

# **Appendix R**

## **MANUFACTURING YOUTH APPRENTICESHIP**

### **MAINTENANCE, INSTALLATION, & REPAIR: ADVANCED INDUSTRIAL EQUIPMENT (UNIT 11)**

# Unit 11: Maintenance, Installation, & Repair Pathway

## Advanced Industrial Equipment

Competency

### 1. Monitor equipment for correct operation

Performance Standard Condition

**Competence will be demonstrated**

- at the worksite

Performance Standard Criteria

**Performance will be successful when:**

- Learner reviews equipment quality measures for trends and problems as required
- Learner compares current equipment performance to optimal equipment operations on a regular basis
- Learner reports any noted deviations from expected performance
- Learner reviews all relevant data before making suggestions
- Learner assists worksite professional to investigate abnormal equipment conditions in a timely manner
- Learner continuously monitors equipment that is corrected to ensure that the corrective action solved the problem
- Learner documents all monitoring activities
- Learner assures that repair history is complete, current and accurate

Learning Objectives

- Identify basic approaches to maintenance
- Explain how to read and review repair history records
- Describe how trends for malfunctioning equipment might appear in production records
- List the tools and equipment at your facility that must be monitored and maintained
- Define Total Productive Maintenance (TPM)
- Describe how monitoring and diagnostic device are used to find out which equipment is operating correctly
- Define statistical distributions
- Calculate mean, median, mode and standard deviation
- List possible sources of variation inherent in data collection
- Identify the purpose of a control chart
- Identify conditions that require preventive or corrective actions
- Explain ways to spot data inaccuracies and respond to them
- Describe quality statistical tools such as histograms, CpK, X bar, and R charts and range

**Comments:**

## **Unit 11: Maintenance, Installation, & Repair Pathway**

### **Advanced Industrial Equipment**

Competency

#### **2. Perform metal cutting, forming, drilling, and/or welding operations**

Performance Standard Condition

#### **Competence will be demonstrated**

- at the worksite

Performance Standard Criteria

#### **Performance will be successful when:**

- Learner follows preventive maintenance and repair of equipment steps
- Learner selects the correct cutting & forming tools, drill bits, and/or welding equipment for the application
- Learner sets up equipment according to established procedures
- Learner processes metal according to specifications
- Learner deburrs material edges

Learning Objectives

- Distinguish between common cutting, drilling and welding processes
- Describe equipment components and safety features
- Describe how to cut, drill, and/or weld metal to tolerances
- Interpret cutting, forming, drilling, and welding symbols on schematics

**Comments:**

# Unit 11: Maintenance, Installation, & Repair Pathway

## Advanced Industrial Equipment

Competency

### 3. Mount a bearing

Performance Standard Condition

**Competence will be demonstrated**

- at the worksite

Performance Standard Criteria

**Performance will be successful when:**

- Learner follows preventive maintenance and repair of equipment steps
- Learner checks running machine for signs (e.g., heat, noise, vibration, etc.) of malfunctioning bearings
- Learner finds the correct reference for bearing numbering
- Learner verifies the correct bearing for the application
- Learner inspects bearing for condition and lubrication
- Learner verifies mounting clearances according to specification
- Learner handles bearings properly to avoid contamination and damage
- Learner assists worksite professional to remove used bearings carefully and correctly
- Learner assists worksite professional to prepare all appropriate surfaces (the shaft and bore) as required
- Learner assists worksite professional to mount bearing according to specifications
- Learner assists worksite professional to analyze reason bearing failed

Learning Objectives

- Identify bearing types and use
- Explain how to match bearing number nomenclature to bearing type
- Explain how to analyze bearings as to type and application
- Discuss the need to prevent contamination of fluids and bearings
- Describe proper function of bearings and couplings and their reliability issues including functioning of transmission equipment, and bearings, shafts, & couplings function

**Comments:**

# Unit 11: Maintenance, Installation, & Repair Pathway

## Advanced Industrial Equipment

Competency

### 4. Perform lubrication procedures

Performance Standard Condition

**Competence will be demonstrated**

- at the worksite

Performance Standard Criteria

**Performance will be successful when:**

- Learner follows preventive maintenance and repair of equipment steps
- Learner checks lubricant levels
- Learner checks for and corrects leakage
- Learner draws lubricant samples for analysis
- Learner tests lubricant for contamination and viscosity
- Learner drains lubricant if required
- Learner fills reservoir with correct lubricant
- Learner uses procedures to avoid contamination
- Learner cleans inlet strainer and filters if required
- Learner adds additional lubrication if required

