



**TheAcademy.com**  
Learning Management On A Global Scale

---

## 2009/2010 Catalog: Industrial

---

## Contents

Library, Series and Bundle Breakdown .....	7
Courses: .....	10
Ammeters, Meggers, and Wheatstone Bridge Series.....	10
Introduction to Megohmmeters .....	10
Using the Megohmmeter .....	10
Wheatstone Bridge .....	11
Using a Wheatstone Bridge .....	11
Clamp-on Ammeters .....	12
AC/DC Motor Maintenance Series.....	12
Introduction to AC Motor Maintenance .....	12
Records, Tools, and Instruments.....	13
Preventive AC Motor Maintenance.....	13
Measurement in Preventive AC Motor Maintenance .....	13
Preparing for Periodic AC Motor Maintenance .....	14
Motor Disassembly and Reassembly in Periodic AC Motor Maintenance .....	14
Corrective Maintenance for AC Motors.....	15
Introduction to DC Motor Maintenance .....	15
Commutator Inspection .....	15
Commutator Wear .....	16
Commutator Maintenance .....	16
Brush Maintenance .....	16
AC/DC Motor Theory Series.....	17
Introduction to AC Components and Motors .....	17
Advanced AC Motor Principles.....	17
Three-Phase Motors - Part 1 .....	18
Three-Phase Motors - Part 2 .....	18
Single-Phase Motors.....	19
Introduction to DC Motors.....	19
Introduction to DC Motor Theory .....	19
Armature Reaction, Compensation, and Induced Voltage .....	20

Series, Shunt, and Compound DC Motors .....	20
Permanent Magnet, Universal, and Brushless DC Motors.....	21
DC Motor Controls .....	21
Conduit Installation Series.....	21
Conduit System Materials .....	22
Conduit Bending .....	22
Conduit Layout and Installation.....	23
Electrical Print Reading Series .....	23
Introduction to Electrical Schematics.....	23
Electrical Schematic Symbols - Input Devices .....	24
Electrical Schematic Symbols - Logic and Output Devices.....	24
Interpreting Electrical Schematics .....	24
Introduction to Electrical Diagrams .....	25
Building Electrical Diagrams .....	25
Single-Line Electrical Diagrams .....	26
Wiring Diagrams .....	26
Electrical Safety Series.....	27
Working Safely with Electricity .....	27
Electrical Circuits and Supplies .....	27
Electrical Shock.....	28
Electrical Personal Protective Equipment.....	28
Protective Gloves and Sleeves .....	29
Eye and Face Protection .....	29
Protective Helmets.....	29
General Protective Equipment .....	30
Electrical Theory for Troubleshooters Series.....	30
Introduction to Electricity .....	30
Basic Electrical Properties .....	31
Series Circuits.....	31
Parallel Circuits.....	32
Alternating Current .....	32
Electromagnetism .....	33
Inductance.....	33

Capacitance .....	33
Three-Phase AC Circuits.....	34
Wye and Delta Connections.....	34
Introduction to Transformers.....	35
Transformers .....	35
Limit Switches Series .....	36
Overview.....	36
Lever-Actuated .....	36
Solid State .....	36
Torque and Geared.....	37
Multimeters Series .....	37
Digital Multimeters.....	37
Analog Multimeters .....	38
Multimeter Selection and Inspection.....	38
Using Multimeters .....	39
Advanced Features of Digital Multimeters .....	39
Oscilloscopes Series.....	39
Introduction to Oscilloscopes.....	40
The Display .....	40
Vertical System Controls .....	40
Horizontal System Controls.....	41
The Trigger System.....	41
Probes .....	41
Setup .....	42
Waveforms.....	42
Measurement .....	43
Troubleshooting Skills: Developing Logical Thinking Series* .....	43
Introduction to Troubleshooting .....	43
Information Gathering.....	44
Troubleshooting .....	44
Improving Skills .....	44
Office Security Series*.....	45
Office Security.....	45

