COMPETENCIES, OBJECTIVES, AND PERFORMANCE TASKS

Power Industry Fundamentals

Power Generation Maintenance Mechanic Level One

Power Generation Maintenance Mechanic Level Two

Power Generation Maintenance Mechanic Level Three

Power Generation Maintenance Mechanic Level Four

15506-09 Maintaining and Repairing Turbine Components

15505-09 Turbines

32305-08 Setting Baseplates and Prealignment

32408-09 Troubleshooting and Repairing Gearboxes

32407-09 Troubleshooting and Repairing Pumps

32403-09 Compressors and Pneumatic Systems

32212-07 Introduction to Tube Work

52402-10 Fuel Preparation and Delivery Equipment

32401-09 Preventive and Predictive Maintenance

52401-10 Vibration and Balancing
Module Overview

There are good vibrations and bad vibrations in machinery. Bad vibrations are often caused by things being damaged or out of balance. This module reviews machine basics and addresses where vibrations can be found and how they can be detected. It also addresses how vibration collection and analysis can be used to detect unbalanced equipment, and how it can be used to balance the equipment.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: Power Industry Fundamentals; Power Generation Maintenance Mechanic Level One; Power Generation Maintenance Mechanic Level Two; and Power Generation Maintenance Mechanic Level Three.

Objectives

When you have completed this module, you will be able to do the following:

1. Explain machine basics.
2. Explain the causes of vibration.
3. Explain vibration analysis.
4. Identify and explain the different kinds of basic vibration test equipment.
5. Explain vibration monitoring.
6. Explain field balancing of machines.
7. Using a vibration monitor, analyze a piece of rotating equipment to determine if vibration is within tolerance.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to:

1. Collect and analyze vibrational date from a rotating part inside an operational machine.
2. Demonstrate or identify where to place a temporary weight, based on a given set of balance data.

Materials and Equipment

- Markers/chalk
- Pencils and scratch paper
- Whiteboard/chalkboard
- Multimedia projector and screen
- Computer
- Appropriate personal protective equipment
- Copies of balancing standards from ISO, NEMA, and API
- Copies of company’s lockout and tagout procedures
- Copies of company’s fall-protection procedures
- Vendor manuals and drawings for machines being evaluated
- Vendor manuals and drawings for any machines being used with this module
- Tools of the trade
- Small gauge pipe and small weights to fit on the ends
- T-joints
- Access to different types of new and used:
  - Electric motors
  - Gearboxes/reducers
  - Pumps
  - Fans
  - Compressors
  - Conveyors
  - Bearings (plain and antifriction)
  - for rotating and non-rotating equipment
  - Couplings (both installed and not installed)
  - Drive belts (installed)
  - Drive chains (installed)
  - A small variable-speed electric motor equipped with a test pulley
  - A small weigh scale
  - Dial indicators for checking shaft runout

continued
Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment. Review safety guidelines associated with collecting and analyzing vibrational data, and equipment balancing. Emphasize the importance of proper housekeeping. Point out the hazards of working near or on rotating equipment.

Additional Resources

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

- Plant Maintenance Resource Center, for articles on bearings and vibration analysis: www.plant-maintenance.com.
- Commtest, for vibration analysis information, products, and training: http://commtest.com.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover Vibration and Balancing. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic Planned</th>
<th>Time</th>
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<td>A. Introduction</td>
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<td>1. Rotating Equipment</td>
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<td>2. Non-Rotating Equipment</td>
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<td>3. Data-Collecting Devices</td>
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<td>4. Reasons for Collecting and Analyzing Data</td>
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</table>

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.
C. Causes of Vibration
   1. Unbalance
   2. Misalignment
   3. Bent Drive Shafts
   4. Loose or Too Tight Mounting Bolts
   5. Worn or Damaged Bearings
   6. Improper Gear Meshing
   7. Loose Drive Belts
   8. Improper Lubrication
   9. Electrical Problems
   10. Destructive Resonant Frequencies

Session II. Vibration Analysis, Test Equipment, and Monitoring; Field Balancing of Machines
A. Vibration Analysis
   1. Frequency
   2. Velocity
   3. Acceleration
   4. Displacement
B. Vibration Test Equipment
   1. Transducers (Detectors)
   2. Vibration Analysis Equipment
   3. Vibration Recording Instruments
C. Vibration Monitoring
   1. Identifying Equipment to be Monitored
   2. Establishing Schedule for Monitoring
   3. Determining Locations of Monitoring Points
   4. Developing and Maintaining Vibration Monitoring Records
   5. Establishing Continuous Monitoring System
D. Field Balancing of Machines
   1. Determining Cause of Unbalance
   2. Calculating Unbalance Force
   3. Determining Required Corrective Action
   4. Balancing Analyzers
   5. Performing Balancing Actions

Session III Laboratory
A. Laboratory (1 session)
   Have trainees collect and analyze vibrational data from an operational machine.
   This laboratory corresponds to Performance Task 1.

Session IV. Laboratory
A. Laboratory
   Have trainees use provided balance data to determine where to place temporary weights on rotating equipment. This laboratory corresponds to Performance Task 2.
Session V. Review and Testing

A. Review

B. Module Examination
   1. Trainees must score 70 percent or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.
MODULE OVERVIEW
This module provides an overview of the preventive and predictive maintenance processes. Information about nondestructive testing is also included.

