Basic Layout
Annotated Instructor's Guide

Module 32201-07

MODULE OVERVIEW

This module introduces the tools and procedures used by industrial maintenance mechanics in layout work.

PREREQUISITES

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

OBJECTIVES

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

1. Identify layout tools and explain their uses.
2. Lay out base lines using the arc method.
3. Lay out base lines using the 3-4-5 method.
4. Scribe straight lines.
5. Scribe perpendicular lines to base lines using a square.
6. Scribe perpendicular lines to an edge using a combination square.
7. Lay out angled lines using a combination square and a protractor.
8. Lay out circles using dividers and trammel points.
9. Lay out perpendicular lines from base lines using dividers and reference points.
10. Bisect lines using dividers.
11. Divide a line into equal parts.
12. Divide a circle into equal parts.
13. Lay out equipment locations.

PERFORMANCE TASKS

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

1. Lay out perpendicular lines from a reference line using:
   - Arc method
   - 3-4-5 method
2. Scribe the following:
   - Straight lines
   - Perpendicular lines to a base line using a square
   - Perpendicular lines to an edge using a combination square
   - Angled lines using a combination square
   - Angled lines using a protractor
   - Circles using dividers
   - Perpendicular lines from base lines using dividers
   - Perpendicular lines from base lines using reference points
3. Bisect lines using dividers.
4. Divide lines into equal parts.
5. Divide circles into equal parts.
6. Lay out equipment locations.

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
Scribers
Steel rules
Steel squares
Combination set
Protractors
Dividers
Trammel points
Prick punch set
Center punch set
Transfer punch set
Straightedge
Blueprints
Chalk box
Wood
Hammer
Nails
Drill and bits
Flange with bolt holes
Bolts
Optical level
Measuring tape
Copies of Quick Quizzes *
Module Examination**
Performance Profile Sheets**

* 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. Emphasize basic hand tool safety. This module may require trainees to visit job sites. Make sure that all trainees are briefed on site safety procedures.

ADDITIONAL RESOURCES

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

Audel Millwrights and Mechanics Guide. Latest Edition. Thomas B. Davis, Carl A. Nelson. Hoboken, NJ: John Wiley & Sons.

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 *Basic Layout*. 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.

Topic	**Planned Time**
Sessions I and II. Introduction to the Drawing Set	
A. Introduction	_____
B. Layout Tools	_____
C. Laying Out Base Lines: Arc Method	_____

D. Laboratory _____
Trainees practice laying out perpendicular lines using the arc method. This laboratory corresponds to Performance Task 1.

E. Laying Out Base Lines: 3-4-5 Method _____

F. Laboratory _____
Trainees practice laying out perpendicular lines using the 3-4-5 method. This laboratory corresponds to Performance Task 1.

Session III. Scribing Lines

A. Scribing Straight Lines _____

B. Scribing Perpendicular Lines _____

C. Scribing Angled Lines _____

D. Scribing Circles and Arcs _____

E. Laying Out Perpendicular Lines _____

F. Laboratory _____
Trainees practice scribing various lines. This laboratory corresponds to Performance Task 2.

Sessions IV and V. Basic Layout

A. Bisecting Angles Using Dividers _____

B. Laboratory _____
Trainees practice bisecting lines using dividers. This laboratory corresponds to Performance Task 3.

C. Dividing Lines into Equal Parts _____

D. Laboratory _____
Trainees practice dividing lines into equal parts. This laboratory corresponds to Performance Task 4.

E. Dividing Circles into Equal Parts _____

F. Laboratory _____
Trainees practice dividing circles into equal parts. This laboratory corresponds to Performance Task 5.

Sessions VI and VII. Equipment Layout

A. Laying Out Equipment Locations _____

B. Laboratory _____
Trainees practice laying out equipment locations. This laboratory corresponds to Performance Task 6.

Session VIII. Review and Testing

A. 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.

Advanced Trade Math
Annotated Instructor's Guide

Module 32301-08

MODULE OVERVIEW

This module provides trainees with advanced practice in geometry, ratios, trigonometry, and algebra.

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*.

OBJECTIVES

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

1. Use tables of equivalents.
2. Perform right angle trigonometry.
3. Calculate takeouts, using trigonometry.
4. Calculate weights of objects.

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
Basic trainee tools
Ruler
Framing square
Scientific calculator
Quick Quiz*
Module Examinations**

* Located at the back of this module

**Located in the Test Booklet

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.

Pipe Fitter's Math Guide, 1989. Johnny Hamilton. Clinton, NC: Construction Trade Press.

Applied Construction Math, Latest Edition. Upper Saddle River, NJ: Prentice Hall Publishing.

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 *Advanced Trade Math*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Sessions I and II. Introduction; Tables of Equivalents; Unit Conversion Tables; Trigonometry I

A. Introduction _____
B. Tables of Equivalents _____
C. Unit Conversion Tables _____
D. Trigonometry _____
   1. Pythagorean Theorem _____

Sessions III through V. Trigonometry II

A. Trigonometry _____
   1. Trigonometric Functions _____
   2. Triangle Calculation _____

Sessions VI through VIII. Trigonometry III

A. Determining the Angles When Side Lengths are Known _____
B. Interpolation _____

Sessions IX and X. Calculating Takeouts Using Trigonometry; Calculating the Weight of an Object

A. Calculating Takeouts Using Trigonometry _____
   1. Takeouts _____
   2. Odd Angles _____
B. Calculating the Weight of an Object _____

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.