Bearings Series .....	46
Introduction to Bearings.....	46
Analyzing Bearing Failure .....	46
Maintaining Bearings .....	46
Centrifugal Pump Repair Series .....	47
Troubleshooting Excessive Leakage .....	47
Troubleshooting Excessive Temperature .....	47
Troubleshooting Loss of Capacity.....	48
Disassembly .....	48
Inspection.....	49
Reassembly .....	49
Hand Tools Series .....	49
Clamps, Vises, and Pliers.....	50
Screwdrivers .....	50
Wrenches .....	50
Hammers, Mallets, and Sledges .....	51
Industrial Hydraulic Power Series .....	51
Introduction to Hydraulic Systems.....	51
Hydraulic Schematics .....	52
Hydraulic Fluids.....	52
Hydraulic Pump Applications .....	53
Positive Displacement Pumps .....	53
Hydraulic Accumulators .....	54
Pressure Control Principles .....	54
Pressure Control Operation.....	55
Pressure Control Valve Applications.....	55
Directional Control Principles .....	56
Flow Control Valves.....	56
Actuator Cylinders .....	57
Hydraulic Motors.....	57
Industrial Lubrication Series.....	58
Introduction to Industrial Lubrication.....	58
Lubricants .....	58

Lubrication Systems.....	59
Filters and Lubrication Maintenance .....	59
Mechanical Print Reading Series .....	60
Introduction to Mechanical Print Reading .....	60
Lines Used in Mechanical Print Reading .....	60
Dimensions in Mechanical Print Reading.....	61
Orthographic Projection.....	61
Mechanical Seals Series .....	62
Introduction to Mechanical Seals .....	62
Mechanical Seal Designs .....	63
Failure Analysis .....	63
Mechanical Seal Maintenance .....	64
Precision Measuring Instruments Series .....	64
Dial Calipers.....	64
Micrometers .....	65
Telescoping and Thickness Gauges .....	65
Dial Indicators.....	65

## Library, Series and Bundle Breakdown

Our industrial content can be purchased as a library set or be individual series. Specific titles inside of a series are not available for individual purchase. For more information, please contact your Account Representative.

### Industrial/Electrical Library

<b>Ammeters, Meggers, and Wheatstone Bridge Series</b>	
Introduction to Megohmmeters	IND101
Using the Megohmmeter	IND102
Wheatstone Bridge	IND103
Using a Wheatstone Bridge	IND104
Clamp-on Ammeters	IND105
<b>AC/DC Motor Maintenance Series</b>	
Introduction to AC Motor Maintenance	IND201
Records, Tools, and Instruments	IND202
Preventive AC Motor Maintenance	IND203
Measurement in Preventive AC Motor Maintenance	IND204
Preparing for Periodic AC Motor Maintenance	IND205
Motor Disassembly and Reassembly in Periodic AC Motor Maintenance	IND206
Corrective Maintenance for AC Motors	IND207
Introduction to DC Motor Maintenance	IND208
Commutator Inspection	IND209
Commutator Wear	IND210
Commutator Maintenance	IND211
Brush Maintenance	IND212
<i>Continued to next page</i>	

<b>Conduit Installation Series</b>	
Conduit System Materials	IND501
Conduit Bending	IND502
Conduit Layout and Installation	IND503
<b>Electrical Print Reading Series</b>	
Introduction to Electrical Schematics	IND601
Electrical Schematic Symbols - Input Devices	IND602
Electrical Schematic Symbols - Logic and Output Devices	IND603
Interpreting Electrical Schematics	IND604
Introduction to Electrical Diagrams	IND605
Building Electrical Diagrams	IND606
Single-Line Electrical Diagrams	IND607
Wiring Diagrams	IND608
<b>Electrical Safety Series</b>	
Working Safely with Electricity	IND701
Electrical Circuits and Supplies	IND702
Electrical Shock	IND703
Electrical Personal Protective Equipment	IND704
Protective Gloves and Sleeves	IND705
<i>Continued to next page</i>	

<b>AC/DC Motor Theory Series</b>	
Introduction to AC Components and Motors	IND401
Advanced AC Motor Principles	IND402
Three-Phase Motors - Part 1	IND403
Three-Phase Motors - Part 2	IND404
Single-Phase Motors	IND405
Introduction to DC Motors	IND406
Introduction to DC Motor Theory	IND407
Armature Reaction, Compensation, and Induced Voltage	IND408
Series, Shunt, and Compound DC Motors	IND409
Permanent Magnet, Universal, and Brushless DC Motors	IND410
DC Motor Controls	IND411
<b>Multimeters Series</b>	
Digital Multimeters	IND2101
Analog Multimeters	IND2102
Multimeter Selection and Inspection	IND2103
Using Multimeters	IND2104
Advanced Features of Digital Multimeters	IND2105
<b>Oscilloscopes Series</b>	
Introduction to Oscilloscopes	IND1001
The Display	IND1002
Vertical System Controls	IND1003
Horizontal System Controls	IND1004
The Trigger System	IND1005
Probes	IND1006
Setup	IND1007
Waveforms	IND1008
Measurement	IND1009