PREREQUISITES
Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Industrial Maintenance Mechanic Level One; Industrial Maintenance Mechanic Level Two; and Industrial Maintenance Mechanic Level Three.

OBJECTIVES
Upon completion of this module, the trainee will be able to do the following:
1. Explain preventive and predictive maintenance.
2. Explain nondestructive testing.
3. Explain ultrasonics.
4. Explain radiography.
5. Explain eddy current inspection.
6. Explain visual and optical inspection.
7. Explain liquid penetrant inspection.
8. Explain magnetic particle inspection.
10. Explain infrared testing.
11. Explain vibration analysis.
12. Explain tribology.

PERFORMANCE TASKS
This is a knowledge-based module; there are no performance tasks.

MATERIALS AND EQUIPMENT LIST
Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Examples of flawed welds, stress cracks, etc.
NDT equipment, including:
- Ultrasonic tester
- Pyrometer
- Eddy current tester
- Borescope
- Liquid penetrant kit
- Magnetic particle yoke
Copies of the Quick Quizzes*
Module Examination**

* Located at the back of this module.
**Located in the Test Booklet.
SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.


TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover Preventive and Predictive Maintenance. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

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<thead>
<tr>
<th>Topic</th>
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<td>Session I. Introduction; Preventive Maintenance; Predictive Maintenance</td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Preventive Maintenance</td>
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<tr>
<td>1. Program Benefits</td>
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<tr>
<td>C. Predictive Maintenance</td>
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<tr>
<td>1. Requirements and Priorities</td>
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<td>2. Documentation</td>
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<tr>
<td>A. Introduction</td>
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<td>B. Ultrasonics</td>
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<td>C. Radiography</td>
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<td>D. Eddy Current Inspection</td>
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<tr>
<td>E. Visual and Optical Inspection</td>
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<tr>
<td>Session III. Nondestructive Testing and Evaluation, Part Two</td>
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<tr>
<td>A. Liquid Penetrant Inspection</td>
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<td>B. Magnetic Particle Inspection</td>
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<tr>
<td>C. Acoustic Emission Testing</td>
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<tr>
<td>D. Infrared Testing</td>
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<tr>
<td>E. Vibration Analysis</td>
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<td>F. Tribology</td>
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</tbody>
</table>
Session IV. Review and Testing

A. Trade Terms and Quick Quizzes

B. Module Review

C. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
Module Overview

This module describes equipment used to move solid fuels into the boiler house facilities. It explains how the fuels are prepared, how the fuels are delivered into the furnaces, and how the fuel residues are removed from the furnaces. The module also covers the maintenance needed to keep the fuel preparation and delivery equipment operating.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Power Industry Fundamentals; Power Generation Maintenance Mechanic Level One; Power Generation Maintenance Mechanic Level Two; Power Generation Maintenance Mechanic Level Three; and Power Generation Maintenance Mechanic Level Four, Modules 52401-10 and 32401-09.

Objectives

When you have completed this module, you will be able to do the following:

1. Explain the basic operations of a coal-fired boiler system.
2. Describe the path that coal takes from the storage area(s) to the coal-preparation equipment.
3. Explain why coal must be prepared, and the methods and equipment used to prepare coal.
4. Describe the checks to make on coal-preparation equipment during overhauls.
5. Explain how solid fuel wastes are disposed of in coal-burning furnace systems.
6. Explain the operation of other solid-fuel furnaces used with boilers.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to:

1. Identify solid fuel preparation equipment from drawings or pictures of actual equipment.
2. Inspect, lubricate, and adjust or repair belt conveyors and feed conveyors used in the delivery of solid fuels to a furnace.
3. Inspect, lubricate, and adjust or repair breakers and crushers or shredders used in the preparation of solid fuels for a furnace.
4. Inspect, lubricate, and adjust or repair coal pulverizers.

Materials and Equipment

- Markers/chalk
- Pencils and scratch paper
- Whiteboard/chalkboard
- Power Generation Maintenance Mechanic Level 4 PowerPoint® Presentation Slides
- Multimedia projector and screen
- Computer
- Appropriate personal protective equipment
- Access to coal-furnace equipment:
  - Delivery conveyors (belt, flight, and bucket)
  - Feed conveyors
  - Breakers
  - Crushers
  - Ball pulverizers
  - Wheel pulverizers
- FD fans
- PA fans
- ID fans
- Access to one or more water-tube boilers
- Tools of the trade
- Tools for measuring clearances
- Grease guns with applicable lubricants
- Flashlights
- Copies of company’s lockout and tagout procedures
- Locks and tags needed for proper lockout
- Any required barrier materials
- Copies of company’s fall protection procedures
- Vendor manuals and drawings for selected machines used with coal-burning furnaces

continued
Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment. Review safety guidelines associated with working on or near conveyors, large fans, crushers, breakers, and pulverizers used to transport, prepare, and deliver solid coal and biomass fuels into furnaces. Emphasize the importance of proper housekeeping.

Additional Resources

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.