Precision Measuring Tools
Annotated Instructor's Guide

Module 32302-08

MODULE OVERVIEW

This module explains how to select, inspect, use, and care for measuring tools common to the industrial maintenance trade.

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*, Module 32301-08.

OBJECTIVES

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

1. Use a level.
2. Use a feeler gauge.
3. Use calipers.
4. Use a micrometer.
5. Use a dial indicator.
6. Use a protractor.
7. Use gauge blocks.
8. Use speed measurement tools.
9. Use a pyrometer.
10. Describe the functions of thermal imaging, vibration analysis, and acoustic vibrations.

PERFORMANCE TASKS

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

1. Use a level.
2. Use a feeler gauge.
3. Use calipers.
4. Use a micrometer.
5. Use a dial indicator.
6. Use a protractor.
7. Use gauge blocks.
8. Use speed measurement tools.
9. Use a pyrometer.

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
Basic trainee tools
Master, mechanic's, optical, and electronic levels
Feeler gauges
Inside, outside, vernier, and dial calipers
Outside, inside, and depth micrometers
Various micrometer tips
Height gauges and surface plates
Various sized dial indicators
Universal bevel protractor
Gauge blocks
Stroboscopes, stroboscopic and mechanical tachometers
Optical, thermocouple, and infrared pyrometers
Sample parts to be measured
Module Examinations*
Performance Profile Sheets*

* 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.starrett.com
www.mitutoyo.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 25 hours are suggested to cover *Precision Measuring Tools*. 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.

Topic **Planned Time**

Sessions I through III. Introduction; Levels; Feeler Gauges; Calipers

A. Introduction _____
B. Levels _____
   1. Master Levels _____
   2. Mechanic's Levels _____
   3. Optical Levels _____
   4. Electronic Levels _____
C. Laboratory _____

   Have the trainees practice using levels. This laboratory corresponds to Performance Task 1.

D. Feeler Gauges _____
E. Laboratory _____

   Have the trainees practice using feeler gauges. This laboratory corresponds to Performance Task 2.

F. Calipers _____
   1. Inside and Outside Calipers _____
   2. Vernier Calipers _____
   3. Dial Calipers _____
G. Laboratory _____

   Have the trainees practice using calipers. This laboratory corresponds to Performance Task 3.

Session IV. Micrometers

A. Micrometers _____
   1. Outside Micrometers _____
   2. Inside Micrometers _____
   3. Depth Micrometers _____
   4. Height Gauges and Surface Plates _____
B. Laboratory _____

   Have the trainees practice using micrometers. This laboratory corresponds to Performance Task 4.

Session V. Dial Indicators; Universal Bevel Protractors

A. Dial Indicators _____

B. Laboratory _____

Have the trainees practice using dial indicators. This laboratory corresponds to Performance Task 5.

C. Universal Bevel Protractors _____

D. Laboratory _____

Have the trainees practice using protractors. This laboratory corresponds to Performance Task 6.

Session VI. Gauge Blocks

A. Gauge Blocks _____

B. Laboratory _____

Have the trainees practice using gauge blocks. This laboratory corresponds to Performance Task 7.

Sessions VII through IX. Speed Measurement Tools; Pyrometers; Thermal and Vibration Analysis

A. Speed Measurement Tools _____

1. Stroboscopes _____
2. Stroboscopic Tachometers _____
3. Mechanical Tachometers _____

B. Laboratory _____

Have the trainees practice using speed measurement tools. This laboratory corresponds to Performance Task 8.

C. Pyrometers _____

D. Laboratory _____

Have the trainees practice using pyrometers. This laboratory corresponds to Performance Task 9.

E. Thermal and Vibration Analysis _____

Session X. Review and Testing

A. Module Review _____

B. 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.

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.

Introduction to Bearings
Annotated Instructor's Guide

Module 32207-07

MODULE OVERVIEW

This module introduces different types of bearings, including plain, ball, roller, thrust, and guide bearings. It describes bearing mountings, including flanged, pillow block, and takeup bearings. It also covers bearing materials and bearing designation systems.

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 32206-07.

OBJECTIVES

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

1. Identify various types of bearings.
2. Identify and explain bearing materials.
3. Identify parts of bearings.

PERFORMANCE TASKS

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

1. Identify various types of bearings.
2. Identify parts of bearings.

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
Plain bearings
Ball bearings
Roller bearings
Thrust bearings
Guide bearings
Flanged bearings
Pillow block bearings
Takeup bearings
Bearing materials
Copies of Quick Quizzes*
Module Examination**
Performance Profile Sheets**

* 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 work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

NTN is a bearing manufacturer whose website provides information on many types of bearings. It also has technical articles on the care and maintenance of bearings. www.NTNBower.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 15 hours are suggested to cover *Introduction to Bearings*. 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.

Topic	**Planned Time**
Session I. Introduction and Bearings I	
A. Introduction	_____
B. Plain Bearings	_____
C. Ball Bearings	_____
Session II. Bearings II	
A. Roller Bearings	_____
B. Thrust Bearings	_____
Sessions III and IV. Bearings III	
A. Guide Bearings	_____
B. Flanged Bearings	_____
C. Pillow Block Bearings	_____
D. Takeup Bearings	_____
E. Laboratory Trainees practice identifying bearings. This laboratory corresponds to Performance Task 1.	_____
Session V. Bearing Materials	
A. Bearing Materials	_____
B. Laboratory Trainees practice identifying parts of bearings. This laboratory corresponds to Performance Task 2.	_____
Session VI. Review and Testing	
A. 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.	