Eye and Face Protection	IND706
Protective Helmets	IND707
General Protective Equipment	IND708
<b>Electrical Theory for Troubleshooters Series</b>	
Introduction to Electricity	IND801
Basic Electrical Properties	IND802
Series Circuits	IND803
Parallel Circuits	IND804
Alternating Current	IND805
Electromagnetism	IND806
Inductance	IND807
Capacitance	IND808
Three-Phase AC Circuits	IND809
Wye and Delta Connections	IND810
Introduction to Transformers	IND811
Transformers	IND812
<b>Limit Switches Series</b>	
Overview	IND901
Lever-Actuated	IND902
Solid State	IND903
Torque and Geared	IND904
<b>Troubleshooting Skills: Developing Logical Thinking Series*</b>	
Introduction to Troubleshooting	IND1101
Information Gathering	IND1102
Troubleshooting	IND1103
Improving Skills	IND1104
<b>Office Security Series*</b>	
Office Security	IND2000

## Industrial/Mechanical Library

Bearings Series	
Introduction to Bearings	IND1201
Analyzing Bearing Failure	IND1202
Maintaining Bearings	IND1203
Maintaining Bearings	IND1203
Centrifugal Pump Repair Series	
Troubleshooting Excessive Leakage	IND1301
Troubleshooting Excessive Temperature	IND1302
Troubleshooting Loss of Capacity	IND1303
Disassembly	IND1304
Inspection	IND1305
Reassembly	IND1306
Hand Tools Series	
Clamps, Vises, and Pliers	IND1401
Screwdrivers	IND1402
Wrenches	IND1403
Hammers, Mallets, and Sledges	IND1404
Industrial Lubrication Series	
Introduction to Industrial Lubrication	IND1601
Lubricants	IND1602
Lubrication Systems	IND1603
Filters and Lubrication Maintenance	IND1604
Mechanical Print Reading Series	
Introduction to Mechanical Print Reading	IND1701
Lines Used in Mechanical Print Reading	IND1702
Dimensions in Mechanical Print Reading	IND1703
Orthographic Projection	IND1704
Office Security Series*	
Office Security	IND2000

Industrial Hydraulic Power Series	
Introduction to Hydraulic Systems	IND1501
Hydraulic Schematics	IND1502
Hydraulic Fluids	IND1503
Hydraulic Pump Applications	IND1504
Positive Displacement Pumps	IND1505
Hydraulic Accumulators	IND1506
Pressure Control Principles	IND1507
Pressure Control Operation	IND1508
Pressure Control Valve Applications	IND1509
Directional Control Principles	IND1510
Flow Control Valves	IND1511
Actuator Cylinders	IND1512
Hydraulic Motors	IND1513
Mechanical Seals Series	
Introduction to Mechanical Seals	IND1801
Mechanical Seal Designs	IND1802
Failure Analysis	IND1803
Mechanical Seal Maintenance	IND1804
Precision Measuring Instruments Series	
Dial Calipers	IND1901
Micrometers	IND1902
Telescoping and Thickness Gauges	IND1903
Dial Indicators	IND1904
Troubleshooting Skills: Developing Logical Thinking Series*	
Introduction to Troubleshooting	IND1101
Information Gathering	IND1102
Troubleshooting	IND1103
Improving Skills	IND1104

## Courses:

### Ammeters, Meggers, and Wheatstone Bridge Series

This series consists of 12 interactive, on-line lessons. These lessons are excellent for the training of electricians and electronic technicians as well as for the multi-craft training needs of process and manufacturing facilities. The first four lessons in this series cover basic electrical concepts including Ohm's Law and Kirchhoff's Law, as well as the use of these laws to determine. This series consists of five lessons and is designed for participants familiar with AC/DC theory, electrical safety, and electrical print reading. A basic understanding of electronic devices and circuits is recommended. The series describes megohmmeters, Wheatstone bridges, and clamp-on ammeters. It gives examples of the use of these instruments, identifies their components, and defines their functions. The lessons also describe safety and selection considerations for their use, how to set up the instruments, how to connect them to the systems under test, and how to take and read measurements, and resistance in series and parallel circuits.