Learning Objectives

- Describe the different types of lubricants, their uses, storage, and disposal requirements
- Discuss how to use a viscosimeter and grease gun
- Identify bearings that do not require lubricant
- Describe how to determine when a bearing has the correct amount of grease/lubricant
- Determine type of lubrication requirements
- Determine locations requiring lubrication
- Determine proper type of lubricant for each location
- Determine amount of lubricant required for each location

**Comments:**

## **Unit 11: Maintenance, Installation, & Repair Pathway**

### **Advanced Industrial Equipment**

#### Competency

#### **5. Assist to identify and diagnose hydraulic OR pneumatic system problems**

#### Performance Standard Condition

##### **Competence will be demonstrated**

- at the worksite
- While assisting a worksite professional

#### Performance Standard Criteria

##### **Performance will be successful when:**

- Learner follows identification and diagnosis of equipment problems steps
- Learner interprets schematics for basic hydraulic system or pneumatic circuit
- Learner assists in taking appropriate readings using meters and testing instruments
- Learner checks pressure in a hydraulic OR pneumatic system at the appropriate location
- Learner assists worksite professional to locate and determine the cause of problems in a hydraulic or pneumatic systems

#### Learning Objectives

- Define the principles of hydraulics
- Explain the purpose and function of hydraulic components
- Describe hydraulic system reliability issues including seals, gaskets, packing, and hydraulic fluids
- Define the principles of pneumatics
- Demonstrate how and where to measure pressure in a pneumatic system
- Describe pneumatic system reliability issues including pressure gage readings, conductors, connectors, seals, gaskets, packing, quick-connect fittings, pneumatic cylinder and motor operations, air muffler operations, actuator power output, and pressure regulator operations

#### **Comments:**

# Unit 11: Maintenance, Installation, & Repair Pathway

## Advanced Industrial Equipment

Competency

### 6. Maintain and repair hydraulic OR pneumatic components

Performance Standard Condition

#### **Competence will be demonstrated**

- at the worksite

Performance Standard Criteria

#### **Performance will be successful when:**

- Learner follows preventive maintenance and repair of equipment steps
- Learner measures and adjusts relief, unloading, and pressure control valves for proper pressure
- Learner measures and adjusts flow controls for proper rates
- Learner checks for system leaks

#### HYDRALICS

- Learner draws sample of hydraulic fluid for analysis
- Learner tests hydraulic fluids for contamination and viscosity
- Learner drains hydraulic fluids if required
- Learner fills reservoir with correct hydraulic fluid
- Learner uses procedures to avoid fluid contamination
- Learner cleans inlet strainer and filters if required
- Learner checks hydraulic power unit for proper performance
- Learner inspects and replaces seals and gaskets if required
- Learner inspects and replaces hoses, tubing and fittings if required
- Learner checks operation of control valves and cylinders and replace if required

#### PNEUMATICS

- Learner measures and adjusts pressure regulators and in-line filters and replace if required
- Learner checks and repairs lines for air leaks
- Learner checks and manually operates all safety valves
- Learner checks air dryer for proper operation
- Learner checks operation of control valves and cylinders and replaces if required
- Learner aligns piston (rod) of pneumatic cylinder
- Learner checks operation of water separator/drain as necessary
- Learner drains receiver tanks
- Learner drains and blows out mains and header pipes
- Learner inspects and fills air lubricators

## Learning Objectives

- Interpret hydraulic schematics
- Interpret pneumatic schematics
- Differentiate between seals, packings, and gaskets on hydraulic systems
- Identify hydraulic components, fittings (threads and types) and lines
- Describe the use of different types of pneumatic conductors and connectors for a given system