Installing Bearings
Annotated Instructor's Guide

Module 32303-08

MODULE OVERVIEW

This module explains how to remove, install, and maintain different types of bearings.

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 and 32302-08.

OBJECTIVES

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

1. Remove bearings.
2. Troubleshoot bearing failures.
3. Install bearings.

PERFORMANCE TASKS

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

1. Remove a bearing.
2. Install a bearing.

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
Manual puller
Hydraulic press (optional)
Manual (arbor) press (optional)
Induction-type bearing heater
Aluminum heating ring
Pillow block bearing
Split-housing pillow block bearing
Angular-contact ball bearing
Sample bearings with the following characteristics:
- Flaking
- Spalling
- Brinelling
- Misalignment damage
- Thrust failure
- Broken cam
- Electric arcing damage
- Fluting
- Lubrication failure
- Contamination failure

Module Examinations*
Performance Profile Sheets*

* 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. This module requires trainees to use heat removal methods. Make sure trainees are briefed on appropriate safety procedures for using heat and cutting torches to remove bearings.

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.

Installing and Replacing Bearings, Chicago, IL: TPC Training Systems.

Care and Maintenance of Bearings, Cat. No 3017/E, NTN® Corporation. www.ntn.ca/index.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 *Installing Bearings*. 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.

Topic	**Planned Time**
Session I. Introduction; Removing Bearings	
A. Introduction	_____
B. Removing Bearings	_____
1. Using Bearing Pullers	_____
2. Presses	_____
3. Hydraulic Bearing Removal	_____
4. Bearing Removal Using Heat	_____
5. Using a Cutting Torch	_____
C. Laboratory Have the trainees practice removing a bearing. This laboratory corresponds to Performance Task 1.	_____
Sessions II and III. Troubleshooting Antifriction Bearings	
A. Troubleshooting Antifriction Bearings	_____
1. Fatigue Failure	_____
2. Brinelling	_____
3. False Brinelling	_____
4. Misalignment	_____
5. Thrust Failure	_____
6. Broken Cam	_____
7. Electric Arcing	_____
8. Lubrication Failure	_____
9. Failure Due to Contamination	_____
Sessions IV through VI. Installing Bearings	
A. Installing Bearings	_____
1. Installing Tapered Roller Bearings, Using the Temperature Mounting Method	_____
2. Installing Thrust Bearings Using Press Mounting	_____
3. Installing Spherical Roller Bearings Using a Hydraulic Nut or Locknut	_____
4. Installing Pillow Block Bearings	_____
5. Installing Angular-Contact Ball Bearings	_____
B. Laboratory Have the trainees practice installing a bearing. This laboratory corresponds to Performance Task 2.	_____

Session VII. Review

A. Module Review _____

Session VIII. 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.

Installing Couplings
Annotated Instructor's Guide

Module 32304-08

MODULE OVERVIEW

This module explains how couplings are installed and aligned, and introduces some of the mounting systems used for various couplings.

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 32303-08.

OBJECTIVES

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

1. Identify and explain coupling types.
2. Install couplings.
3. Remove couplings.

PERFORMANCE TASKS

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

1. Identify, assemble, and install couplings as assigned by the instructor.
2. Remove a coupling using mechanical pullers.
3. Remove a coupling using the hydraulic or thermal method.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Basic trainee tools

Oil

Rags

Hone or emery cloth

Dial indicator

Micrometer

Feeler gauge

Appropriate personal protective equipment
- Protective gloves
- Eye protection

Samples of various types of couplings, including:
- Rigid couplings
  - Flanged, sleeve, clamp
- Mechanical flexible couplings
  - Slider, gear, chain, grid
- Material flexible couplings
  - Spider, spring, tire, flexible disc, pin and bushing, pin and disc, spacer, universal joint
- Soft-start couplings
  - Fluid, shot, clutch-style

Mechanical pullers

Hydraulic pump

Heating blanket or heating coil

Quick Quiz*

Module Examinations**

Performance Profile Sheets**

* 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. 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.lovejoy-inc.com
www.davidbrown.com
pt.rexnord.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 15 hours are suggested to cover *Installing Couplings*. 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.

Topic	**Planned Time**
Session I. Introduction; Rigid Couplings	
A. Introduction	_____
B. Rigid Couplings	_____
1. Flanged Couplings	_____
2. Sleeve Couplings	_____
3. Clamp Couplings	_____
Session II. Flexible Couplings	
A. Flexible Couplings	_____
1. Mechanical Flexible Couplings	_____
2. Material Flexible Couplings	_____
Session III. Soft-Start Couplings	
A. Soft-Start Couplings	_____
1. Fluid Couplings	_____
2. Shot Couplings	_____
3. Clutch-Style Couplings	_____
Session IV. Installing Couplings	
A. Installing Couplings	_____
1. General Coupling Installation	_____
2. Split Coupling Installation	_____
3. Interference-Fit Installation	_____
4. Setting the Coupling Gap	_____
5. Grid Coupling Installation	_____
B. Laboratory	_____
Have the trainees practice identifying, assembling, and installing couplings as assigned. This laboratory corresponds to Performance Task 1.	

Session V. Removing Couplings

A. Removing Couplings _____

1. General Coupling Removal _____
2. Mechanical Pullers _____
3. Hydraulic Removal _____

B. Laboratory _____

Have the trainees practice removing a coupling using mechanical pullers. This laboratory corresponds to Performance Task 2.

C. Laboratory _____

Have the trainees practice removing a coupling using the hydraulic or thermal method. This laboratory corresponds to Performance Task 3.

Session VI. Review and Testing

A. Module Review _____

B. 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.

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.

Installing Mechanical Seals
Annotated Instructor's Guide

Module 32308-08

MODULE OVERVIEW

This module introduces the many types of mechanical seals available, including their characteristics and applications. Note that this module is an elective; it is not required for successful level completion.

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 32307-08.

OBJECTIVES

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

1. Identify types of mechanical seals and explain their applications.
2. Safety and accurately remove and inspect mechanical seals.
3. Safety and accurately install mechanical seals.

PERFORMANCE TASKS

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

1. Identify given mechanical seals and explain their applications.
2. Safety and accurately remove and inspect a mechanical seal.
3. Safely and accurately install a mechanical seal.

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
Basic trainee tools
Hone or emery cloth
Oil
Rags
Micrometer
Dial indicator
Soft-blow mallet

Samples of various mechanical seals, including:
- Single inside / outside
- Double mechanical
- Tandem
- Cartridge
- Balanced /unbalanced
- Single-spring / multiple-spring
- Welded metal bellows
- Elastomer bellows
- Rotating / stationary

Centrifugal pump with mechanical seal
Samples of manufacturer's instructions for seals
Quick Quiz*
Module Examinations**
Performance Profile Sheets**

* 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. 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.flowserve.com
www.chesterton.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 20 hours are suggested to cover *Installing Mechanical Seals*. 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.

Topic **Planned Time**

Session I. Introduction and Basic Design

A. Introduction _____
B. Basic Design _____

Sessions II and III. Mechanical Seal Classifications

A. Mechanical Seal Classifications _____
   1. Classifying Mechanical Seals by Arrangement _____
   2. Classifying Mechanical Seals by Design _____
B. Laboratory _____

   Have the trainees practice identifying mechanical seals and explaining their applications. This laboratory corresponds to Performance Task 1.

Sessions IV through VI. Replacing Mechanical Seals

A. Replacing Mechanical Seals _____
   1. Removing Mechanical Seals _____
   2. Inspecting Mechanical Seals _____
   3. Installing Mechanical Seals _____
B. Laboratory _____

   Have the trainees practice safely and accurately removing and inspecting a mechanical seal. This laboratory corresponds to Performance Task 2.

C. Laboratory _____

   Have the trainees practice safely and accurately installing a mechanical seal. This laboratory corresponds to Performance Task 3.

Session VII. Review

A. Module Review _____

Session VIII. 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.

Conventional Alignment
Annotated Instructor's Guide

Module 32306-08

MODULE OVERVIEW

This module explains how to align machinery and couplings. Trainees will learn how to use dial indicators to achieve accurate alignment. Also covered is information on coupling stress, its causes, and how to correct it.

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 32305-08.

OBJECTIVES

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

1. Explain types of misalignment.
2. Align couplings using feeler gauge, straightedge, and dial indicator methods.
3. Identify and eliminate coupling stress.

PERFORMANCE TASKS

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

1. Use the straightedge and feeler gauge methods, and then a dial indicator to:
   - Level and align the driven on a base.
   - Adjust vertical angularity of the driver.
   - Adjust vertical offset of the driver.
   - Adjust horizontal angularity of the driver.
   - Adjust horizontal offset of the driver.
   - Adjust vertical offset and angularity.
   - Adjust horizontal offset and angularity.
2. Check for and eliminate coupling stress.
3. Check for and calculate indicator sag.

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
Basic trainee tools
Alignment simulator
Straightedge
Square
Chalk or grease pencils
Feeler gauges
Machinist's rule
Dial indicators
Shims
Module Examinations*
Performance Profile Sheets*

* 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.peopleflo.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 *Conventional Alignment*. 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.

Topic	**Planned Time**
Sessions I through IV. Introduction; Types of Misalignment; Coupling Stress	
A. Introduction	_____
B. Types of Misalignment	_____
1. Vertical Offset	_____
2. Vertical Angularity	_____
3. Horizontal Offset	_____
4. Horizontal Angularity	_____
5. Alignment Terminology	_____
C. Coupling Stress	_____
1. Causes of Coupling Stress	_____
2. Checking for Coupling Stress	_____
3. Eliminating Coupling Stress	_____
D. Laboratory	_____
Have the trainees practice checking for and eliminating coupling stress. This laboratory corresponds to Performance Task 2.	
Sessions V through X. Aligning Couplings, Using the Straightedge and Feeler Gauge Method; Aligning Couplings, Using the Dial Indicator Method	
A. Aligning Couplings, Using the Straightedge and Feeler Gauge Method	_____
1. Adjusting Vertical Angularity	_____
2. Adjusting Vertical Offset	_____
3. Adjusting Horizontal Angularity	_____
4. Adjusting Horizontal Offset	_____
5. Adjusting Vertical Angularity and Offset	_____
6. Adjusting Horizontal Angularity and Offset	_____
B. Aligning Couplings, Using the Dial Indicator Method	_____
1. Setting Up Dial Indicators	_____
2. Taking Top View Measurements	_____
3. Taking Side View Measurements	_____
4. Taking Angularity and Offset Measurements	_____

C. Laboratory _____

Have the trainees practice using the straightedge and feeler gauge methods, and then a dial indicator to: level and align the driven on a base; adjust vertical angularity of the driver; adjust vertical offset of the driver; adjust horizontal angularity of the driver; adjust horizontal offset of the driver; adjust vertical offset and angularity; and adjust horizontal offset and angularity. This laboratory corresponds to Performance Task 1.