Almost any subject associated with energy can be found on the US Department of Energy’s website: www.energy.gov.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 25 hours are suggested to cover Fuel Preparation and Delivery Equipment. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td>Session I. Introduction; Coal-Fired Boiler Basics; Coal Delivery</td>
<td></td>
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</tbody>
</table>
Session II. Laboratory
A. Laboratory
From actual machine manuals and equipment drawings, have the trainees identify specific equipment items used between the solid fuel storage area and the feed hoppers. This laboratory corresponds to Performance Task 1.

Session III. Coal Preparation, Part One
A. Coal Preparation
1. Breakers
2. Crushers
3. Feed Conveyors

Sessions IV and V. Laboratories
A. Laboratory
From actual machine manuals and equipment drawings of breakers, crushers or shredders, and feed conveyors, have the trainees identify specific equipment items used in the preparation of solid fuels for a furnace. This laboratory corresponds to Performance Task 1.

B. Laboratory
Have trainees inspect, lubricate, and adjust or repair belt conveyors and feed conveyors used in the delivery of solid fuels to a furnace. This laboratory corresponds to Performance Task 2.

C. Laboratory
Have trainees inspect, lubricate, and adjust or repair breakers and crushers or shredders used in the preparation of solid fuels for a furnace. This laboratory corresponds to Performance Task 3.

Session VI. Coal Preparation, Part Two
A. Coal Preparation
1. Air Systems
2. Ball and Wheel Pulverizers
3. Other Types of Pulverizers

Sessions VII and VIII. Laboratories
A. Laboratory
From actual machine manuals and equipment drawings of air systems and pulverizers used in the preparation of solid fuels for a furnace, have the trainees identify specific equipment items. This laboratory corresponds to Performance Task 1.

B. Laboratory
Have trainees inspect, lubricate, and adjust or repair coal pulverizers. This laboratory corresponds to Performance Task 4.

Session IX. Waste Disposal Systems; Other Solid Fuel Systems
A. Waste Disposal System
1. Fly Ash
2. Bottom Ash

B. Other Solid Fuel Systems
1. Wood Fuels
2. Biomass Fuels
Session X. Review and Testing

A. Review

B. Module Examination
   1. Trainees must score 70 percent or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.
MODULE OVERVIEW
This module describes the various aspects of identifying problem tubes, tube rolling, tube plugging, and tube extraction.

PREREQUISITES
Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Industrial Maintenance Mechanic Level One; and Industrial Maintenance Mechanic Level Two, Modules 32201-07 through 32211-07.

OBJECTIVES
Upon completion of this module, the trainee will be able to do the following:

1. Identify rolling equipment.
2. Identify problem tubes.
3. Explain methods of rolling tubes, plugging tubes, and extracting tubes.

PERFORMANCE TASKS
Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify rolling equipment.
2. Select the tools necessary for rolling tubes.
3. Identify types of plugs.

MATERIALS AND EQUIPMENT LIST

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Overhead projector and screen</td>
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<tr>
<td>Transparencies</td>
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<tr>
<td>Blank acetate sheets</td>
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<td>Transparency pens</td>
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<td>Whiteboard/chalkboard</td>
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<td>Markers/chalk</td>
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<td>Pencils and scratch paper</td>
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<tr>
<td>Appropriate personal protective equipment</td>
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<tr>
<td>NDE testing equipment as available</td>
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<tr>
<td>Rolling equipment or manufacturers’ literature</td>
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<tr>
<td>Various types of plugs</td>
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<tr>
<td>Copies of Quick Quiz*</td>
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<tr>
<td>Module Examination**</td>
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<td>Performance Profile Sheets**</td>
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* Located in the back of this module
**Located in the Test Booklet.

SAFETY CONSIDERATIONS
Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.
ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

- www.tcwilson.com/literature.php
- www.goodway.com/company_info/news_events/boiler_tube_cleaning.aspx
- www.watercressline.co.uk/tw/pages/92212bo2.htm

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Introduction to Tube Work*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

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<thead>
<tr>
<th>Topic</th>
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<tr>
<td>A. Introduction</td>
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<td>B. Identifying Tube Problems</td>
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<td>C. Condition Assessment Examination Methods</td>
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<tr>
<td>D. Condition Assessment of Boiler Components and Auxiliaries</td>
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<td>E. Damage Mechanisms</td>
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<td>F. Overall Evaluation Program</td>
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<td>G. Detailed Inspection Program</td>
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<td><strong>Session II. Tube Replacement</strong></td>
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<td>A. Tubing Extraction</td>
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<td>B. Tube Sheet and Tubing End Hole Preparation</td>
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<tr>
<td>C. Tube Placement</td>
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<tr>
<td>D. Cleanliness and Use of Lubricants</td>
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<tr>
<td><strong>Sessions III. Tube Expanding</strong></td>
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<tr>
<td>A. Guideline Procedures for Expanding Tube Ends</td>
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<tr>
<td>B. Tube Expanding Equipment</td>
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<tr>
<td>C. Laboratory</td>
<td>____________</td>
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<tr>
<td>Trainees practice identifying rolling equipment. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td>D. Expansion (Rolling) Procedure</td>
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<td>E. Sounding</td>
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</tbody>
</table>
Sessions IV. Plugging of Tubes, Review and Testing

A. Pluggable Tubes

B. Guideline Procedures for Plugging Tubes in Drums and Headers

C. Review

D. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

E. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
MODULE OVERVIEW

This module presents the basics of compressed air (pneumatic) systems, including descriptions of the machinery used in these systems. Procedures for troubleshooting pneumatic systems are also explained.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Industrial Maintenance Mechanic Level One; Industrial Maintenance Mechanic Level Two; Industrial Maintenance Mechanic Level Three; and Industrial Maintenance Mechanic Level Four, Modules 32401-09 and 32402-09.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

2. Identify and explain pneumatic system components and symbols.
3. Explain pneumatic safety.
4. Explain the physical characteristics of gases.
5. Explain compressing gases.
6. Explain the pneumatic transmission of energy.
7. Explain the principles of compressor operation.
8. Identify and explain types of compressors.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify at least four components of basic pneumatic equipment.
2. Identify various types of compressors.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Safety video or DVD
Video/DVD player
Various types of compressors
Photographs or diagrams of different types of compressors
Manufacturers’ maintenance and repair manuals
Compressor system setups
Old or broken compressors
Reciprocating compressors
Dry intake air filters
Mechanical filters
Pictures of coolers
Samples of various lubricants
Grease gun
Appropriate machine oil
Silicone lubricant
Allen wrenches
Flare nut wrenches
Shaft key wrenches
Pipe wrenches
Arbor press or length of pipe to install bearings
Assorted screwdrivers
Ball-peen hammers
Bearing pullers

(continued)
Carpenter’s levels | Gaskets
---|---
Feeler gauges | O-rings
Pressure gauges | Teflon® tape
Needle-nose pliers | Copies of Quick Quizzes*
Sharp knives | Module Examinations**
Torque wrenches | Performance Profile Sheets**
Anti-seize compound

*Located at the back of this module.
**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees will identify compressors and compressor components and may be asked to operate a compressor.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.


Ingersoll-Rand Company for hydraulic and pneumatic products and product information (literature, specifications, drawings)
http://fluids.ingersollrand.com

MFD Pneumatics, for pneumatic products and product information (literature, specifications, drawings)
http://www.mfdpneumatics.com

Parker Hannifin Corporation, for training materials, products, and product information (literature, specifications, drawings)
http://www.parker.com

Quincy Compressor, for training materials, products, and product information (literature, specifications, drawings)
http://www.quincycompressor.com

Womack Machine Supply Company, for training materials
http://www.womackmachine.com
TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 35 hours are suggested to cover Compressors and Pneumatic Systems. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

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<td>A. Introduction</td>
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<td>B. Pneumatic System Safety</td>
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<tr>
<td>Session II. Physical Characteristics of Gases; Effects of Atmospheric Pressure; Compressing Gases; Pneumatic Transmission of Energy</td>
<td></td>
</tr>
<tr>
<td>A. Physical Characteristics of Gases</td>
<td></td>
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<tr>
<td>B. Effects of Atmospheric Pressure</td>
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<tr>
<td>C. Compressing Gases</td>
<td></td>
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<tr>
<td>D. Pneumatic Transmission of Energy</td>
<td></td>
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<tr>
<td>Sessions III and IV. Compressor Operation and Types</td>
<td></td>
</tr>
<tr>
<td>A. Positive-Displacement Compressors</td>
<td></td>
</tr>
<tr>
<td>B. Continuous-Flow Compressors</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
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<tr>
<td>Have trainees identify various types of compressors. This laboratory corresponds to Performance Task 2.</td>
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<tr>
<td>D. Compressor Controls</td>
<td></td>
</tr>
<tr>
<td>Sessions V–VIII. Treatment of Compressed Air</td>
<td></td>
</tr>
<tr>
<td>A. Intake Filters</td>
<td></td>
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<tr>
<td>B. Intercoolers and Aftercoolers</td>
<td></td>
</tr>
<tr>
<td>C. Separators and Chemical Dryers</td>
<td></td>
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<tr>
<td>D. Receivers, In-Line Filters, and Pressure Regulators</td>
<td></td>
</tr>
<tr>
<td>E. Lubricators, F-R-Ls, and Air Treatment Controls</td>
<td></td>
</tr>
<tr>
<td>Sessions IX and X. Pneumatic System Components; Pneumatic Symbols</td>
<td></td>
</tr>
<tr>
<td>A. Valves</td>
<td></td>
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<tr>
<td>B. Actuators</td>
<td></td>
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<tr>
<td>C. Mufflers</td>
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<tr>
<td>D. Laboratory</td>
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<tr>
<td>Have trainees identify at least four components of basic pneumatic equipment. This laboratory corresponds to Performance Task 1.</td>
<td></td>
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<tr>
<td>E. Pneumatic Symbols</td>
<td></td>
</tr>
</tbody>
</table>
Sessions XI–XIII. Troubleshooting Pneumatic Systems
A. Drive Section Problems
B. Compression Section Problems
C. Pre-Storage Problems
D. Storage Section Problems
E. Post-Storage Problems
F. Troubleshooting Air-Driven Devices

Session XIV. Review and Testing
A. Trade Terms Quick Quiz
B. Module Review
C. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
D. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
MODULE OVERVIEW
This module covers how to inspect, troubleshoot, and prepare pumps for shutdown. It also covers removing pumps from the system, disassembly, and reassembly.

PREREQUISITES
Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Industrial Maintenance Mechanic Level One; Industrial Maintenance Mechanic Level Two; Industrial Maintenance Mechanic Level Three; and Industrial Maintenance Mechanic Level Four, Modules 32401-09 through 32406-09.

OBJECTIVES
Upon completion of this module, the trainee will be able to do the following:
1. Inspect a pump.
2. Troubleshoot a pump.
3. Prepare a pump for shutdown and repair.
4. Remove a pump from the system.
5. Disassemble a pump.
6. Reassemble a pump.
7. Install a pump.
8. Prepare a checklist for pump startup.

PERFORMANCE TASKS
Under the supervision of the instructor, the trainee should be able to do the following:
1. Inspect and/or troubleshoot a pump.
2. Disassemble and reassemble a pump.

MATERIALS AND EQUIPMENT LIST

<table>
<thead>
<tr>
<th>Materials and Equipment</th>
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</thead>
<tbody>
<tr>
<td>Overhead projector and screen</td>
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<tr>
<td>Transparencies</td>
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<tr>
<td>Blank acetate sheets</td>
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<tr>
<td>Transparency pens</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
</tr>
<tr>
<td>Markers/chalk</td>
</tr>
<tr>
<td>Pencils and scratch paper</td>
</tr>
<tr>
<td>Appropriate personal protective equipment</td>
</tr>
<tr>
<td>Company safety manual</td>
</tr>
<tr>
<td>Manufacturers’ maintenance and repair manuals</td>
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<tr>
<td>Lock washers</td>
</tr>
<tr>
<td>Gaskets</td>
</tr>
<tr>
<td>O-rings</td>
</tr>
<tr>
<td>Various types of pumps</td>
</tr>
<tr>
<td>Pump setups</td>
</tr>
<tr>
<td>Old or broken pumps</td>
</tr>
<tr>
<td>Assorted screwdrivers</td>
</tr>
<tr>
<td>Ball-peen hammer</td>
</tr>
<tr>
<td>Needle-nose pliers</td>
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<tr>
<td>Snap-ring pliers</td>
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<tr>
<td>Arbor press or length of pipe to install bearings</td>
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<tr>
<td>Bearing pullers</td>
</tr>
<tr>
<td>Combination wrench sets</td>
</tr>
<tr>
<td>Torque wrenches</td>
</tr>
<tr>
<td>Allen wrenches</td>
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<tr>
<td>Shaft key wrenches</td>
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<tr>
<td>Flare nut wrenches</td>
</tr>
<tr>
<td>Socket sets</td>
</tr>
<tr>
<td>Emery cloths and hones</td>
</tr>
<tr>
<td>600-grit sandpaper</td>
</tr>
<tr>
<td>Feeler gauges</td>
</tr>
</tbody>
</table>

(continued)
SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with pumps. Ensure that they are briefed on appropriate shop safety procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

- Flowserve: http://www.flowserve.com/eim/Literature

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover Troubleshooting and Repairing Pumps. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td>Session I. Introduction; Inspecting and Troubleshooting Pumps</td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Inspecting Pumps</td>
<td></td>
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<tr>
<td>C. Performing Preventive Maintenance on Pumps</td>
<td></td>
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<tr>
<td>D. Troubleshooting Pumps</td>
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<tr>
<td>E. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have trainees practice inspecting and troubleshooting a pump. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
<tr>
<td>Sessions II and III. Disassembling and Reassembling Pumps</td>
<td></td>
</tr>
<tr>
<td>A. Preparing a Pump for Shutdown and Repair</td>
<td></td>
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<tr>
<td>B. Removing a Pump from the System</td>
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<tr>
<td>C. Disassembling a Split-Casing Pump</td>
<td></td>
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<tr>
<td>D. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have trainees practice disassembling a pump. This laboratory corresponds to Performance Task 2.</td>
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<tr>
<td>E. Reassembling a Pump</td>
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<tr>
<td>F. Laboratory</td>
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<tr>
<td>Have trainees practice reassembling a pump. This laboratory corresponds to Performance Task 2.</td>
<td></td>
</tr>
</tbody>
</table>

Additional Resources:

- Dial indicators
- Portable crane/rigging device
- Silicone lubricant
- Sling and hardware for rigging
- Grease gun
- Appropriate machine oil
- Copies of the Quick Quizzes*
- Module Examinations**
- Performance Profile Sheets**
Session IV. Installing a Pump; Startup Procedures; Review and Testing

A. Installing a New or Removed Pump

B. Pump Startup Procedures and Operational Tests

C. Review

D. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

E. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
MODULE OVERVIEW

This module covers gearboxes and how to inspect, remove, reassemble, install, and maintain them. It also includes information about gear types, gear operation, and measuring and adjusting backlash and bearing clearance.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Industrial Maintenance Mechanic Level One; Industrial Maintenance Mechanic Level Two; Industrial Maintenance Mechanic Level Three; and Industrial Maintenance Mechanic Level Four, Modules 32401-09 through 32407-09.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Identify and explain gearboxes.
2. Explain how gears operate and identify types of gears.
3. Identify types of gearboxes and use diagnostic charts.
4. Troubleshoot gearboxes.
5. Remove and disassemble gearboxes.
6. Identify gear wear patterns.
7. Measure and adjust backlash and bearing clearance.
8. Install and maintain gearboxes.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify types of gears.
2. Identify types of gearboxes.
3. Inspect and/or troubleshoot a gearbox.
4. Disassemble and reassemble a gearbox.
5. Identify gear wear patterns.
6. Measure backlash and bearing clearance.

MATERIALS AND EQUIPMENT LIST

- Overhead projector and screen
- Transparencies
- Blank acetate sheets
- Transparency pens
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and scratch paper
- Appropriate personal protective equipment
- Manufacturers’ service and repair manuals
- Non-working gearboxes for troubleshooting and disassembly
- Lockout/tagout devices
- Ultrasonic tester

Various types of gears, including:
- Spur
- Helical
- Double helical
- Herringbone
- Worm
- Bevel
- Spiral bevel
- Hypoid bevel
- Zerol bevel

Various types of gearboxes, including:
- Parallel
- In-line
- Right-angle drive
- Shaft mount

(continued)
SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to troubleshoot, disassemble, and reassemble gearboxes. Ensure that they are briefed on appropriate shop safety procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following references are suggested for both instructors and motivated trainees interested in further study. These are optional resources for continued education rather than for task training.

Mobil Brief Product Descriptions, Mobil Oil Corporation, published annually
Plant Services: http://www.plantservices.com/articles/2004/393.htm

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover Troubleshooting and Repairing Gearboxes. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td>Session I. Introduction to Gearboxes</td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Understanding Gearboxes</td>
<td></td>
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<tr>
<td>C. Gear Types</td>
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<tr>
<td>D. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have trainees practice identifying gear types. This laboratory corresponds to Performance Task 1.</td>
<td></td>
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<tr>
<td>E. Types of Gearboxes</td>
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<tr>
<td>F. Laboratory</td>
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<tr>
<td>Have trainees practice identifying types of gearboxes. This laboratory corresponds to Performance Task 2.</td>
<td></td>
</tr>
</tbody>
</table>

Wrenches
Pans for oil
Cleaning solvent
Rags
Solvent MSDS
High-spot blue and applicator
Dead-blow hammer
Dial indicator
Feeler gauge
Gear pullers
Heating torch
Hydraulic press
Lifting devices
Bearing heater
Video or DVD on chemical safety
Video or DVD player
Copies of the Quick Quizzes*
Module Examinations**
Performance Profile Sheets**

* Located at the back of this module.
**Located in the Test Booklet.
Session II. Troubleshooting Gearboxes
   A. Troubleshooting Gearboxes
   B. Laboratory
       Have trainees practice troubleshooting gearboxes. This laboratory corresponds to Performance Task 3.

Sessions III and IV. Disassembling and Reassembling Gearboxes
   A. Repairing Gearboxes
   B. Removing Gearboxes
   C. Disassembling and Reassembling Gearboxes
   D. Laboratory
       Have trainees practice disassembling and reassembling gearboxes. This laboratory corresponds to Performance Task 4.

Session V. Gear Wear Patterns
   A. Identifying Gear Wear Patterns
   B. Laboratory
       Have trainees practice identifying gear wear patterns. This laboratory corresponds to Performance Task 5.

Sessions VI and VII. Repairing Gearboxes
   A. Measuring and Adjusting Backlash
   B. Measuring and Setting Bearing Clearance
   C. Laboratory
       Have trainees practice measuring backlash and bearing clearance. This laboratory corresponds to Performance Task 6.
   D. Installing Gearboxes
   E. Maintaining Gearboxes

Session VIII. Review and Testing
   A. Module Review
   B. Module Examination
       1. Trainees must score 70% or higher to receive recognition from NCCER.
       2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
   C. Performance Testing
       1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
       2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
MODULE OVERVIEW
This module teaches trainees how to lay out and install baseplates. It also explains the process of pre-alignment.

PREREQUISITES
Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Industrial Maintenance Mechanic Level One; Industrial Maintenance Mechanic Level Two; and Industrial Maintenance Mechanic Level Three, Modules 32301-08 through 32304-08.

OBJECTIVES
Upon completion of this module, the trainee will be able to do the following:

1. Establish baseplate and soleplate locations.
2. Install baseplates and soleplates.
3. Identify proper anchor bolts for installation.
4. Field-verify a plate installation.
5. Set driven equipment.
6. Set a driver.

PERFORMANCE TASKS
Under the supervision of the instructor, the trainee should be able to do the following:

1. Establish baseplate and soleplate locations and elevations for a specified plate installation.
2. Set anchor bolts and shim packs.
3. Set up a piano wire jig.
4. Set a baseplate and soleplate.
5. Field-verify a plate installation.
6. Set a piece of driven equipment.
7. Set a driver.