## Comments:

## Unit 11: Maintenance, Installation, & Repair Pathway

### Advanced Industrial Equipment

Competency

#### 7. Maintain and repair mechanical drive system problems

Performance Standard Condition

**Competence will be demonstrated**

- at the worksite

Performance Standard Criteria

**Performance will be successful when:**

- Learner follows preventive maintenance and repair of equipment steps
- Learner checks pulley and belts for tension, wear and damage
- Learner mounts new pulleys to shafts if required
- Learner maintains, installs, aligns, and adjusts tension on a belt drive
- Learner cleans, installs, and aligns gear drives
- Learner maintains, installs, aligns, and adjust tension a chain and sprocket drive
- Learner installs and aligns couplings
- Learner checks and corrects motor mounting for soft foot condition, angular & groove alignment
- Learner applies lubrication to mechanical drive system according to specifications
- Learner removes foreign debris from cooling towers
- Learner replaces air filters

Learning Objectives

- Locate the major components of a mechanical drive system including v-belts, pulleys and chain drives
- Distinguish between various kinds of mechanical power transmissions
- Recognize reliability issues for belt and chain drives
- Determine proper belt deflection force required for tension

**Comments:**

## **Unit 11: Maintenance, Installation, & Repair Pathway**

### **Advanced Industrial Equipment**

Competency

#### **8. Maintain and repair electrical control system problems**

Performance Standard Condition

##### **Competence will be demonstrated**

- at the worksite

Performance Standard Criteria

##### **Performance will be successful when:**

- Learner assists to identify and diagnose electrical circuit problems
- Learner follows preventive maintenance and repair of equipment steps
- Learner replaces faulty lighting components
- Learner replaces blown fuse or tripped circuit breaker
- Learner constructs common control circuits using switches and relays
- Learner assists to adjust, repair or replace faulty circuit components
- Learner assists to install conduit and wiring

Learning Objectives

- Describe special safety precautions needed when working with electrical components
- Explain ground requirements
- Compare lamp wattage, lumens, size and types of lighting and fixtures
- Compare wire size and types
- Compare conduit size and types
- Determine bend radius and location
- Describe how to assemble a wire bundle
- Explain how to connect wires to termination points

**Comments:**

## Unit 11: Maintenance, Installation, & Repair Pathway

### Advanced Industrial Equipment

Competency

#### 9. Assist to qualify and install equipment

Performance Standard Condition

**Competence will be demonstrated**

- at the worksite
- While assisting a worksite professional

Performance Standard Criteria

**Performance will be successful when:**

- Identify and evaluate required technical, environmental, safety and performance features of equipment needed
- Verify final selection of equipment from qualified vendor
- Obtain manufacturer's recommendations for installation site requirements.  
Check the equipment operation site for the fulfillment of the manufacturer's recommendations (utilities such as electricity, water and gases plus environmental conditions such as humidity, temperature, vibration level and dust).  
Allow sufficient space for the equipment itself, related SOPs, operating manuals, logbooks and any software
- Receive equipment and check for damage
- Install equipment according to manufacturer recommendations
- Level and fasten installed equipment as required
- Test and validate the equipment operationally for all types of applications, stresses, and routine operation
- If equipment is customized or adjusted, test and validate for specific changes made
- Determine performance start up qualification (criteria, procedures, critical parameters, test intervals) and sample analysis for each run or use
- Determine cleaning, preventive maintenance (PM), routine servicing and authorized repair engineers
- Update maintenance schedules with new equipment PM and servicing
- Document qualification and installation such as initial calibration, initial operational testing, quality control procedures and parameters, customization and testing, determination of maintenance and servicing, list of authorized service engineers, etc.

## Learning Objectives

- Define the following components of equipment qualification: design qualification, installation qualification, operational qualification, performance qualification, maintenance qualification
- Explain the role of the vendor and the role of the user in all phases of equipment qualification
- List examples of technical, environmental and safety factors that need to be considered when purchasing industrial equipment
- Describe the vendor qualification process
- Distinguish between initial operational qualification of equipment and routine performance qualification
- Describe the impact of Total Quality Management (TQM) principles and ISO9000 certification on equipment qualification
- Explain the purpose of data collection and analysis to qualify equipment
- Identify statistical tools used in performance qualification
- Identify methods of inspecting materials, processes, and final products in qualifying equipment
- Explain the purpose of documentation and record keeping for equipment qualification
- Explain the importance of testing and documenting customized or adjusted equipment

## Comments: