminals
- Size wiring for a control circuit given voltage and current requirements and NEC code
- Interpret wiring specifications including standard color coding
- Strip wire
- Attach wires to terminals
- Describe types of wire and their application

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 5.14, 5.15
6.5	Operational Analysis	5.03 thru 5.15

ABILITIES		Attributes that influence performance
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	5.02 thru 4.15
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	5.05 thru 5.09, 4.11, 4.12, 4.13, 4.14,
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.14. Replace electrical control wiring using solder attachment (ES)

Duty: Test and replace electrical control wiring using solder attachment

Performance Standard:

- Perform a continuity test on wiring connected via soldering
- Prepare wire for soldering
- Solder wire to terminals
- Test and inspect a solder joint for integrity
- Describe types of soldering and solder materials and their application.

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
5	Mechanical	5.02, thru 5.09, 5.14
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 5.14, 5.15
6.5	Operational Analysis	5.03 thru 5.15

ABILITIES		Attributes that influence performance
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	5.02 thru 5.15
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	5.05 thru 5.09, 5.11, 5.12, 5.13, 5.14,
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

Duty Title: 5.15. Transformers

Duty: Test and replace transformers

Performance Standard:

- Define transformer ratio
- Describe types and configurations (Y, Delta) of transformers and their application
- Explain the rating of a transformer
- Describe connection point and taps for each type of transformer
- Test a transformer
- Disconnect and reconnect primary and secondary transformers
- Replace primary and secondary transformers

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	5.02 thru 5.15
4	Mathematics	5.02 thru 5.15
6	Physics	5.03, 5.05, 5.09, 5.11, 5.12, 5.15
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	5.03, 5.05 thru 5.15
1.5	Mathematics	5.03, 5.05 thru 5.15
1.8	Science	5.02, 5.04 thru 5.09, 5.11, 5.12, 5.15
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	5.03 thru 5.15
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	5.02 thru 5.15
6.3	Installation Design	5.02 thru 5.15
6.4	Installation Technical	5.03, 5.05 thru 5.10, 5.13, 5.14, 5.15
6.5	Operational Analysis	5.03 thru 5.15

ABILITIES		Attributes that influence performance
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	5.02 thru 5.15
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	5.03 thru 5.15
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	5.03 thru 5.15

IMT Level I General: Knowledge, Skills, Abilities and Other Characteristics (KSAOs)

The performance standards for an Industrial Maintenance Technician (IMT) Level I consists of nine (9) Duty Areas:

Duty Area 1: Maintenance Operations
Duty Area 2: Basic Mechanical Systems
Duty Area 3: Basic Hydraulic Systems
Duty Area 4: Basic Pneumatic Systems
Duty Area 5: Electrical Systems
Duty Area 6: Electronic Control Systems
Duty Area 7: Process Control Systems
Duty Area 8: Maintenance Welding
Duty Area 9: Maintenance Piping

The following KSAOs are held in common and apply to all nine areas and their corresponding Duty Titles.

Inclusive KSAOs for IMT Level I	
KNOWLEDGE	**The attainment of facts and principles**
2. Communications	Knowledge of communication, dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, audial and visual media.
8. Public Safety and Security	Knowledge of relevant equipment, policies, procedures and strategies to promote effective local, state or national security operations for the protection of people, data, property and institutions.
SKILLS	**Developed capabilities to work with given knowledge**
1. Basic	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.1 Active Learning and Listening	Understanding the implications of new information, utilizing in problem solving and decision making
1.3 Communication	Understanding the appropriate uses to convey and receive information
1.4 Effective Speaking and Writing	Communicating and conveying information verbally and in writing

1.7 Reading Comprehension	Understanding written material in work related documents
ABILITIES	**Attributes that influence performance**
1. Cognitive	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.2 Deductive Reasoning	Ability to apply general rules to specific problems
1.3 Expression	Ability to communicate information and ideas in writing and speaking so others can understand
1.5 Focus	Capability to pay attention to specifics or details with distractions
1.6 Inductive Reasoning	Ability to combined pieces of information to form general rules or conclusions
1.7 Information Organization	Ability to arrange objects or actions in an order or pattern related to a specific rule or set of rules
1.9 Memorization	Ability to remember information
OTHER CHARACTERISTICS	**Characteristics that may influence or have an effect towards work performance and influence occupational requirements**
1. Work Activities	**Performing specific functions or duties**
1.1. Controlling Machines and Processes	Utilizing mechanisms or direct physical activity to operate machines or processes
1.2. Drafting, Layout and Specification	Drawing, designing, detailing instructions or specifications for devices, parts, equipment for fabrication, assembly or maintaining
1.3. Handling and Moving Objects	Handling, installing, moving and positioning of materials
1.4. Inspection	Inspecting equipment, structures or materials to identify the cause of errors or other problems or defects
1.5. Monitoring	Monitor and review information from material, events, equipment or environment
1.6. Organization and Decision Making	Organize, plan, prioritize, analyze and evaluate information
1.7. Repairing and Maintaining	Servicing, repairing, adjusting and testing machines, devices, moving parts and equipment
2. Work Interests	**Preferences to work environments**

2.1. Conventional	Work activities that follow procedures, rules and routines. Working with data and details. Working under a line of authority
2.2. Investigative	Working with ideas and an extensive amount of thinking. Exploring and searching for facts and figuring out problems mentally
2.3. Realistic	Work activities that include practical, hands-on problems and solutions. Working with materials like wood, tools and machinery. Working outside and indoors
3. Work Styles	**Personal characteristics that can affect job performance**
3.1. Adaptability	Open to change
3.2. Analytical Thinking	Using logic to address problems
3.3. Attention to Detail	Being careful about detail and thorough in completing tasks
3.4. Dependability	Being reliable, responsible and fulfilling obligations
3.5. Initiative	Willingness to take on responsibilities and challenges
3.6. Persistence	Being diligent in the face of obstacles
3.7. Self-control	Maintaining composure in difficult situations
3.8. Stress Tolerance	Accepting criticism and dealing effectively with high stress situations
4. Work Values	**Global aspects important to a person's satisfaction**
4.1. Achievement	Result oriented, use of strongest abilities, giving a feeling of accomplishment
4.2. Independence	Responsible, work on own and make decisions, giving a feeling of autonomy
4.3. Relationships	Provide services to others and work with co-workers in a friendly non-competitive environment, giving a feeling of worth

VI. DUTY AREA 6: ELECTRONIC CONTROL SYSTEMS (ECS)

A. DUTIES AND DUTY TITLES

Duty Title: 6.01 Adhere to electronic power and control systems safety rules
Duty: Adhere to safety, health and environmental rules and regulations for electronic power and control systems

Duty Title: 6.02 Connect and test a DC power supply
Duty: Connect and test linear and switching DC power supplies

Duty Title: 6.03 Install and test a solid-state relay
Duty: Install and test solid-state AC and DC discrete and analog relays

Duty Title: 6.04 Install and test analog electronic sensors
Duty: Install, adjust and test analog sensors and signal conditioning equipment

Duty Title: 6.05 AC variable frequency drive
Duty: Install and operate an AC variable frequency volts-to-hertz motor drive system

Duty Title: 6.06 Transfer programs to programmable controller using a PC
Duty: Connect and transfer programs to a Programmable Controller (PLC) using a PC

Duty Title: 6.07 Create a basic PLC ladder-style program
Duty: Create a basic PLC ladder-style program

Duty Title: 6.08 Install and test basic PLC components
Duty: Install and test basic PLC components

Duty Title: 6.09 Basic troubleshooting
Duty: Troubleshoot PLC and controlled components

B. ELECTRONIC CONTROL SYSTEMS: PERFORMANCE STANDARDS

Duty Title: 6.01. Adhere to electronic power and control systems safety rules (ECS)

Duty: Adhere to safety, health and environmental rules and regulations for electronic power and control systems

Performance Standard:

- Identify roles and responsibilities for safety, health and environment
- Adhere to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace
- Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)
- Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state
- Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job
- Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information
- List and select proper fall protection for working at heights and using ladders, scaffolding and lifts
- Identify and recognize 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)
- Describe the process used to perform a job safety analysis
- Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)
- Identify fuel source and selection of correct extinguisher class

ECS Specific:

- Describe safety procedures for disconnecting or connecting electronic components
- Describe the hazards and precautionary safety procedures for working with electronic systems
- Define the standards to adhere to grounding safety procedures
- Define the NFPA 70E arc Flash guidelines and their importance

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
3	Customer Service	6.01
SKILLS		**Developed capabilities to work with given knowledge**
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	6.01
4.2	Instructing	6.01, 6.02, 6.03
4.3	Perceptiveness	6.01
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.13	Time Sharing	6.01
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.3	Reaction Time	6.01, 6.04
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	6.01
4.3	Speech Recognition	6.01

Duty Title: 6.02. Connect and test a DC power supply (ECS)

Duty: Connect and test linear and switching DC power supplies

Performance Standard:

- Measure output from a DC power supply (to determine noise or quality of filtering)
- Describe the operation of PN junction diodes, LEDs, Zener diodes and voltage regulators
- Describe the operation half wave and full wave rectifiers
- Describe the operation of capacitive, inductive and resistive power filters
- Describe the operation of bipolar and FET transistors (used in power supplies) and SCRS
- Describe the operation of linear and switching power supplies
- Connect and test linear and switching DC power supplies

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
5	Mechanical	6.02, 6.03, 6.04, 6.05, 6.07, 6.09
6	Physics	6.02, 6.03, 6.07, 6.08, 6.09
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.6	Operation Monitoring	6.02, 6.03, 6.04, 6.05, 6.08, 6.09
1.8	Science	6.02, 6.03, 6.05, 6.06, 6.07, 6.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	6.02 thru 6.06, 6.08, 6.09
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.2	Instructing	6.01, 6.02, 6.03
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**

6.2	Equipment Selection	6.02, 6.03, 6.05 thru 6.09
6.3	Installation Design	6.02 thru 6.09
6.5	Operational Analysis	6.02 thru 6.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	6.02 thru 6.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	6.02 thru 6.06, 6.08, 6.09

Duty Title: 6.03. Install and test a solid-state relay (ECS)

Duty: Install and test solid-state AC and DC relays

Performance Standard:

- Describe the operation of discrete and analog solid-state relays
- Describe the operation of sourcing and sinking circuits
- Describe styles of solid-state relays and mountings
- Interpret solid-state relay schematic symbols
- Interpret solid-state relay specifications
- Install solid-state relays in an electrical circuit given a schematic
- Describe types of failures of solid-state relays
- Use a multimeter to test a solid-state relay

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	6.03 thru 6.09
5	Mechanical	6.02, 6.03, 6.04, 6.05, 6.07, 6.09
6	Physics	6.02, 6.03, 6.07, 6.08, 6.09
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.6	Operation Monitoring	6.02, 6.03, 6.04, 6.05, 6.08, 6.09
1.8	Science	6.02, 6.03, 6.05, 6.06, 6.07, 6.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	6.02 thru 6.06, 6.08, 6.09
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.2	Instructing	6.01, 6.02, 6.03
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**

6.2	Equipment Selection	6.02, 6.03, 6.05 thru 6.09
6.3	Installation Design	6.02 thru 6.09
6.4	Installation Technical	6.03, 6.04, 6.05, 6.06, 6.08
6.5	Operational Analysis	6.02 thru 6.09
6.7	Programming	6.03, 6.05 thru 6.09
6.10	Technology	6.03, 6.06, 6.07, 6.08, 6.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	6.02 thru 6.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	6.03, 6.04, 6.05, 6.08, 6.09
3.2	Dexterity	6.03, 6.04, 6.05, 6.06, 6.08, 6.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	6.02 thru 6.06, 6.08, 6.09

Duty Title: 6.04. Install and test analog electronic sensors (ECS)

Duty: Install, adjust and test analog sensors and signal conditioning equipment

Performance Standard:

- Describe the operation of 4-20 ma current output and voltage output signals
- Describe the operation of signal conditioners for analog sensors
- Describe the operation of thermistors, RTD temperature sensors and thermocouples
- Describe the operation of resistive, capacitive and piezoelectric pressure sensors
- Interpret specifications for analog sensors
- Connect and test sensors and associated signal conditioner
- Describe types of failures of analog sensors
- Adjust the range and zero point of an analog signal conditioner

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	6.03 thru 6.09
5	Mechanical	6.02, 6.03, 6.04, 6.05, 6.07, 6.09
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	6.04, 6.05, 6.06, 6.08, 6.09
1.5	Mathematics	6.04, 6.05, 6.06, 6.08, 6.09
1.6	Operation Monitoring	6.02, 6.03, 6.04, 6.05, 6.08, 6.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	6.02 thru 6.06, 6.08, 6.09
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	6.04, 6.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**

6.3	Installation Design	6.02 thru 6.09
6.4	Installation Technical	6.03, 6.04, 6.05, 6.06, 6.08
6.5	Operational Analysis	6.02 thru 6.09
6.6	Operational Control	6.04, 6.05, 6.07, 6.08, 6.09
6.8	Quality Control	6.04, 6.05, 6.08, 6.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	6.04 thru 6.09
1.10	Number Proficiency	6.04, 6.05
1.11	Perceptual	6.04 thru 6.09
1.12	Technical Design	6.02 thru 6.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	6.03, 6.04, 6.05, 6.08, 6.09
3.2	Dexterity	6.03, 6.04, 6.05, 6.06, 6.08, 6.09
3.3	Reaction Time	6.01, 6.04
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	6.02 thru 6.06, 6.08, 6.09

Duty Title: 6.05. AC variable frequency drive (ECS)

Duty: Install and operate an AC variable frequency volts-to-hertz motor drive system

Performance Standard:

- Describe the operation of an AC VFD motor control system
- Describe the function and use of common AC drive parameters
- Describe the operation of IGBT and FET transistors as used in VFDs
- Describe VFD alarms/diagnostics and their importance
- Explain purpose of a grounding ring and its use with a VFD
- Connect and operate an AC variable frequency drive (VFD) with an AC motor and relay control circuit
- Explain and manually operate an AC VFD using an onboard HMI
- View and edit parameters in an AC VFD using an onboard HMI

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	6.03 thru 6.09
5	Mechanical	6.02, 6.03, 6.04, 6.05, 6.07, 6.09
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	6.04, 6.05, 6.06, 6.08, 6.09
1.5	Mathematics	6.04, 6.05, 6.06, 6.08, 6.09
1.6	Operation Monitoring	6.02, 6.03, 6.04, 6.05, 6.08, 6.09
1.8	Science	6.02, 6.03, 6.05, 6.06, 6.07, 6.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.1	Equipment Maintenance	6.05
6.2	Equipment Selection	6.02, 6.03, 6.05 thru 6.09
6.3	Installation Design	6.02 thru 6.09
6.4	Installation Technical	6.03, 6.04, 6.05, 6.06, 6.08

6.5	Operational Analysis	6.02 thru 6.09
6.6	Operational Control	6.04, 6.05, 6.07, 6.08, 6.09
6.7	Programming	6.03, 6.05 thru 6.09
6.8	Quality Control	6.04, 6.05, 6.08, 6.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	6.04 thru 6.09
1.10	Number Proficiency	6.04, 6.05
1.11	Perceptual	6.04 thru 6.09
1.12	Technical Design	6.02 thru 6.09
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	6.05
2.2	Strength	6.05
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	6.03, 6.04, 6.05, 6.08, 6.09
3.2	Dexterity	6.03, 6.04, 6.05, 6.06, 6.08, 6.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	6.02 thru 6.06, 6.08, 6.09

Duty Title: 6.06. Transfer programs to a programmable controller using a PC (ECS)

Duty*:* Connect and transfer programs to a Programmable Controller (PLC) using a PC

Performance Standard:

- Describe the basic operation of a PLC
- Describe the basic operation and navigation of PC software for PLCs
- Describe the nomenclature used for PLC program file elements
- Describe how PLCs are wired to power, I/O and network devices
- Describe the operation of a PLC network
- Describe how devices are identified on a PLC network
- Describe the use and importance of comments in ladder logic
- Change PLC modes
- Connect and transfer programs between a PC and a programmable controller via a serial, USB or Ethernet connection

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	6.03 thru 6.09
7	Production and Processing	6.06 thru 6.09
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	6.04, 6.05, 6.06, 6.08, 6.09
1.5	Mathematics	6.04, 6.05, 6.06, 6.08, 6.09
1.8	Science	6.02, 6.03, 6.05, 6.06, 6.07, 6.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	6.02 thru 6.06, 6.08, 6.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**

6.2	Equipment Selection	6.02, 6.03, 6.05 thru 6.09
6.3	Installation Design	6.02 thru 6.09
6.4	Installation Technical	6.03, 6.04, 6.05, 6.06, 6.08
6.5	Operational Analysis	6.02 thru 6.09
6.7	Programming	6.03, 6.05 thru 6.09
6.10	Technology	6.03, 6.06, 6.07, 6.08, 6.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	6.04 thru 6.09
1.11	Perceptual	6.04 thru 6.09
1.12	Technical Design	6.02 thru 6.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	6.03, 6.04, 6.05, 6.06, 6.08, 6.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	6.02 thru 6.06, 6.08, 6.09