#### Introduction to Megohmmeters

*IND101, Duration: 30 minutes*

##### Summary:

This is the first lesson in the Ammeters, Meggers, and Wheatstone Bridge Series. This lesson explains Ohm's Law and how it is used when analyzing test results. The basic components, uses, and functions of a megohmmeter are described. Insulation and causes of insulation damage are also covered.

##### Topics:

1. Megger Basics
2. Insulation
3. Basic Components
4. Digital Megger
5. Function of a Megger

##### Objectives:

- Explain the formula for Ohm's Law
- Explain how a working knowledge of Ohm's Law can be helpful when analyzing test results
- Describe, and give an example of, the use of a megger
- List the causes of damaged insulation
- Describe the causes and effects of low resistance readings
- Identify the basic components of a typical megger
- Identify the switches on a digital megger
- Define the function of a megger

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

#### Using the Megohmmeter

*IND102, Duration: 30 minutes*

##### Summary:

This is the second lesson in the Ammeters, Meggers, and Wheatstone Bridge Series. This lesson describes safety issues to consider when using a megohmmeter, how to select the correct megger for the job, setup, and the steps necessary to take a megger reading.

##### Topics:

1. Selecting a Megger
2. Setting up a Megger
3. Attaching Leads to the System

#### 4. Taking a Reading

##### Objectives:

- Describe safety considerations when using a megohmmeter
- List considerations when selecting a megger
- Describe the procedures for setting up a megger
- Describe how to attach the leads to the system
- Describe how to take a reading with a megger

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Introduction to Megohmmeters is recommended*

### Wheatstone Bridge

*IND103, Duration: 30 minutes*

##### Summary:

This is the third lesson in the Ammeters, Meggers, and Wheatstone Bridge Series. This lesson explains what a bridge circuit is, the purpose and components of a Wheatstone bridge, and its function.

##### Topics:

1. What is a Wheatstone Bridge
2. Wheatstone Bridge Components
3. How a Wheatstone Bridge Works

##### Objectives:

- Define a bridge circuit
- Identify the components of a Wheatstone bridge
- Define the function of a Wheatstone bridge

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

### Using a Wheatstone Bridge

*IND104, Duration: 30 minutes*

##### Summary:

This is the fourth lesson in the Ammeters, Meggers, and Wheatstone Bridge Series. This lesson explains how to balance a Wheatstone bridge and the process used to set mechanical and electrical zero. How to interpret the readings of a Wheatstone bridge is also explained.

##### Topics:

1. Balancing the Bridge
2. Setting Mechanical Zero
3. Measuring Resistance
4. Interpreting Readings

##### Objectives:

- Describe how to balance a Wheatstone bridge
- Describe how to set mechanical and electrical zero on a Wheatstone bridge
- Describe how to take a reading with a Wheatstone bridge
- Describe how to interpret a Wheatstone bridge reading
- Interpret a Wheatstone bridge reading

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Wheatstone Bridge is required.*

## Clamp-on Ammeters

*IND105, Duration: 30 minutes*

### Summary:

This is the final lesson in the Ammeters, Meggers, and Wheatstone Bridge Series. This lesson presents the components and features and functions of clamp-on ammeters. The lesson also describes safety considerations that should be noted when selecting a clamp-on ammeter. Instruction in the procedures for setting up, taking readings, and modifying the range of a clamp-on ammeter are also covered.

### Topics:

1. Components
2. Types of Clamp-on Ammeters
3. Pointer Lock and Peak Value
4. Clamp-on Ammeter Range
5. Clamp-on Ammeter Function
6. Safety and Selection
7. Taking a Reading

### Objectives:

- Identify the components of a clamp-on ammeter
- Describe the range function of a clamp-on ammeter
- Define the function of a clamp-on ammeter
- Describe safety and selection considerations for using a clamp-on ammeter
- Define the "record and lock" features
- Describe the procedures for setting up a clamp-on ammeter
- Describe how to take a reading and modify the range of a clamp-on ammeter

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## AC/DC Motor Maintenance Series

This series was designed to provide training for electricians, mechanics, and others, wanting to know more about AC and DC motor maintenance. This series consists of 12 interactive, on-line lessons that address AC and DC motor maintenance. These lessons take approximately 30 to 45 minutes each to complete.