MATERIALS AND EQUIPMENT LIST

<table>
<thead>
<tr>
<th>Item</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead projector and screen</td>
<td>Drill and drill bits</td>
</tr>
<tr>
<td>Transparencies</td>
<td>Precision square</td>
</tr>
<tr>
<td>Blank acetate sheets</td>
<td>Feeler gauge</td>
</tr>
<tr>
<td>Transparency pens</td>
<td>Straightedge</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Grouting</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Plywood or planking (for form)</td>
</tr>
<tr>
<td>Pencils and scratch paper</td>
<td>Rigid and flexible couplings</td>
</tr>
<tr>
<td>Appropriate personal protective equipment</td>
<td>Transfer punch</td>
</tr>
<tr>
<td>Alignment simulator</td>
<td>Tram plate</td>
</tr>
<tr>
<td>Blueprints</td>
<td>A piece of driven equipment</td>
</tr>
<tr>
<td>Optical or laser level</td>
<td>A driver</td>
</tr>
<tr>
<td>GPS unit (optional)</td>
<td>Dial indicator</td>
</tr>
<tr>
<td>Chalk box</td>
<td>Theodolites</td>
</tr>
<tr>
<td>Measuring tape</td>
<td>Electronic transits</td>
</tr>
<tr>
<td>Anchor, jack, and foundation bolts</td>
<td>Screw jack</td>
</tr>
<tr>
<td>Plywood jig</td>
<td>Screw jack and wedge type levelers</td>
</tr>
<tr>
<td>Piano wire jig / piano wire</td>
<td>Module Examinations*</td>
</tr>
<tr>
<td>Shim packs</td>
<td>Performance Profile Sheets*</td>
</tr>
</tbody>
</table>

* Located in the Test Booklet
SAFETY CONSIDERATIONS
Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires that the trainees use hand tools. Ensure that trainees are briefed on shop safety procedures.

ADDITIONAL RESOURCES
This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

www.ludeca.com
www.giantpumps.com

TEACHING TIME FOR THIS MODULE
An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 30 hours are suggested to cover Setting Baseplates and Prealignment. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td>Sessions I and II. Introduction; Establishing Baseplate and Soleplate Locations</td>
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</tr>
<tr>
<td>A. Introduction</td>
<td></td>
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<tr>
<td>B. Establishing Baseplate and Soleplate Locations</td>
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</tr>
<tr>
<td>1. Laying Out Baseplates and Soleplates</td>
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<tr>
<td>2. Establishing Plate Elevation</td>
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<tr>
<td>3. Optical Theodolites</td>
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<td>4. Electronic Transits and Theodolites</td>
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<tr>
<td>5. Using a String Line Level</td>
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<tr>
<td>C. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have the trainees practice establishing baseplate and soleplate locations and elevations for a specified plate installation. This laboratory corresponds to Performance Task 1.</td>
<td></td>
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<tr>
<td>Sessions III through V. Installing Baseplates and Soleplates</td>
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<tr>
<td>A. Installing Baseplates and Soleplates</td>
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<tr>
<td>1. Setting Anchor Bolts</td>
<td></td>
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<tr>
<td>2. Setting Shim Packs</td>
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<tr>
<td>3. Setting Up Piano Wire Jigs</td>
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<tr>
<td>4. Setting the Plate</td>
<td></td>
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<tr>
<td>B. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have the trainees practice setting anchor bolts and shim packs. This laboratory corresponds to Performance Task 2.</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have the trainees practice setting up a piano wire jig. This laboratory corresponds to Performance Task 3.</td>
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<tr>
<td>D. Laboratory</td>
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<tr>
<td>Have the trainees practice setting a baseplate and soleplate. This laboratory corresponds to Performance Task 4.</td>
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</tbody>
</table>
Session VI. Field-Verifying Installation
   A. Field-Verifying Installation
   B. Laboratory
      Have the trainees practice field-verifying a plate installation. This laboratory corresponds to Performance Task 5.

Session VII. Grouting; Inspecting the Equipment
   A. Grouting
   B. Inspecting the Equipment

Session VIII. Installing Couplings
   A. Installing Couplings
      1. Clearance Installation

Sessions IX and X. Setting the Driven Piece of Equipment; Setting the Driver; Alignment
   A. Setting the Driven Piece of Equipment
   B. Setting the Driver
   C. Alignment
   D. Laboratory
      Have the trainees practice setting a piece of driven equipment. This laboratory corresponds to Performance Task 6.
   E. Laboratory
      Have the trainees practice setting a driver. This laboratory corresponds to Performance Task 7.

Session XI. Review
   A. Module Review

Session XII. Testing
   A. Module Examination
      1. Trainees must score 70 percent or higher to receive recognition from NCCER.
      2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
   B. Performance Testing
      1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
      2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
MODULE OVERVIEW
This module describes steam, gas, and hydraulic turbines. Trainees will become familiar with turbine components as they learn the principles by which turbines operate.

PREREQUISITES
Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Millwright Level One; Millwright Level Two; Millwright Level Three; Millwright Level Four; and Millwright Level Five, Modules 15501-09 through 15504-09.

OBJECTIVES
Upon completion of this module, the trainee will be able to do the following:
1. Identify and explain impulse and reaction blades.
2. Identify and explain types of turbines.
3. Identify and explain steam turbine components.
4. Identify and explain gas turbine components.
5. Explain types of water turbines.

PERFORMANCE TASKS
This is a knowledge-based module. There are no Performance Tasks.

MATERIALS AND EQUIPMENT LIST
Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Photos or videos/DVDs showing the components and/or operation of steam, gas, and water turbines
TV/VCR/DVD player

Examples or pictures of impulse and reaction blades
Examples, photos, videos, or DVDs of Pelton wheels, Francis Wheels, and Kaplan wheels
Examples or pictures of turbine components:
Compressor parts
Combustor parts
Turbine section parts
Auxiliary support systems
Bearing

Copies of the Quick Quiz*
Module Examinations**

*Located at the back of this module.
**Located in the Test Booklet.

SAFETY CONSIDERATIONS
Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly.


### ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

- Environmental Protection Agency
- General Electric Company
  - www.gepower.com/home/index.htm
- Siemens Corporation
  - www.powergeneration.siemens.com/home
  - http://mysite.du.edu/~jcalvert/tech/fluids/turbine.htm

### TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *Turbines*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

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<td>F. Condensate System</td>
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Session V. Gas Turbine Compressor Parts
   A. Inlet Guide Vanes
   B. Rotor and Stator Blades
   C. Discharge Section
   D. Bleed-Off Lines

Session VI. Gas Turbine Combustor and Turbine Section Components
   A. Combustor Components
      1. Combustion Chambers
      2. Fuel Nozzles
      3. Igniters and Crossfire Tubes
      4. Flame Detectors
      5. Transition Pieces
   B. Turbine Section Components
      1. Nozzles
      2. Rotor Blades
      3. Exhaust Silencer

Session VII. Gas Turbine Auxiliary Support Systems
   A. Starting Systems
   B. Lube Oil System
   C. Fuel System
   D. Water Cooling System

Session VIII. Review and Testing
   A. Module Review
   B. Module Examination
      1. Trainees must score 70% or higher to receive recognition from NCCER.
      2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
MODULE OVERVIEW
This module covers basic turbine components, typical problems encountered when working with turbines, and guidelines for maintaining and repairing various types of turbines. Techniques for gaining access to components and replacing them are also covered.

PREREQUISITES
Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Millwright Level One; Millwright Level Two; Millwright Level Three; Millwright Level Four; and Millwright Level Five, Modules 15501-09 through 15505-09.

OBJECTIVES
Upon completion of this module, the trainee will be able to do the following:
1. Inspect sealing glands and carbon rings.
2. Replace nozzle rings and reversing blade assemblies.
3. Inspect governor systems.
4. Replace rotor bearings.
5. Adjust overspeed trip mechanisms.
6. Inspect rotor assemblies.

PERFORMANCE TASKS
Under the supervision of the instructor, the trainee should be able to do the following:
1. Identify six of the following pieces of turbine equipment:
   • Sealing glands
   • Carbon rings
   • Rotor bearings
   • Nozzle rings
   • Governor
   • Trip linkage
   • Rotor
   • Oil pump

MATERIALS AND EQUIPMENT LIST

| Overhead projector and screen | Paste sealing compound |
| Transparencies                | Antigalling compound   |
| Blank acetate sheets          | Silicone grease        |
| Transparency pens            | Bearing puller         |
| Whiteboard/chalkboard        | Dial indicator         |
| Markers/chalk                | Sleeve-type bearing driver |
| Pencils and scratch paper    | Torch                  |
| Appropriate personal protective equipment | Hot oil or bearing heater |
| Toolbox with common mechanic tools | Shims                 |
| Plastic sealing compound     | Compressed air         |

continued
SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

- Environmental Protection Agency
- General Electric Company
  www.gepower.com/home/index.htm
- Siemens Corporation
  www.powergeneration.siemens.com
- http://mysite.du.edu/~jcalvert/tech/fluids/turbine.htm

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Maintaining and Repairing Steam Turbine Components*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
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<tr>
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<td>Session I. Introduction; Maintaining and Repairing Turbine Casings, Sealing Glands, and Carbon Rings</td>
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<tr>
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<tr>
<td>B. Maintaining and Repairing Turbine Casings</td>
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<tr>
<td>C. Maintaining and Repairing Sealing Glands and Carbon Rings</td>
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<tr>
<td>1. Disassembling Sealing Glands</td>
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<td>2. Replacing Carbon Rings</td>
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<td>3. Assembling Sealing Glands</td>
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</table>
Session II. Maintaining Governor Systems; Replacing Nozzle Rings, Reversing Blade Assemblies, and Rotor Locating Bearings

A. Maintaining Governor Systems
   1. Removing and Replacing Governor Components

B. Replacing Nozzle Rings and Reversing Blade Assemblies

C. Replacing Rotor Locating Bearings

Session III. Replacing Bearing Pedestals and Housings; Maintaining Overspeed Trip Mechanisms, Part One

A. Replacing Bearing Pedestals and Housings
   1. Replacing Exhaust-End Bearing Pedestals
   2. Replacing Steam-End Bearing Housings
   3. Aligning Exhaust-End Bearing Pedestals and Steam-End Housings

B. Maintaining Overspeed Trip Mechanisms
   1. Disassembling/Assembling Overspeed Trip Mechanisms
   2. Replacing Plunger Assemblies and Trip Bodies

Session IV. Maintaining Overspeed Trip Mechanisms, Part Two

A. Maintaining Overspeed Trip Mechanisms
   1. Adjusting Trip Pin and Plunger Clearance
   2. Adjusting Turbine Trip Speeds
   3. Disassembling/Assembling Trip Valves
   4. Backseating Trip Valves
   5. Maintaining Governor Valves

Session V. Maintaining Rotor Assemblies and Large Steam Turbines

A. Maintaining Rotor Assemblies

B. Maintaining Large Steam Turbines

C. Laboratory
   Have trainees practice identifying turbine components. This laboratory corresponds to Performance Task 1.

Session VI. Review and Testing

A. Module Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.