Duty Title: 6.07. Create a basic PLC ladder-style program (ECS)

Duty: Create and interpret a basic PLC ladder-style program

Performance Standard:

- Use PC software to open a PLC program and review the files
- Interpret PLC programs with internal and external contacts, timers, counters, non-retentive output coils, internal coils, subroutines, conditional commands and math commands.
- Interpret PLC programs that control and sequence electric motors and fluid power systems
- Interpret a PLC I/O Diagram
- Identify an I/O device given a memory address
- Describe the function of an analog I/O card
- Describe the address scheme of a PLC
- Describe the operation of basic PLC commands including: internal and external contacts, timers, counters, non-retentive output coils, internal coils

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	6.03 thru 6.09
5	Mechanical	6.02, 6.03, 6.04, 6.05, 6.07, 6.09
6	Physics	6.02, 6.03, 6.07, 6.08, 6.09
7	Production and Processing	6.06 thru 6.09
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.8	Science	6.02, 6.03, 6.05, 6.06, 6.07, 6.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	6.02, 6.03, 6.05 thru 6.09

6.3	Installation Design	6.02 thru 6.09
6.5	Operational Analysis	6.02 thru 6.09
6.6	Operational Control	6.04, 6.05, 6.07, 6.08, 6.09
6.7	Programming	6.03, 6.05 thru 6.09
6.10	Technology	6.03, 6.06, 6.07, 6.08, 6.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	6.04 thru 6.09
1.11	Perceptual	6.04 thru 6.09
1.12	Technical Design	6.02 thru 6.09

Duty Title: 6.08. Install and test a HMI and PLC System (ECS)

Duty: Install and test a HMI and Programmable Controller System

Performance Standard:

- Connect and configure a HMI to a PLC via a network or direct connection
- Install and configure a PLC and its components
- Power up a HMI
- View data from a HMI panel
- Navigate HMI screens using touchscreen and function keys
- Interpret the operation of a PLC program that uses a ladder logic program to interface to a hardware component

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	6.03 thru 6.09
6	Physics	6.02, 6.03, 6.07, 6.08, 6.09
7	Production and Processing	6.06 thru 6.09
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	6.04, 6.05, 6.06, 6.08, 6.09
1.5	Mathematics	6.04, 6.05, 6.06, 6.08, 6.09
1.6	Operation Monitoring	6.02, 6.03, 6.04, 6.05, 6.08, 6.09
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	6.02 thru 6.06, 6.08, 6.09
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	6.08, 6.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**

6.2	Equipment Selection	6.02, 6.03, 6.05 thru 6.09
6.3	Installation Design	6.02 thru 6.09
6.4	Installation Technical	6.03, 6.04, 6.05, 6.06, 6.08
6.5	Operational Analysis	6.02 thru 6.09
6.6	Operational Control	6.04, 6.05, 6.07, 6.08, 6.09
6.7	Programming	6.03, 6.05 thru 6.09
6.8	Quality Control	6.04, 6.05, 6.08, 6.09
6.10	Technology	6.03, 6.06, 6.07, 6.08, 6.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	5.04 thru 6.09
1.11	Perceptual	5.04 thru 6.09
1.12	Technical Design	5.02 thru 6.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	6.03, 6.04, 6.05,6.08, 6.09
3.2	Dexterity	6.03, 6.04, 6.05, 6.06, 6.08, 6.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.1	Auditory Attention	6.08, 6.09
4.4	Visual Depth Perception	6.02 thru 6.06, 6.08, 6.09

Duty Title: 6.09. Basic mechatronic troubleshooting (ECS)

Duty: Troubleshoot a PLC and its controlled components: mechanical, electrical and software

Performance Standard:

- Use a PLC troubleshooting flow chart to troubleshoot a PLC system
- Use PLC program history to troubleshoot a PLC system
- Use systematic methodologies to troubleshoot a basic PLC-controlled machine orsystem and its components
- Use a HMI to troubleshoot a PLC-controlled machine
- Troubleshoot a HMI on a PLC-controlled machine
- Make mechanical, electrical and software adjustments to tune the performance of a PLC-controlled machine
- Use team skills to install, troubleshoot and optimize systems

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	6.03 thru 6.09
5	Mechanical	6.02, 6.03, 6.04, 6.05, 6.07, 6.09
6	Physics	6.02, 6.03, 6.07, 6.08, 6.09
7	Production and Processing	6.06 thru 6.09
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	6.04, 6.05, 6.06, 6.08, 6.09
1.5	Mathematics	6.04, 6.05, 6.06, 6.08, 6.09
1.6	Operation Monitoring	6.02, 6.03, 6.04, 6.05, 6.08, 6.09
1.8	Science	6.02, 6.03, 6.05, 6.06, 6.07, 6.09
2	**Complex Problem Solving**	**Developed capacities used to solve novel, ill-defined problems in complex, real-world settings**
2.1	Problem Solving	6.09

3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	6.02 thru 6.06, 6.08, 6.09
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	6.08, 6.09
5.2	Decision Making	6.09
5.3	Evaluation	6.04, 6.09
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	6.02, 6.03, 6.05 thru 6.09
6.3	Installation Design	6.02 thru 6.09
6.5	Operational Analysis	6.02 thru 6.09
6.6	Operational Control	6.04, 6.05, 6.07, 6.08, 6.09
6.7	Programming	6.03, 6.05 thru 6.09
6.8	Quality Control	6.04, 6.05, 6.08, 6.09
6.9	Repair	6.09
6.10	Technology	6.03, 6.06, 6.07, 6.08, 6.09
6.11	Troubleshooting	6.09
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.1	Adaptability	6.09
1.4	Fluency	6.09
1.8	Mathematical Reasoning	6.04 thru 6.09
1.11	Perceptual	6.04 thru 6.09
1.12	Technical Design	6.02 thru 6.09
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	6.03, 6.04, 6.05, 6.08, 6.09
3.2	Dexterity	6.03, 6.04, 6.05, 6.06, 6.08, 6.09
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**

4.1	Auditory Attention	6.08, 6.09
4.4	Visual Depth Perception	6.02 thru 6.06, 6.08, 6.09

IMT Level I - General: Knowledge, Skills, Abilities and Other Characteristics (KSAOs)

The performance standards for an Industrial Maintenance Technician (IMT) Level I consists of nine (9) Duty Areas.

Duty Area 1: Maintenance Operations
Duty Area 2: Basic Mechanical Systems
Duty Area 3: Basic Hydraulic Systems
Duty Area 4: Basic Pneumatic Systems
Duty Area 5: Electrical Systems
Duty Area 6: Electronic Control Systems
Duty Area 7: Process Control Systems
Duty Area 8: Maintenance Welding
Duty Area 9: Maintenance Piping

The following KSAOs are held in common and apply to all nine areas and their corresponding Duty Titles.

Inclusive KSAOs for IMT Level I	
KNOWLEDGE	**The attainment of facts and principles**
2. Communications	Knowledge of communication, dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, audial and visual media.
8. Public Safety and Security	Knowledge of relevant equipment, policies, procedures and strategies to promote effective local, state or national security operations for the protection of people, data, property and institutions.
SKILLS	**Developed capabilities to work with given knowledge**
1. Basic	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.1 Active Learning and Listening	Understanding the implications of new information, utilizing in problem solving and decision making
1.3 Communication	Understanding the appropriate uses to convey and receive information
1.4 Effective Speaking and Writing	Communicating and conveying information verbally and in writing
1.7 Reading Comprehension	Understanding written material in work related documents
ABILITIES	**Attributes that influence performance**