### Introduction to AC Motor Maintenance

*IND201, Duration: 30 minutes*

### Summary:

This is the first lesson in the AC/DC Motor Maintenance Series. The lesson explains the purpose of AC motor maintenance programs and the types of motor maintenance. The lesson also identifies safety procedures that should be used during motor maintenance.

### Topics:

1. Why Have and AC Motor Maintenance Program?
2. Three Types of Motor Maintenance
3. Safety and AC Motor Maintenance

### Objectives:

- Identify characteristics of a motor maintenance program
- Identify types of motor maintenance
- Identify safety procedures to use during motor maintenance

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Records, Tools, and Instruments

*IND202, Duration: 30 minutes*

### Summary:

This is the second lesson in the AC/DC Motor Maintenance Library. The lesson explains the purpose of keeping complete and accurate records using various record keeping formats. The lesson also identifies tools and instruments used for given tasks in motor maintenance.

### Topics:

1. Purpose of Record Keeping
2. Maintenance Records
3. Tools and Instruments

### Objectives:

Identify reasons for having a record keeping system

Identify categories of information for a record keeping system

Select the appropriate motor maintenance tools and instruments for given tasks

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Introduction to AC Motor Maintenance is recommended.*

## Preventive AC Motor Maintenance

*IND203, Duration: 30 minutes*

### Summary:

This is the third lesson in the AC/DC Motor Maintenance Library. The lesson explains aspects of preventive motor maintenance, the steps in inspecting a motor for general maintenance and for identifying problems, and cleaning and lubricating a motor as part of a preventive motor maintenance program.

### Topics:

1. Definition of Preventive Motor Maintenance
2. Inspection
3. Methods of Inspection
4. Cleaning
5. Lubrication

### Objectives:

Identify characteristics of preventive motor maintenance

Inspect a motor for general maintenance and for identifying problems

Clean and lubricate a motor as warranted by a preventive maintenance inspection

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Introduction to AC Motor Maintenance is recommended.*

## Measurement in Preventive AC Motor Maintenance

*IND204, Duration: 30 minutes*

### Summary:

This is the fourth lesson in the AC/DC Motor Maintenance Library. The lesson demonstrates the need for taking measurements, and the importance of comparing measurements. Causes and effects of current variations, temperature extremes, and vibration measurements are described.

### Topics:

1. Measurement Basics
2. Current Measurement
3. Temperature Measurement
4. Vibration Measurement

### Objectives:

- Explain the need for taking measurements in preventive motor maintenance
- Explain the importance of comparing measurement readings
- Take current measurements in preventive motor maintenance

- Explain the causes of current variation in an AC motor
- Take temperature measurements in preventive motor maintenance
- Explain the causes and effects of excessive temperature in an AC motor
- Take vibration measurements in preventive motor maintenance
- Explain the causes of vibration in an AC motor

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lessons: Introduction to AC Motor Maintenance, Records, Tools, and Instruments and Preventive AC Motor Maintenance, is recommended.*

## Preparing for Periodic AC Motor Maintenance

*IND205, Duration: 30 minutes*

### Summary:

This is the fifth lesson in the AC/DC Motor Maintenance Library. The lesson identifies the characteristics of periodic motor maintenance and the major components of an AC motor. Instruction in testing winding resistance, and winding insulation resistance, as part of pre-maintenance testing is given.

### Topics:

Introduction to Periodic Motor Maintenance

Major Components of an AC Motor

Pre-Maintenance Testing

### Objectives:

- Identify characteristics of periodic motor maintenance
- Identify the major components of an AC motor
- Perform pre-maintenance testing: Winding insulation resistance
- Perform pre-maintenance testing: Winding resistance

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lessons: Introduction to AC Motor Maintenance and Records, Tools, and Instruments, is recommended.*

## Motor Disassembly and Reassembly in Periodic AC Motor Maintenance

*IND206, Duration: 30 minutes*

### Summary:

This is the sixth lesson in the AC/DC Motor Maintenance Library.