D. Laboratory _____

Have the trainees practice checking for and calculating indicator sag. This laboratory corresponds to Performance Task 3.

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.

Reverse Alignment
Annotated Instructor's Guide

Module 32404-09

MODULE OVERVIEW

This module covers setting up reverse dial indicator jigs and performing reverse dial alignment using both the chart and mathematical methods. Basic information about shaft alignment and coupling stress is also presented.

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 32403-09.

OBJECTIVES

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

1. Explain how machinery can be misaligned.
2. Explain the conditions that can cause misalignment.
3. Measure shaft runout, using a dial indicator.
4. Set up complex reverse dial indicator jigs.
5. Measure indicator sag using complex reverse dial indicator jigs.
6. Perform reverse dial indicator alignment, using a graphical alignment chart and using a mathematical equation.

PERFORMANCE TASKS

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

1. Measure shaft runout, using a dial indicator jig.
2. Set up a complex reverse alignment jig.
3. Measure indicator sag, using a complex reverse dial indicator jig.
4. Perform reverse alignment, using the alignment demonstration rig and the graphical chart.
5. Perform reverse alignment, using the alignment demonstration rig and the mathematical equation.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Dial indicator on a base
Complex reverse dial indicator jig
Dial indicators
Alignment simulators or equipment to be aligned
Graph paper
Calculators
Reverse dial indicator plotting guide
Graphical alignment chart
Copies of Quick Quizzes*
Module Examinations**
Performance Profile Sheets**

* Located at the back of this module.

**Located in the Test Booklet.

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.

A Millwright's Guide to Motor/Pump Alignment, 2nd ed. Tommy B. Harlon. New York, NY: Industrial Press, 2008.

The Optalign Training Book. Galen Evans and Pedro Casanova. Miami, FL: Ludeca, Inc.

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 *Reverse Alignment*. 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.

Topic	**Planned Time**
Session I. Introduction; Descriptive Terms and Conditions	
A. Introduction	_____
B. Descriptive Terms and Conditions	_____
C. Conditions	_____
1. Checking for Soft Foot, Rough Alignment, and Shaft Runout	_____
D. Laboratory	_____
Have trainees practice checking for shaft runout.	
Session II. Coupling Stress	
A. Coupling Stress	_____
B. Causes of Coupling Stress	_____
1. Incorrect Pipe Weldments	_____
2. Improper Placement of Pipe Hangers	_____
3. Defective Anchor Bolts	_____
4. Bad Bearings	_____
5. Improper Foundations	_____
Session III. Reverse Dial Indicator Jigs	
A. Introduction	_____
B. Alignment Demonstration Rig	_____
C. Dial Indicators	_____
D. Measuring Shaft Runout	_____
E. Laboratory	_____
Have trainees measure shaft runout using a dial indicator jig. This laboratory corresponds to Performance Task 1.	
Session IV. Reverse Dial Indicator Alignment, Part One	
A. Setting Up Complex Reverse Dial Indicator Jigs	_____
1. Same-Side Mounting	_____
2. Opposite-Side Mounting	_____
3. Checking Indicator Sag	_____
B. Laboratory	_____
Have trainees set up a complex reverse dial indicator jig and check for indicator sag. This laboratory corresponds to Performance Tasks 2 and 3.	

Sessions V–VII. Reverse Dial Indicator Alignment, Part Two

A. Performing Reverse Dial Indicator Alignment _____
   1. Charting Alignment _____
   2. Performing Alignment _____

B. Alignment Equation _____

C. Recording Alignment _____

Sessions VIII–XI. Reverse Dial Indicator Alignment, Part Three

A. Laboratory _____

   Have trainees perform reverse alignment using the alignment demonstration rig, graphical chart, and mathematical equation. This laboratory corresponds to Performance Tasks 4 and 5.

Session XII. 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.

Laser Alignment
Annotated Instructor's Guide

Module 32405-09

MODULE OVERVIEW

This module covers the basic principles of lasers, laser alignment, laser/detector operation, and troubleshooting lasers. This module also covers conditions that affect alignment, such as soft foot and coupling stress.

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 32404-09.

OBJECTIVES

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

1. Explain lasers and laser alignment systems.
2. Operate a laser alignment system.
3. Align machinery trains.
4. Perform vertical alignment.
5. Explain soft foot, thermal growth, and coupling stress.
6. Troubleshoot repeatability and laser problems.

PERFORMANCE TASKS

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

1. Identify the major components of the Optalign® laser alignment system.
2. Perform a rough alignment.
3. Set up the laser alignment equipment.
4. Check the initial alignment.
5. Draw a scale graphical plot of a machinery train.
6. Align the machinery train.
7. Vertically align a machine.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Graph paper
Appropriate personal protective equipment
Alignment simulators or equipment to be aligned
Wrenches
Laser alignment equipment
Copies of the Quick Quizzes*
Module Examinations**
Performance Profile Sheets**

* 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. This module requires trainees to align machinery using laser alignment equipment. Ensure that all trainees are briefed on the appropriate shop safety procedures.

ADDITIONAL RESOURCES

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

The Optalign Training Book. Galen Evans and Pedro Casanova. Miami, FL: Ludeca, Inc.

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 *Laser Alignment*. 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.

Topic **Planned Time**

Session I. Introduction; Soft Foot; Thermal Growth; Coupling Stress

A. Introduction _____
B. Soft Foot _____
   1. Types of Soft Foot _____
C. Thermal Growth _____
D. Coupling Stress _____
   1. Causes of Coupling Stress _____

Sessions II. Basic Laser Principles; Optalign® Laser Alignment

A. Basic Laser Principles _____
B. Laser Safety _____
C. Optalign® Laser Alignment _____
D. Descriptive Characteristics of Misalignment _____
   1. Optalign® System Capabilities/Limitations _____
E. Laboratory _____

   Have trainees practice identifying the major components of the Optalign® laser alignment system. This laboratory corresponds to Performance Task 1.

Sessions III -V. Laser Detector Operation; Alignment Procedures, Part One

A. Laser/Detector Operation _____
B. Alignment Procedures _____
C. Rough Alignment _____
   1. Laboratory _____

      Have trainees practice performing a rough alignment. This laboratory corresponds to Performance Task 2.

D. Setting Up Laser Equipment; Initial Laser Alignment _____
   1. Laboratory _____

      Have trainees practice setting up the laser alignment equipment and checking the initial alignment. This laboratory corresponds to Performance Tasks 3 and 4.

Sessions VI and VII. Laser Operation and Alignment Procedures, Part Two

A. Aligning Machinery Trains _____

B. Laboratory _____

Have the trainees practice drawing a scale graphical plot of a machinery train, then aligning a machinery train. This laboratory corresponds to Performance Tasks 5 and 6.

Session VIII. Laser Operation and Alignment Procedures, Part Three

A. Determining Targets _____

B. Aligning Vertical Machines _____

C. Laboratory _____

Have the trainees perform a vertical alignment. This laboratory corresponds to Performance Task 7.

Session IX. Troubleshooting

A. Machinery Defects _____

B. Incorrectly Installed Brackets _____

C. System Failure or Defect _____

Session X. 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.

Installing Belt and Chain Drives
Annotated Instructor's Guide

Module 32307-08

MODULE OVERVIEW

This module provides information on different types of chains and belts, and how they are used to drive parallel shafts.

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 32306-08.

OBJECTIVES

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

1. Identify belt drive types.
2. Install a belt drive.
3. Identify chain drive types.
4. Install a chain drive.

PERFORMANCE TASKS

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

1. Identify belt drive types.
2. Install a belt drive.
3. Identify chain drive types.
4. Install a chain drive.

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
Basic trainee tools
V-belts
Timing belts
Roller chains
Silent chains
Cleaning solvent
Oil
Rags
Hone, fine file, light grinder, or emery cloth
Straightedge
Piano wire
Micrometer
Chain breaker and riveter
Oil
Sprocket alignment tool
Various types of belt drives
Various types of chain drives
ANSI Standard B29.1, Transmission Roller Chains and Sprocket Teeth
ANSI Standard B29.2, Inverted-Tooth Chains and Sprocket Teeth
Specialized tools, including laser alignment tools
Module Examinations*
Performance Profile Sheets*

* 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.gates.com
www.beltcorp.com
www.hitmax.com
www.tsubakimoto.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 10 hours are suggested to cover *Installing Belt and Chain Drives*. 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.

Topic	**Planned Time**
Session I. Introduction; Belt Drive Types	
A. Introduction	_____
B. Belt Drive Types	_____
1. V-Belts	_____
2. Synchronous Belts	_____
C. Laboratory	_____
Have the trainees practice identifying belt drive types. This laboratory corresponds to Performance Task 1.	
Session II. Installing Belt Drives	
A. Installing Belt Drives	_____
B. Laboratory	_____
Have the trainees practice installing a belt drive. This laboratory corresponds to Performance Task 2.	
Session III. Chain Drive Types; Installing Chain Drives; Chain Tools	
A. Chain Drive Types	_____
1. Roller Chains	_____
2. Silent Chains	_____
B. Laboratory	_____
Have the trainees practice identifying chain drive types. This laboratory corresponds to Performance Task 3.	
C. Installing Chain Drives	_____
D. Laboratory	_____
Have the trainees practice installing a chain drive. This laboratory corresponds to Performance Task 4.	
E. Chain Tools	_____

Session IV. Review and Testing

A. Module Review _____

B. 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.

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.

Introduction to Piping Components
Annotated Instructor's Guide

Module 32202-07

MODULE OVERVIEW

This module introduces chemical, compressed air, fuel oil, steam, and water systems and explains how to identify them by color-code. It also explains thermal expansion of pipes and pipe insulation.

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*, Module 32201-07.

OBJECTIVES

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

1. Identify and explain the types of piping systems.
2. Identify piping systems according to color-coding.
3. Explain the effects and corrective measures for thermal expansion in piping systems.
4. Explain types and applications of pipe insulation.

PERFORMANCE TASKS

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

1. Identify the type of piping system designated by the following:
   - Red color-code
   - Yellow color-code
   - Green color-code
   - Bright blue color-code

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
MSDSs for commonly used chemicals
Various types of pipe from different piping systems
Sections of color-coded pipe for identification
Samples of various insulation materials
Bimetallic strip
Acetylene torch with rosebud
Calculator
Copies of the Quick Quiz*
Module Examination**
Performance Profile Sheets**

* 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.

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. This is optional material for continued education rather than for task training.

Audel Mechanical Trades Pocket Manual, 1990. Carl Nelson. New York, NY: Macmillan Publishing Company.

The Pipe Fitters Blue Book, 2002. W. V. Graves. Clinton, NC: Construction Trades Press.

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 5 hours are suggested to cover *Introduction to Piping 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.

Topic	**Planned Time**
Session I. Piping Systems	
A. Introduction	_____
B. Types of Piping Systems	_____
C. Identifying Piping Systems	_____
D. Laboratory Trainees practice identifying piping systems as designated by various color-codes. This laboratory corresponds to Performance Task 1.	_____
Session II. Thermal Expansion, Insulation, Review and Testing	
A. Thermal Expansion	_____
B. Pipe Insulation	_____
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.	_____

Copper and Plastic Piping Practices
Annotated Instructor's Guide

Module 32203-07

MODULE OVERVIEW

This module covers various types of plastic and copper pipe and fittings, and provides step-by-step instructions for measuring, cutting, and joining plastic and copper piping.

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 and 32202-07.

OBJECTIVES

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

1. Identify types of materials and schedules of copper and plastic piping.
2. Identify proper and improper applications of copper and plastic piping.
3. Identify the material properties, storage, and handling requirements of copper piping.
4. Identify types of fittings and valves used with plastic piping.
5. Identify types of fittings and valves used with copper piping.
6. Identify and determine the types of hanging and supporting copper and plastic piping.
7. Identify the various techniques used in hanging and supporting copper and plastic piping.
8. Properly measure, cut, and join copper and plastic piping.
9. Explain proper procedures for the safe handling, storage, and protection of copper and plastic pipes.

PERFORMANCE TASKS

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

1. Correctly measure the diameter of copper tubing.
2. Cut and ream copper tubing using a tube cutter.
3. Correctly bend copper tubing using bending tools.
4. Make a swage joint in a section of copper tubing.
5. Make and join single flare connections.
6. Join two sections of tubing using a compression fitting.
7. Cut and join two sections of plastic pipe using appropriate fittings.

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
MSDSs for solvents used to join plastic pipe
Samples of various types of plastic pipe
Manufacturers' literature on various types of plastic pipe
Various types of fittings for plastic pipe
Hacksaw
Plastic pipe cutters
Plastic pipe reamers
Transition and fusion fittings
Solvent cements and instructions
Bell-and-spigot pipe
Tools and materials used to join PEX
Tools used to join PE tubing
Samples of copper pipe
Rulers
Measuring tape
Fittings and valves used with copper pipe
Tube cutter
Copper pipe reamers
Copper pipe bending tools
Soldering torches
Flux and flux brushes
Solder paste
Wire solder
Flaring tools
Flared fittings
Swage fittings
Swaging tool
Various types of copper pipe supports
Copies of Quick Quizzes*
Module Examination**
Performance Profile Sheets**

* 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 requires trainees to work with plastic and copper pipe. Ensure that they are briefed on shop safety procedures. Emphasize chemical and hand tool safety.

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.plasticpipe.org/publications/pe_handbook.html
www.copper.org/applications/plumbing/techref/cth/cth_main.htm
www.charlottepipe.com/Default.aspx?Page=ABSPVCDWVTechInstall&type=ABSPVCDWV

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 5 hours are suggested to cover *Copper and Plastic Piping Practices*. 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.

Topic **Planned Time**

Session I. Introduction to Plastic and Copper Pipe

A. Introduction _____

B. Plastic Pipe and Fittings _____

C. Laboratory _____
Trainees practice cutting and joining two sections of plastic pipe. This laboratory corresponds to Performance Task 7.

D. Copper Pipe _____

E. Laboratory _____
Trainees practice measuring the diameter of copper pipe. This laboratory corresponds to Performance Task 1.

F. Fittings and Valves _____

G. Measuring, Cutting, Bending, Joining, and Grooving _____

H. Laboratory _____
Trainees practice cutting and reaming copper pipe. This laboratory corresponds to Performance Task 2.

I. Laboratory _____
Trainees practice bending copper pipe. This laboratory corresponds to Performance Task 3.

Session II. Joining Copper Pipe, Review and Testing

A. Joining Copper Pipe _____

B. Laboratory _____
Trainees practice joining copper pipe. This laboratory corresponds to Performance Tasks 4–6.

C. Hangers and Supports _____

D. Insulating Pipes and Pressure Testing _____

E. Review _____

F. 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.

G. 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.

Introduction to Ferrous Metal Piping Practices
Annotated Instructor's Guide

Module 32204-07

MODULE OVERVIEW

This module covers various types of iron and steel pipe and fittings, and provides step-by-step instructions for cutting, threading, and joining ferrous piping.

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 32203-07.

OBJECTIVES

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

1. Identify the types of ferrous metal pipes.
2. Measure the sizes of ferrous metal pipes.
3. Identify the common malleable iron fittings.
4. Cut, ream, and thread ferrous metal pipe.
5. Join lengths of threaded pipe together and install fittings.
6. Describe the main points to consider when installing pipe runs.
7. Describe the method used to join grooved piping.

PERFORMANCE TASKS

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

1. Identify types of carbon steel pipe.
2. Identify pipe sizes and weights.
3. Identify various pipe fittings.
4. Use three methods for measuring pipe.
5. Apply pipe dope to pipe threads.
6. Apply Teflon® tape to pipe threads.
7. Assemble threaded pipe to fittings.

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

Sections of black iron and galvanized steel pipe of different sizes and weights

Short sections of pipe for cutting and threading

Threaded sections of pipe

Assorted fittings
- Tees
- Elbows
- Unions
- Couplings
- Nipples
- Crosses
- Plugs
- Caps
- Bushings

Examples of grooved pipe, typical fittings, and gaskets

Examples of flanged pipe and fittings

Drift pins

continued

Pipe drawings and specifications
Cutting oil
Measuring tape
Framing squares
Fitting manufacturer's makeup chart
Pipe stand
Yoke and chain vises
Pipe cutters
Reamers
Pipe wrenches
Chain wrenches
Strap wrenches
Stock and dies
Thread gauge
Powered pipe threader
Rags
Teflon® tape
Pipe dope
Pipe hangers and supports
Module Examination*
Performance Profile Sheets*

*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 trainees to work with hand tools. Ensure that they 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.

Cast Iron Soil Pipe Institute website, www.cispi.org, "*Cast Iron Soil Pipe and Fittings Handbook*," reviewed August 2003.

National Standard Plumbing Code, 2003. Falls Church, VA: Plumbing, Heating, and Cooling Contractors National Association.

Plumbing: Design and Installation, Second Edition, 2002. L.V. Ripka. Homewood, IL: American Technical Publishers.

Plumbing and Mechanical website, www.pmmag.com, "*Forecasting the Lifespan of a Sprinkler System*," Mark Bromann, reviewed August 2003.

Plumbing and Mechanical website, www.pmmag.com, "*Point/Counterpoint: Domestic vs. Imported Cast-Iron Pipe*," Joe Christiansen and Paula M. Bowe, reviewed August 2003.

Victaulic website, www.victaulic.com, "*Pipe Preparation Tools and Parts*," reviewed November 2003.

Water and Plumbing, Volume 3, 2000. Ifte Choudhury and J. Trost. Upper Saddle River, NJ: Prentice Hall.

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 5 hours are suggested to cover *Introduction to Ferrous Metal Piping Practices*. 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.

Topic **Planned Time**

Session I. Introduction to Ferrous Metal Pipe

A. Introduction _____

B. Introduction to Ferrous Metal Pipe _____

C. Laboratory _____
Trainees practice identifying types of carbon steel pipe and pipe sizes and weights. This laboratory corresponds to Performance Tasks 1 and 2.

D. Fittings and Valves _____

E. Pipe Fittings _____

F. Laboratory _____
Trainees practice identifying various pipe fittings. This laboratory corresponds to Performance Task 3.

Session II. Joining Methods, Review, and Testing

A. Measuring Steel Pipe _____

B. Laboratory _____
Trainees practice using three methods to measure steel pipe. This laboratory corresponds to Performance Task 4.

C. Assembling Threaded Pipe _____

D. Laboratory _____
Trainees practice assembling steel pipe. This laboratory corresponds to Performance Tasks 5–7.

E. Hangers and Supports _____

F. Review _____

G. 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.

H. 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.

Identify, Install, and Maintain Valves
Annotated Instructor's Guide

Module 32205-07

MODULE OVERVIEW

This module explains how to remove threaded and flanged valves, how to replace a valve stem O-ring and bonnet gaskets, and how to repack a valve stuffing box. It also discusses the purpose of valve packing.

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 32204-07.

OBJECTIVES

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

1. Remove and install threaded valves.
2. Remove and install flanged valves.
3. Replace valve stem O-rings.
4. Replace bonnet gaskets.
5. Explain the purpose of valve packing.
6. Repack a valve.

PERFORMANCE TASKS

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

1. Identify types of valves and explain their purposes and installation.
2. Repack a valve.
3. Replace a bonnet gasket.
4. Replace a valve stem O-ring.

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
Assorted screwdrivers
Channel-lock pliers
Combination wrenches
Drift pins
Hacksaws
Levels
Pipe cutters
Pipe threaders
Pipe vises
Pipe wrenches
Putty knives
Sharp knives
Tape measure
Torque wrenches
Tri squares
Valve O-rings
Valve packing removal tools
Antiseize compound
Bonnet gaskets
Carbon steel pipe to match valve sizes
Flange gaskets
Flanged valves in a small system
Pipe joint compound
Thread cutting oil
Threaded pipe unions
Threaded valves in a small system
Valve packing
Valves that contain O-rings
Copies of the Quick Quiz*
Module Examination**
Performance Profile Sheets**

* 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 requires trainees to work with valves. Ensure that all trainees are properly briefed on equipment use and hand tool safety procedures. 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.

Choosing the Right Valve, Crane Company; 300 Park Avenue, New York, NY.

Piping Pointers; Application and Maintenance of Valves and Piping Equipment, Crane Company; 300 Park Avenue, New York, NY.

www.dezurikwater.com/basic_valves_instruction_index.htm

www.valmatic.com/manuals.jsp

www.velan.com/products/index.htm

www.acipco.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 10 hours are suggested to cover *Identify, Install, and Maintain Valves*. 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.

Topic **Planned Time**

Session I. Removing and Installing Valves

A. Introduction _____
B. Removing and Installing Threaded Valves _____
C. Removing and Installing Flanged Valves _____
D. Troubleshooting Valves _____
E. Laboratory _____
Trainees practice identifying valves and explaining their purposes and installation. This laboratory corresponds to Performance Task 1.

Session II. Valve Stem O-Rings and Bonnet Gaskets

A. Types of O-Rings _____
B. Replacing Valve Stem O-Rings _____
C. Laboratory _____
Trainees practice replacing valve stem O-rings. This laboratory corresponds to Performance Task 4.
D. Replacing Bonnet Gaskets _____
E. Laboratory _____
Trainees practice replacing bonnet gaskets. This laboratory corresponds to Performance Task 3.

Session III. Repacking Valves

A. Packing Shapes and Materials _____
B. Repacking Valves _____
C. Laboratory _____
Trainees practice repacking valves. This laboratory corresponds to Performance Task 2.

Session IV. Review and Testing

A. 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.