1. Cognitive	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.2 Deductive Reasoning	Ability to apply general rules to specific problems
1.3 Expression	Ability to communicate information and ideas in writing and speaking so others can understand
1.5 Focus	Capability to pay attention to specifics or details with distractions
1.6 Inductive Reasoning	Ability to combined pieces of information to form general rules or conclusions
1.7 Information Organization	Ability to arrange objects or actions in an order or pattern related to a specific rule or set of rules
1.9 Memorization	Ability to remember information
OTHER CHARACTERISTICS	**Characteristics that may influence or have an effect towards work performance and influence occupational requirements**
2. Work Activities	**Performing specific functions or duties**
1.1. Controlling Machines and Processes	Utilizing mechanisms or direct physical activity to operate machines or processes
1.2. Drafting, Layout and Specification	Drawing, designing, detailing instructions or specifications for devices, parts, equipment for fabrication, assembly or maintaining
1.3. Handling and Moving Objects	Handling, installing, moving and positioning of materials
1.4. Inspection	Inspecting equipment, structures or materials to identify the cause of errors or other problems or defects
1.5. Monitoring	Monitor and review information from material, events, equipment or environment
1.6. Organization and Decision Making	Organize, plan, prioritize, analyze and evaluate information
1.7. Repairing and Maintaining	Servicing, repairing, adjusting and testing machines, devices, moving parts and equipment
2. Work Interests	**Preferences to work environments**
2.1. Conventional	Work activities that follow procedures, rules and routines. Working with data and details. Working under a line of authority
2.2. Investigative	Working with ideas and an extensive amount of thinking. Exploring and searching for facts and figuring out problems mentally
2.3. Realistic	Work activities that include practical, hands-on problems and

	solutions. Working with materials like wood, tools and machinery. Working outside and indoors
3. Work Styles	**Personal characteristics that can affect job performance**
3.1. Adaptability	Open to change
3.2. Analytical Thinking	Using logic to address problems
3.3. Attention to Detail	Being careful about detail and thorough in completing tasks
3.4. Dependability	Being reliable, responsible and fulfilling obligations
3.5. Initiative	Willingness to take on responsibilities and challenges
3.6. Persistence	Being diligent in the face of obstacles
3.7. Self-control	Maintaining composure in difficult situations
3.8. Stress Tolerance	Accepting criticism and dealing effectively with high stress situations
4. Work Values	**Global aspects important to a person's satisfaction**
4.1. Achievement	Result oriented, use of strongest abilities, giving a feeling of accomplishment
4.2. Independence	Responsible, work on own and make decisions, giving a feeling of autonomy
4.3. Relationships	Provide services to others and work with co-workers in a friendly non-competitive environment, giving a feeling of worth

VII. DUTY AREA 7: PROCESS CONTROL SYSTEMS (PCS)

A. DUTIES AND DUTY TITLES

Duty Title: 7.01 Adhere to process control systems safety rules
Duty: Adhere to safety, health and environmental rules and regulations for process control systems

Duty Title: 7.02 Process control nomenclature and documentation
Duty: Read and interpret process control system documentation, including identifying components on a P&ID diagram, instrument tag and instrument index

Duty Title: 7.03 Calibrate and test analog sensors
Duty: Calibrate, adjust and test analog sensors and signal conditioning equipment

Duty Title: 7.04 Calibrate and test final control elements
Duty: Calibrate, adjust and test pneumatic proportional valves and I/P transmitters

Duty Title: 7.05 Install and operation of a basic controller
Duty: Build a simple/basic process single loop system

B. PROCESS CONTROL SYSTEMS: PERFORMANCE STANDARDS

Duty Title: 7.01. Adhere to process control systems safety rules (PCS)

Duty: Adhere to safety, health and environmental rules and regulations for process control systems

Performance Standard:

- Identify roles and responsibilities for safety, health and environment
- Adhere to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace
- Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)
- Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state
- Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job
- Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information
- List and select proper fall protection for working at heights and using ladders, scaffolding and lifts
- Identify and recognize 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)
- Describe the process used to perform a job safety analysis
- Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)
- Identify fuel source and selection of correct extinguisher class

PCS Specific:

- Describe safety procedures for disconnecting or connecting process control components
- Describe hazards and precautionary safety procedures for working with process control systems
- Define the environmental rules and regulations that could be impacted while working with process control systems

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
3	Customer Service	7.01
SKILLS		**Developed capabilities to work with given knowledge**
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	7.01
4.2	Instructing	7.01
4.3	Perceptiveness	7.01
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.13	Time Sharing	7.01
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.3	Reaction Time	7.01
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	7.01
4.3	Speech Recognition	7.01

Duty Title: 7.02. Process control nomenclature and documentation (PCS)

Duty: Read and interpret process control system documentation, including identifying components on a P&ID diagram, instrument tag and instrument index

Performance Standard:

- Identify process control components given their ISA P&ID schematic symbol
- Interpret the operation of a process control system given a P&ID diagram
- Identify and understand components on a P&ID diagram given their instrument tags
- Interpret instrument data given an instrument index

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	7.02 thru 7.05
5	Mechanical	7.02 thru 7.05
6	Physics	7.02 thru 7.05
7	Production and Processing	7.02 thru 7.05
SKILLS		**Developed capabilities to work with given knowledge**
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.3	Installation Design	7.02 thru 7.05
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.11	Perceptual	7.02 thru 7.05
1.12	Technical Design	7.02 thru 7.05

Duty Title: 7.03. Calibrate and test analog sensors (PCS)

Duty: Calibrate, adjust and test analog sensors and signal conditioning equipment

Performance Standard:

- Describe the operation of current-output and voltage-output signal sensors
- Describe the operation of signal conditioners for analog sensors
- Describe the operation of various transmitter types
- Interpret specifications for analog sensors
- Interpret units of measurement variables converted from raw data units (4-20 ma)
- Connect and test sensors and associated signal conditioners
- Adjust the span and zero point of analog sensor
- Describe types of failures of analog sensors

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	7.02 thru 7.05
5	Mechanical	7.02 thru 7.05
6	Physics	7.02 thru 7.05
7	Production and Processing	7.02 thru 7.05
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	7.03, 7.04, 7.05
1.5	Mathematics	7.03, 7.04, 7.05
1.6	Operation Monitoring	7.03 thru 7.05
1.8	Science	7.03 thru 7.05
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	7.03, 7.04, 7.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	7.03, 7.04, 7.05

6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	7.03, 7.04, 7.05
6.3	Installation Design	7.02 thru 7.05
6.4	Installation Technical	7.03, 7.04, 7.05
6.5	Operational Analysis	7.03, 7.04, 7.05
6.8	Quality Control	7.03, 7.04, 7.05
6.10	Technology	7.03 thru 7.05
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	7.03, 7.04, 7.05
1.10	Number Proficiency	7.03, 7.04, 7.05
1.11	Perceptual	7.02 thru 7.05
1.12	Technical Design	7.02 thru 7.05
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	7.03, 7.04, 7.05
3.2	Dexterity	7.03, 7.04, 7.05
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	7.03, 7.04, 7.05

Duty Title: 7.04. Calibrate and test final control elements (PCS)

Duty: Calibrate, adjust and test pneumatic proportional valves and I/P transmitters

Performance Standard:

- Describe the operation of current-output and voltage-output signal final control elements
- Describe the operation of I/P converters
- Describe the operation of pneumatic proportional valves
- Connect and test 2-way and 3-way pneumatic proportional valves
- Connect and test an I/P converter
- Calibrate an I/P converter
- Calibrate a pneumatic proportional valve

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	7.02 thru 7.05
5	Mechanical	7.02 thru 7.05
6	Physics	7.02 thru 7.05
7	Production and Processing	7.02 thru 7.05
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	7.03, 7.04, 7.05
1.5	Mathematics	7.03, 7.04, 7.05
1.6	Operation Monitoring	7.03 thru 7.05
1.8	Science	7.03 thru 7.05
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	7.03, 7.04, 7.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	7.03, 7.04, 7.05

6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	7.03, 6.04, 6.05
6.3	Installation Design	7.02 thru 6.05
6.4	Installation Technical	7.03, 6.04, 6.05
6.5	Operational Analysis	7.03, 6.04, 6.05
6.8	Quality Control	7.03, 6.04, 6.05
6.10	Technology	7.03 thru 6.05
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	7.03, 7.04, 7.05
1.10	Number Proficiency	7.03, 7.04, 7.05
1.11	Perceptual	7.02 thru 7.05
1.12	Technical Design	7.02 thru 7.05
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	7.03, 7.04, 7.05
3.2	Dexterity	7.03, 7.04, 7.05
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	7.03, 7.04, 7.05

Duty Title: 7.05. Install and operation of a basic single loop system (PCS)

Duty: Build a simple/basic single loop process control system

Performance Standard:

- Identify components for a basic single loop process control system
- Draw a print of a single loop process control system
- Connect, calibrate and tune a single loop process control system
- Describe the operation of a PID process control loop
- Describe the operation of a single loop process controller
- Describe the basic operation and application of PLC process control and Distributed Control Systems (DCS)

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	7.02 thru 7.05
5	Mechanical	7.02 thru 7.05
6	Physics	7.02 thru 7.05
7	Production and Processing	7.02 thru 7.05
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	7.03, 7.04, 7.05
1.5	Mathematics	7.03, 7.04, 7.05
1.6	Operation Monitoring	7.03 thru 7.05
1.8	Science	7.03 thru 7.05
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	7.03, 7.04, 7.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	7.03, 7.04, 7.05

6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	7.03, 7.04, 7.05
6.3	Installation Design	7.02 thru 7.05
6.4	Installation Technical	7.03, 7.04, 7.05
6.5	Operational Analysis	7.03, 7.04, 7.05
6.6	Operational Control	7.05
6.7	Programming	7.05
6.8	Quality Control	7.03, 7.04, 7.05
6.9	Repair	7.05
6.10	Technology	7.03 thru 7.05
6.11	Troubleshooting	7.05
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.4	Fluency	7.05
1.8	Mathematical Reasoning	7.03, 7.04, 7.05
1.10	Number Proficiency	7.03, 7.04, 7.05
1.11	Perceptual	7.02 thru 7.05
1.12	Technical Design	7.02 thru 7.05
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.1	Control Precision	7.03, 7.04, 7.05
3.2	Dexterity	7.03, 7.04, 7.05
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	7.03, 7.04, 7.05

IMT Level I – General Knowledge, Skills, Abilities and Other Attributes (KSAOs)

The performance standards for an Industrial Maintenance Technician (IMT) Level I consists of nine (9) Duty Areas.

Duty Area 1: Maintenance Operations
Duty Area 2: Basic Mechanical Systems
Duty Area 3: Basic Hydraulic
Duty Area 4: Basic Pneumatic Systems
Duty Area 5: Electrical Systems
Duty Area 6: Electronic Control Systems
Duty Area 7: Process Control Systems
Duty Area 8: Maintenance Welding
Duty Area 9: Maintenance Piping

The following KSAOs are held in common and apply to all nine areas and their corresponding Duty Titles.

Inclusive KSAOs for IMT Level I	
KNOWLEDGE	**The attainment of facts and principles**
2. Communications	Knowledge of communication, dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, audial and visual media.
8. Public Safety and Security	Knowledge of relevant equipment, policies, procedures and strategies to promote effective local, state or national security operations for the protection of people, data, property and institutions.
SKILLS	**Developed capabilities to work with given knowledge**
1. Basic	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.1 Active Learning and Listening	Understanding the implications of new information, utilizing in problem solving and decision making
1.3 Communication	Understanding the appropriate uses to convey and receive information
1.4 Effective Speaking and Writing	Communicating and conveying information verbally and in writing
1.7 Reading Comprehension	Understanding written material in work related documents
ABILITIES	**Attributes that influence performance**

1. Cognitive	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.2 Deductive Reasoning	Ability to apply general rules to specific problems
1.3 Expression	Ability to communicate information and ideas in writing and speaking so others can understand
1.5 Focus	Capability to pay attention to specifics or details with distractions
1.6 Inductive Reasoning	Ability to combined pieces of information to form general rules or conclusions
1.7 Information Organization	Ability to arrange objects or actions in an order or pattern related to a specific rule or set of rules
1.9 Memorization	Ability to remember information
OTHER CHARACTERISTICS	**Characteristics that may influence or have an effect towards work performance and influence occupational requirements**
1. Work Activities	**Performing specific functions or duties**
1.1. Controlling Machines and Processes	Utilizing mechanisms or direct physical activity to operate machines or processes
1.2. Drafting, Layout and Specification	Drawing, designing, detailing instructions or specifications for devices, parts, equipment for fabrication, assembly or maintaining
1.3. Handling and Moving Objects	Handling, installing, moving and positioning of materials
1.4. Inspection	Inspecting equipment, structures or materials to identify the cause of errors or other problems or defects
1.5. Monitoring	Monitor and review information from material, events, equipment or environment
1.6. Organization and Decision Making	Organize, plan, prioritize, analyze and evaluate information
1.7. Repairing and Maintaining	Servicing, repairing, adjusting and testing machines, devices, moving parts and equipment
2. Work Interests	**Preferences to work environments**
2.1. Conventional	Work activities that follow procedures, rules and routines. Working with data and details. Working under a line of authority
2.2. Investigative	Working with ideas and an extensive amount of thinking. Exploring and searching for facts and figuring out problems mentally
2.3. Realistic	Work activities that include practical, hands-on problems and

	solutions. Working with materials like wood, tools and machinery. Working outside and indoors
3. Work Styles	**Personal characteristics that can affect job performance**
3.1. Adaptability	Open to change
3.2. Analytical Thinking	Using logic to address problems
3.3. Attention to Detail	Being careful about detail and thorough in completing tasks
3.4. Dependability	Being reliable, responsible and fulfilling obligations
3.5. Initiative	Willingness to take on responsibilities and challenges
3.6. Persistence	Being diligent in the face of obstacles
3.7. Self-control	Maintaining composure in difficult situations
3.8. Stress Tolerance	Accepting criticism and dealing effectively with high stress situations
4. Work Values	**Global aspects important to a person's satisfaction**
4.1. Achievement	Result oriented, use of strongest abilities, giving a feeling of accomplishment
4.2. Independence	Responsible, work on own and make decisions, giving a feeling of autonomy
4.3. Relationships	Provide services to others and work with co-workers in a friendly non-competitive environment, giving a feeling of worth

VIII: DUTY AREA 8: MAINTENANCE WELDING (MW)

A. DUTIES AND DUTY TITLES

Duty Title: 8.01 Adhere to welding safety rules
Duty: Adhere to safety, health and environmental rules and regulations for welding

Duty Title: 8.02 Use an acetylene torch
Duty: Use an acetylene Torch to cut steel parts

Duty Title: 8.03 Basic welding
Duty: Explain welding theory, equipment and selection process

Duty Title: 8.04 Prepare parts to be welded
Duty: Prepare metal parts to be welded including degreasing, cleaning, grinding and inspecting

Duty Title: 8.05 Use SMAW Welder to make basic welds on flat stock
Duty: Set up a SMAW Welder for operation and make basic welds

Duty Title: 8.06 Use GMAW Welder a make basic welds on flat stock
Duty: Use a GMAW Welder to make basic welds on flat steel

Duty Title: 8.07 Weld inspection
Duty: Visually inspect welds identify defects

Duty Title: 8.08 Use plasma cutter to cut flat stock
Duty: Use plasma cutter to cut flat stock

B. MAINTENANCE WELDING: PERFORMANCE STANDARDS

Duty Title: 8.01 Adhere to welding safety rules (MW)

Duty: Adhere to safety, health and environmental rules and regulations for welding

Performance Standard:

- Identify roles and responsibilities for safety, health and environment
- Adhere to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace
- Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)
- Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state
- Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job
- Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information
- List and select proper fall protection for working at heights and using ladders, scaffolding and lifts
- Identify and recognize 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)
- Describe the process used to perform a job safety analysis
- Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)
- Identify fuel source and selection of correct extinguisher class

MW-Specific:

- Describe hazards and precautionary safety procedures for welding and cutting
- Describe the ANSIZ49.1, safety requirements and hot work permits while working with welding/cutting equipment, including compressed gas, regulators, electrical systems, high speed grinding equipment and hot work permits
- Describe the reasons for proper ventilation and selection of ventilation equipment
- Describe the health hazards to individuals performing welding/cutting work

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
3	Customer Service	8.01
SKILLS		**Developed capabilities to work with given knowledge**
4	**Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	8.01
4.2	Instructing	8.01
4.3	Perceptiveness	8.01
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.13	Time Sharing	8.01
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.3	Reaction Time	8.01, 8.02, 8.05, 8.06, 8.08
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	8.01
4.3	Speech Recognition	8.01

Duty Title: 8.02 Use an acetylene torch (MW)

Duty: Use an acetylene torch to cut steel parts

Performance Standard:

- Set up a torch and tanks for operation
- Select correct tips for thickness of metal
- Explain how to care for torch tips
- Select/choose proper PPE
- Use a torch to perform a straight cut on various thickness of metals up to ½" thick
- Explain regulator/pressure adjustments/tank transportation and storage
- Explain flashback

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	8.02, 8.03
5	Mechanical	8.02 thru 8.08
6	Physics	8.02 thru 8.08
7	Production and Processing	8.02 thru 8.08
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	8.02 thru 8.08
1.6	Operation Monitoring	8.02 thru 8.08
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	8.02 thru 8.08
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	8.02 thru 8.08
6.3	Installation Design	8.02 thru 8.08

6.4	Installation Technical	8.02 thru 8.08
6.5	Operational Analysis	8.02 thru 8.08
6.6	Operational Control	8.02 thru 8.08
6.8	Quality Control	8.02 thru 8.08
6.10	Technology	8.02 thru 8.08
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	8.02 thru 8.08
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	8.02, 8.05, 8.06, 8.08
2.2	Strength	8.02, 8.05, 8.06, 8.08
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	8.02, 8.05, 8.06, 8.08
3.3	Reaction Time	8.01, 8.02, 8.05, 8.06, 8.08
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	8.02, 8.05, 8.06, 8.08

Duty Title: 8.03 Basic welding (MW)

Duty: Explain welding theory, equipment and selection process

Performance Standard:

- Identify weld symbols on a welding schematic
- Select a welding process for a given application
- Explain welding rod designations and wire
- Identify parts of a welder
- Define proper grounding techniques
- Explain welding processes; SMAW, GMAW, TIG, resistance
- Explain the setup of a welder for the process; amp adjustment/volt adjustment – wire feed speed
- Describe properties of metal and selection of metal to be welded or selecting welding rod and wiring to be used for material to be welded

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	8.02, 8.03
4	Mathematics	8.07, 8.03
5	Mechanical	8.02 thru 8.08
6	Physics	8.02 thru 8.08
7	Production and Processing	8.02 thru 8.08
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	8.02 thru 8.08
1.5	Mathematics	8.07, 8.03
1.6	Operation Monitoring	8.02 thru 8.08
1.8	Science	8.03, 8.04, 8.07
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	8.02 thru 8.08

6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	8.02 thru 8.08
6.3	Installation Design	8.02 thru 8.08
6.4	Installation Technical	8.02 thru 8.08
6.5	Operational Analysis	8.02 thru 8.08
6.6	Operational Control	8.02 thru 8.08
6.8	Quality Control	8.02 thru 8.08
6.10	Technology	8.02 thru 8.08
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	8.02 thru 8.08

Duty Title: 8.04 Prepare parts to be welded (MW)

Duty: Prepare metal parts to be welded including degreasing, cleaning, grinding

Performance Standard:

- Identify metal to be used for weld
- Choose proper PPE for grinding/cleaning
- Remove chrome or galvanized plating
- Remove coating/plating
- Address ventilation considerations when grinding/cleaning
- Identify reasons to clean parts to be welded
- Define method of cleaning various metals and the material to be used
- Determine the procedure that is needed for a given type of weld joint or process
- Degrease, clean and grind metal to be welded

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
5	Mechanical	8.02 thru 8.08
6	Physics	8.02 thru 8.08
7	Production and Processing	8.02 thru 8.08
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	8.02 thru 8.08
1.6	Operation Monitoring	8.02 thru 8.08
1.8	Science	8.03, 8.04 8.07
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	8.02 thru 8.08
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	8.02 thru 8.08

6.3	Installation Design	8.02 thru 8.08
6.4	Installation Technical	8.02 thru 8.08
6.5	Operational Analysis	8.02 thru 8.08
6.6	Operational Control	8.02 thru 8.08
6.8	Quality Control	8.02 thru 8.08
6.9	Repair	8.04 thru 8.08
6.10	Technology	8.02 thru 8.08
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	8.02 thru 8.08

Duty Title: 8.05 Use SMAW Welder to make basic welds on flat stock (MW)

Duty: Set up a SMAW Welder for operation and make basic welds

Performance Standard:

- Choose proper PPE for SMAW Welding
- Set up a SMAW for welding operations
- Choose correct SMAW electrode for metal being used and thickness
- Use proper grounding techniques
- Set up part to be welded using a clamp, vise or fixture
- Identify welding effects on parts to be welded
- Remove chip slag and wire brush weld
- Use a SMAW Welder to perform basic types of welds including tack, butt joint,
- lap joint, T-joint, corner joint and groove joint in various positions

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
5	Mechanical	8.02 thru 7.08
6	Physics	8.02 thru 7.08
7	Production and Processing	8.02 thru 7.08
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	8.02 thru 7.08
1.6	Operation Monitoring	8.02 thru 7.08
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	8.02 thru 7.08
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	8.02 thru 7.08

6.3	Installation Design	8.02 thru 8.08
6.4	Installation Technical	8.02 thru 8.08
6.5	Operational Analysis	8.02 thru 8.08
6.6	Operational Control	8.02 thru 8.08
6.8	Quality Control	8.02 thru 8.08
6.9	Repair	8.04 thru 8.08
6.10	Technology	8.02 thru 8.08
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	8.02 thru 8.08
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	8.02, 8.05, 8.06, 8.08
2.2	Strength	8.02, 8.05, 8.06, 8.08
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	8.02, 8.05, 8.06, 8.08
3.3	Reaction Time	8.01, 8.02, 8.05, 8.06, 8.08
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	8.02, 8.05, 8.06, 8.08

Duty Title: 8.06 Use GMAW Welder a make basic welds on flat stock (MW)

Duty: Use a GMAW Welder to make basic welds on flat steel

Performance Standard:

- Choose proper PPE for GMAW Welding
- Choose GMAW Welding wire for metal being used and thickness
- Set up a GMAW Welder for operation and make basic welds
- Identify and select proper gasses for GMAW Welding
- Set up part to be welded using a clamp, vise or fixture
- Explain need for proper selection of nozzles and tips in the GMAW process
- Perform basic welds using a GMAW Welder including: tack, butt joint, lap joint, T-joint corner joint and groove joint in various positions
- Clean weld

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
5	Mechanical	8.02 thru 8.08
6	Physics	8.02 thru 8.08
7	Production and Processing	8.02 thru 8.08
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	8.02 thru 8.08
1.6	Operation Monitoring	8.02 thru 8.08
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	8.02 thru 8.08
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	7.02 thru 7.08

6.3	Installation Design	8.02 thru 8.08
6.4	Installation Technical	8.02 thru 8.08
6.5	Operational Analysis	8.02 thru 8.08
6.6	Operational Control	8.02 thru 8.08
6.8	Quality Control	8.02 thru 8.08
6.9	Repair	8.04 thru 8.08
6.10	Technology	8.02 thru 8.08
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	8.02 thru 8.08
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	8.02, 8.05, 8.06, 8.08
2.2	Strength	8.02, 8.05, 8.06, 8.08
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	8.02, 8.05, 8.06, 8.08
3.3	Reaction Time	8.01, 8.02, 8.05, 8.06, 8.08
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	8.02, 8.05, 8.06, 8.08

Duty Title: 8.07 Weld Inspection (MW)

Duty: Visually inspect welds to identify defects

Performance Standard:

- Define common weld defects: porosity, undercut, inclusions, poor penetration, burn through and cold lap
- Define proper welding sizing-including shape form and length
- Describe various weld inspection methods
- Describe countermeasures for common defects
- Visually inspect welds to identify common weld defects

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
4	Mathematics	8.07, 8.03
5	Mechanical	8.02 thru 8.08
6	Physics	8.02 thru 8.08
7	Production and Processing	8.02 thru 8.08
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	8.02 thru 8.08
1.5	Mathematics	8.07, 8.03
1.6	Operation Monitoring	8.02 thru 8.08
1.8	Science	8.03, 8.04, 8.07
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	8.02 thru 8.08
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.1	Critical Thinking	8.07
5.3	Evaluation	8.07

6	**Technical**	***Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems***
6.2	Equipment Selection	*8.02 thru 8.08*
6.3	Installation Design	*8.02 thru 8.08*
6.4	Installation Technical	8.02 thru 8.08
6.5	Operational Analysis	8.02 thru 8.08
6.6	Operational Control	8.02 thru 8.08
6.8	Quality Control	8.02 thru 8.08
6.9	Repair	8.04 thru 8.08
6.10	Technology	8.02 thru 8.08
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.11	Perceptual	8.07
1.12	Technical Design	8.02 thru 8.08

Duty Title: 8.08 Use Plasma Cutter to Cut Flat Stock (MW)

Duty: Use a plasma cutter to cut flat stock

Performance Standard:

- Choose proper PPE for plasma cutting
- Choose proper plasma cutter tip/cup and electrode for the process and thickness
- Set up and adjust a plasma cutter properly to cut metal
- Set proper air pressure for cutting metal using a plasma cutter
- Use a plasma cutter to perform a straight cut on various metals up to ½" thick
- Explain the operation of plasma cutter

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
5	Mechanical	8.02 thru 8.08
6	Physics	8.02 thru 8.08
7	Production and Processing	8.02 thru 8.08
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	8.02 thru 8.08
1.6	Operation Monitoring	8.02 thru 8.08
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	8.02 thru 8.08
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	8.02 thru 8.08
6.3	Installation Design	8.02 thru 8.08
6.4	Installation Technical	8.02 thru 8.08
6.5	Operational Analysis	8.02 thru 8.08

6.6	Operational Control	8.02 thru 8.08
6.8	Quality Control	8.02 thru 8.08
6.9	Repair	8.04 thru 8.08
6.10	Technology	8.02 thru 8.08
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.12	Technical Design	8.02 thru 8.08
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	8.02, 8.05, 8.06, 8.08
2.2	Strength	8.02, 8.05, 8.06, 8.08
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	8.02, 8.05, 8.06, 8.08
3.3	Reaction Time	8.01, 8.02, 8.05, 8.06, 8.08
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	8.02, 8.05, 8.06, 8.08

IMT Level I – General: Knowledge, Skills, Abilities and Other Characteristics (KSAOs)

The performance standards for an Industrial Maintenance Technician (IMT) Level I consists of nine (9) Duty Areas.

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Duty Area 2: Basic Mechanical Systems
Duty Area 3: Basic Hydraulic and Pneumatic Systems
Duty Area 4: Basic Pneumatic Systems
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Duty Area 7: Process Control Systems
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The following KSAOs are held in common and apply to all nine areas and their corresponding Duty Titles.

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1.4 Effective Speaking and Writing	Communicating and conveying information verbally and in writing
1.7 Reading Comprehension	Understanding written material in work related documents

ABILITIES	**Attributes that influence performance**
1. Cognitive	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.2 Deductive Reasoning	Ability to apply general rules to specific problems
1.3 Expression	Ability to communicate information and ideas in writing and speaking so others can understand
1.5 Focus	Capability to pay attention to specifics or details with distractions
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1.3. Handling and Moving Objects	Handling, installing, moving and positioning of materials
1.4. Inspection	Inspecting equipment, structures or materials to identify the cause of errors or other problems or defects
1.5. Monitoring	Monitor and review information from material, events, equipment or environment
1.6. Organization and Decision Making	Organize, plan, prioritize, analyze and evaluate information
1.7. Repairing and Maintaining	Servicing, repairing, adjusting and testing machines, devices, moving parts and equipment
2. Work Interests	**Preferences to work environments**
2.1. Conventional	Work activities that follow procedures, rules and routines. Working with data and details. Working under a line of authority
2.2. Investigative	Working with ideas and an extensive amount of thinking. Exploring and searching for facts and figuring out problems mentally

2.3. Realistic	Work activities that include practical, hands-on problems and solutions. Working with materials like wood, tools and machinery. Working outside and indoors
3. Work Styles	**Personal characteristics that can affect job performance**
3.1. Adaptability	Open to change
3.2. Analytical Thinking	Using logic to address problems
3.3. Attention to Detail	Being careful about detail and thorough in completing tasks
3.4. Dependability	Being reliable, responsible and fulfilling obligations
3.5. Initiative	Willingness to take on responsibilities and challenges
3.6. Persistence	Being diligent in the face of obstacles
3.7. Self-control	Maintaining composure in difficult situations
3.8. Stress Tolerance	Accepting criticism and dealing effectively with high stress situations
4. Work Values	**Global aspects important to a person's satisfaction**
4.1. Achievement	Result oriented, use of strongest abilities, giving a feeling of accomplishment
4.2. Independence	Responsible, work on own and make decisions, giving a feeling of autonomy
4.3. Relationships	Provide services to others and work with co-workers in a friendly non-competitive environment, giving a feeling of worth

IX: DUTY AREA 9: MAINTENANCE PIPING (MP)

A. DUTIES AND DUTY TITLES

Duty Title: 9.01 Adhere to piping system safety rules
Duty: Adhere to safety, health and environmental rules and regulations for piping systems

Duty Title: 9.02 Interpret basic piping schematics
Duty: Read and interpret piping schematics

Duty Title: 9.03 Identification and selection of correct material
Duty: Identify and select proper materials for installation and replacement

Duty Title: 9.04 Measurement and preparation
Duty: Prepare material for installation or repair of piping systems

Duty Title: 9.05 Installation piping systems
Duty: Assemble and disassemble piping systems

B. MAINTENANCE PIPING: PERFORMANCE STANDARDS

Duty Title: 9.01. Adhere to piping system safety rules (MP)

Duty: Adhere to safety, health and environmental rules and regulations for piping systems

Performance Standard:

- Identify roles and responsibilities for safety, health and environment
- Adhere to OSHA, NIOSH, EPA and other federal and state safety requirements for the workplace
- Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam and compressed air)
- Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state
- Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job
- Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information
- List and select proper fall protection for working at heights and using ladders, scaffolding and lifts
- Identify and recognize 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)
- Describe the process used to perform a job safety analysis
- Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety)
- Identify fuel source and selection of correct extinguisher class

MP-Specific:

- Identify required machine guarding for piping systems
- Identify different types of materials being handled by piping systems and their hazards
- Describe safety procedures for tightening, disconnecting or connecting piping system components
- Describe procedures for safe handling and disposal of piping contents
- Describe dangers of personal contact with pressurized hot or cold piping systems
- Adhere to guidelines to avoid contact with hot surfaces in piping systems
- Describe proper set-up, cleaning, isolation and purging procedures of working on process gases and combustible piping systems

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
3	Customer Service	9.01
6	Physics	All
7	Production and Processing	All
SKILLS		**Developed capabilities to work with given knowledge**
4	**Skills: Social**	**Developed capacities used to work with people to achieve goals**
4.1	Coordination	9.01
4.2	Instructing	9.01, 9.02
4.3	Perceptiveness	9.01
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.11	Perceptual	All
1.13	Time Sharing	9.01
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.3	Reaction Time	9.01
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.2	Speech Clarity	9.01
4.3	Speech Recognition	9.01

Duty Title: 9.02. Interpret basic piping schematics (MP)

Duty: Read and interpret piping schematics

Performance Standard:

- Identify basic piping components given their ISA schematic symbol, including:
  - Directional control valves, pressure control valve, flow control valves, cylinders, motors, instrumentation, pumps, various types of operators, filters
- Interpret piping line types and symbols on a schematic
- Identify and explain connectors and fittings specifications for processes
- Interpret the operation of a basic piping systems given a schematic

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	9.02, 9.03, 9.04, 9.05
5	Mechanical	9.02, 9.03, 9.04, 9.05
6	Physics	All
7	Production and Processing	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.6	Operation Monitoring	9.02, 9.04, 9.05
4	**Skills: Social**	**Developed capacities used to work with people to achieve goals**
4.2	Instructing	9.01, 9.02
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	9.02, 9.03, 9.04, 9.05
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	9.02 thru 9.05
6.3	Installation Design	9.02 thru 9.05

6.5	Operational Analysis	9.02, 9.03, 9.04, 9.05
6.6	Operational Control	9.02, 9.04, 9.05
6.8	Quality Control	9.02 thru 9.05
6.10	Technology	9.02 thru 9.05
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.11	Perceptual	All
1.12	Technical Design	9.02 thru 9.05

Duty Title: 9.03 Identification and selection of piping material

Duty: Identify and select proper materials for installation and replacement

Performance Standard:

- Select the proper tools to use with piping systems
- Define piping types and size by schedule and material
- Define tubing type and size by OD/ID and material
- Describe sealants, gaskets and solder types
- Explain types and ratings of hoses
- Explain types and uses of hangers
- Identify and select correct materials for process/medium compatibility
    - Fitting, connections,
    - Pipe or tubing
    - Sealants, gaskets or solder/weld

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	9.02, 9.03, 9.04, 9.05
4	Mathematics	9.03, 9.04, 9.05
5	Mechanical	9.02, 9.03, 9.04, 9.05
6	Physics	All
7	Production and Processing	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	9.03, 9.04, 9.05
1.5	Mathematics	9.03, 9.04, 9.05
1.8	Science	9.03, 9.04, 9.05
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	9.03, 9.04, 9.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**

5.3	Evaluation	9.02, 9.03, 9.04, 9.05
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	9.02 thru 9.05
6.3	Installation Design	9.02 thru 9.05
6.4	Installation Technical	9.03, 9.04, 9.05
6.5	Operational Analysis	9.02, 9.03, 9.04, 9.05
6.8	Quality Control	9.02 thru 9.05
6.10	Technology	9.02 thru 9.05
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	9.03, 9.04, 9.05
1.10	Number Proficiency	9.03, 9.04, 9.05
1.11	Perceptual	All
1.12	Technical Design	9.02 thru 9.05

Duty Title: 9.04 Measurement and preparation of piping (MP)

Duty: Prepare material for installation or repair of piping systems

Performance Standard:

- Interpret or detail the appropriate measurement of materials for cutting or bending
- Calculate pipe length required for installation or repair
- Use threading machines, tubing benders and cutting devices to prepare pipe and tubing
- Perform surface preparation for all types of connections
- Measure, cut and prepare iron pipe for installation or replacement
- Measure, cut and prepare PVC, CPVC pipe for installation
- Measure, cut and prepare tubing for installation

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	9.02, 9.03, 9.04, 9.05
4	Mathematics	9.03, 9.04, 9.05
5	Mechanical	9.02, 9.03, 9.04, 9.05
6	Physics	All
7	Production and Processing	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	9.03, 9.04, 9.05
1.5	Mathematics	9.03, 9.04, 9.05
1.6	Operation Monitoring	9.02, 9.04, 9.05
1.8	Science	9.03, 9.04, 9.05
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	9.03, 9.04, 9.05
5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	9.02, 9.03, 9.04, 9.05

6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	9.02 thru 9.05
6.3	Installation Design	9.02 thru 9.05
6.4	Installation Technical	9.03, 9.04, 9.05
6.5	Operational Analysis	9.02, 9.03, 9.04, 9.05
6.6	Operational Control	9.02, 9.04, 9.05
6.8	Quality Control	9.02 thru 9.05
6.9	Repair	9.04, 9.05
6.10	Technology	9.02 thru 9.05
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	9.03, 9.04, 9.05
1.10	Number Proficiency	9.03, 9.04, 9.05
1.11	Perceptual	All
1.12	Technical Design	9.02 thru 9.05
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	9.04, 9.05
2.2	Strength	9.04, 9.05
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	9.04, 9.05
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	9.04, 9.05

Duty Title: 9.05. Installation of piping systems (MP)

Duty: Perform assembly and disassembly of piping systems

Performance Standard:

- Explain support devices for all types of pipe systems
- Describe the effect of pipe strain on equipment
- Explain importance of proper torque
- Explain proper installation of sealants and gaskets
- Remove and install threaded pipe and fittings
- Remove and install tubing and fittings
- Remove and install PVC and CPVC pipe and fittings
- Remove and install bolted piping flanges

KSAO		Duty Titles
KNOWLEDGE		**The attainment of facts and principles**
1	Building and Construction	9.02, 9.03, 9.04, 9.05
4	Mathematics	9.03, 9.04, 9.05
5	Mechanical	9.02, 9.03, 9.04, 9.05
6	Physics	All
7	Production and Processing	All
SKILLS		**Developed capabilities to work with given knowledge**
1	**Basic**	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.2	Application	9.03, 9.04, 9.05
1.5	Mathematics	9.03, 9.04, 9.05
1.6	Operation Monitoring	9.02, 9.04, 9.05
1.8	Science	9.03, 9.04, 9.05
3	**Resource Management**	**Developed capacities used to allocate resources efficiently**
3.1	Material Resources	9.03, 9.04, 9.05
4	**Skills: Social**	**Developed capacities used to work with people to achieve goals**

5	**Systems**	**Developed capacities used to understand, monitor and improve socio-technical systems**
5.3	Evaluation	9.02, 9.03, 9.04, 9.05
6	**Technical**	**Developed capacities used to design, set-up, operate and correct malfunctions involving application of machines or technological systems**
6.2	Equipment Selection	9.02 thru 9.05
6.3	Installation Design	9.02 thru 9.05
6.4	Installation Technical	9.03, 9.04, 9.05
6.5	Operational Analysis	9.02, 9.03, 9.04, 9.05
6.6	Operational Control	9.02, 9.04, 9.05
6.8	Quality Control	9.02 thru 9.05
6.9	Repair	9.04, 9.05
6.10	Technology	9.02 thru 9.05
ABILITIES		**Attributes that influence performance**
1	**Cognitive**	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.8	Mathematical Reasoning	9.03, 9.04, 9.05
1.10	Number Proficiency	9.03, 9.04, 9.05
1.11	Perceptual	All
1.12	Technical Design	9.02 thru 9.05
2	**Physical**	**Abilities that influence strength, endurance, flexibility, balance and coordination**
2.1	Flexibility	9.04, 9.05
2.2	Strength	9.04, 9.05
3	**Psychomotor**	**Abilities that influence the capacity to manipulate and control objects**
3.2	Dexterity	9.04, 9.05
4	**Sensory**	**Abilities that influence visual, auditory and speech perception**
4.4	Visual Depth Perception	9.04, 9.05

IMT Level I - General: Knowledge, Skills, Abilities and Other Characteristics (KSAOs)

The performance standards for an Industrial Maintenance Technician (IMT) Level I consists of nine (9) Duty Areas.

Duty Area 1: Maintenance Operations
Duty Area 2: Basic Mechanical Systems
Duty Area 3: Basic Hydraulic Systems
Duty Area 4: Basic Pneumatic Systems
Duty Area 5: Electrical Systems
Duty Area 6: Electronic Control Systems
Duty Area 7: Process Control Systems
Duty Area 8: Maintenance Welding
Duty Area 9 Maintenance Piping

The following KSAOs are held in common and apply to all nine areas and their corresponding Duty Titles.

Inclusive KSAOs for IMT Level I	
KNOWLEDGE	**The attainment of facts and principles**
2. Communications	Knowledge of communication, dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, audial and visual media.
8. Public Safety and Security	Knowledge of relevant equipment, policies, procedures and strategies to promote effective local, state or national security operations for the protection of people, data, property and institutions.
SKILLS	**Developed capabilities to work with given knowledge**
1. Basic	**Developed capacities that facilitate learning or the more rapid acquisition of knowledge**
1.1 Active Learning and Listening	Understanding the implications of new information, utilizing in problem solving and decision making
1.3 Communication	Understanding the appropriate uses to convey and receive information
1.4 Effective Speaking and Writing	Communicating and conveying information verbally and in writing
1.7 Reading Comprehension	Understanding written material in work related documents
ABILITIES	**Attributes that influence performance**

1. Cognitive	**Abilities that influence the acquisition and application of knowledge in problem solving**
1.2 Deductive Reasoning	Ability to apply general rules to specific problems
1.3 Expression	Ability to communicate information and ideas in writing and speaking so others can understand
1.5 Focus	Capability to pay attention to specifics or details with distractions
1.6 Inductive Reasoning	Ability to combined pieces of information to form general rules or conclusions
1.7 Information Organization	Ability to arrange objects or actions in an order or pattern related to a specific rule or set of rules
1.9 Memorization	Ability to remember information
OTHER CHARACTERISTICS	**Characteristics that may influence or have an effect towards work performance and influence occupational requirements**
1. Work Activities	**Performing specific functions or duties**
1.1. Controlling Machines and Processes	Utilizing mechanisms or direct physical activity to operate machines or processes
1.2. Drafting, Layout and Specification	Drawing, designing, detailing instructions or specifications for devices, parts, equipment for fabrication, assembly or maintaining
1.3. Handling and Moving Objects	Handling, installing, moving and positioning of materials
1.4. Inspection	Inspecting equipment, structures or materials to identify the cause of errors or other problems or defects
1.5. Monitoring	Monitor and review information from material, events, equipment, or environment
1.6. Organization and Decision Making	Organize, plan, prioritize, analyze and evaluate information
1.7. Repairing and Maintaining	Servicing, repairing, adjusting and testing machines, devices, moving parts and equipment
2. Work Interests	**Preferences to work environments**
2.1. Conventional	Work activities that follow procedures, rules and routines. Working with data and details. Working under a line of authority
2.2. Investigative	Working with ideas and an extensive amount of thinking. Exploring and searching for facts and figuring out problems mentally
2.3. Realistic	Work activities that include practical, hands-on problems and

	solutions. Working with materials like wood, tools and machinery. Working outside and indoors
3. Work Styles	**Personal characteristics that can affect job performance**
3.1. Adaptability	Open to change
3.2. Analytical Thinking	Using logic to address problems
3.3. Attention to Detail	Being careful about detail and thorough in completing tasks
3.4. Dependability	Being reliable, responsible and fulfilling obligations
3.5. Initiative	Willingness to take on responsibilities and challenges
3.6. Persistence	Being diligent in the face of obstacles
3.7. Self-control	Maintaining composure in difficult situations
3.8. Stress Tolerance	Accepting criticism and dealing effectively with high stress situations
4. Work Values	**Global aspects important to a person's satisfaction**
4.1. Achievement	Result oriented, use of strongest abilities, giving a feeling of accomplishment
4.2. Independence	Responsible, work on own and make decisions, giving a feeling of autonomy
4.3. Relationships	Provide services to others and work with co-workers in a friendly non-competitive environment, giving a feeling of worth

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Regional Validation Groups (RVG)

RVG meetings were held in the following locations across the United States:

- Chippewa Valley Technical College - Eau Claire, WI
- Iowa Advanced Manufacturing Center - Ankeny, IA
- Laney College - Oakland, CA
- Lehigh Career and Technical Institute-Schnecksville, PA
- Rock Valley College - Rockford, IL
- Tennessee Colleges Applied Technology - Nashville, TN

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