### Topics:

1. Motor Disassembly
2. Cleaning and Inspection
3. Motor Reassembly

### Objectives:

- Describe how to properly disassemble an AC motor for periodic motor maintenance
- Disassemble an AC motor
- Identify the proper way to clean a disassembled AC motor
- List the various AC motor parts and what to look for during inspection
- Describe how to reassemble an AC motor
- Reassemble an AC motor
- Describe how to perform post-maintenance testing

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Corrective Maintenance for AC Motors

*IND207, Duration: 30 minutes*

### Summary:

This is the seventh lesson in the AC/DC Motor Maintenance Library. This lesson discusses causes and corrective actions for various motor malfunctions.

### Topics:

1. Motor Won't Start
2. Abnormal Noise
3. Motor Overheating
4. Overheated Bearings

### Objectives:

- Identify causes and corrective actions for a motor that will not start
- Identify causes and corrective actions for a motor with abnormal noise
- Identify causes and corrective actions for a motor overheating
- Identify causes and corrective actions for a motor with overheated bearings

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of AC motor components is recommended. Review of the lesson: Motor Disassembly and Reassembly in Periodic AC Motor Maintenance, is suggested.*

## Introduction to DC Motor Maintenance

*IND208, Duration: 30 minutes*

### Summary:

This is the eighth lesson in the AC/DC Motor Maintenance Library. This lesson introduces participants to DC motors and compares them to AC motors.

### Topics:

1. AC and DC Motor Similarities
2. Commutator Construction
3. Commutation

### Objectives:

- Identify similarities between AC and DC motors
- Identify the difference between AC and DC motors
- Identify components of a DC motor commutator and their function
- Identify factors that affect commutation

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Commutator Inspection

*IND209, Duration: 30 minutes*

### Summary:

The ninth lesson in the AC/DC Motor Maintenance Library, this lesson shows participants how to identify some problems that affect the commutator.

### Topics:

1. Oxide Film Inspection
2. High Mica
3. Uneven Segments
4. Solder

### Objectives:

- Describe the color of the commutator and explain the function of the oxide film
- Identify the causes of high mica and corrective actions
- Identify the causes of uneven segments and corrective actions
- Identify the causes of thrown solder and corrective actions

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of DC motor components and commutation is recommended.*

## Commutator Wear

*IND210, Duration: 30 minutes*

### Summary:

This is the tenth lesson in the AC/DC Motor Maintenance Library. This lesson trains participants to recognize friction damage, streaking, threading, and grooving, the cause of these problems, and corrective actions.

### Topics:

1. Friction
2. Streaking
3. Threading
4. Grooving

### Objectives:

- Identify wear patterns, their causes, and corrective actions
- Identify the causes of arcing and corrective actions
- Identify the causes of high mica and corrective actions

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of DC motor components and commutator inspection is recommended.*

## Commutator Maintenance

*IND211, Duration: 30 minutes*

### Summary:

This is the eleventh lesson in the AC/DC Motor Maintenance Library. The lesson demonstrates the process of preparing a commutator for reconditioning, how to properly cut mica, how to check the commutator after maintenance, and explains the purpose of performing a commutator run-in procedure.

### Topics:

1. Preparing the Commutator for Reconditioning
2. Cutting Mica
3. Commutator Film

### Objectives:

- Explain how to prepare a commutator for reconditioning
- Explain how to undercut the mica of a commutator
- Describe how to clean and check the commutator after maintenance
- Explain the purpose of performing a commutator run-in procedure

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of DC motor components and commutator inspection is recommended.*

## Brush Maintenance

*IND212, Duration: 30 minutes*

### Summary:

This is the final lesson in the AC/DC Motor Maintenance Library. The lesson describes how to select and inspect brushes. The lesson identifies the procedures for cleaning, inspecting, and setting the height of a brush holder. How to seat brushes and adjust spring pressure is demonstrated.

### Topics:

1. Brush Inspection
2. Brush Selection
3. Brush Holder Installation

4. Seating Brushes
5. Spring Pressure

**Objectives:**

- Describe how to inspect various aspects of a brush
- Identify the factors to be considered when selecting a brush
- Identify the procedures for cleaning and inspecting the brush holders
- Identify the steps involved in setting the height of a brush holder
- Identify the procedure for installing brushes
- Explain how to seat brushes
- Explain how to adjust spring pressure

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of DC motor components is recommended.*

## AC/DC Motor Theory Series

The AC/DC Motor Theory library was specifically developed for electricians and electronic technicians as well as for the multi-craft training needs of process and manufacturing facilities. This library consists of 11 interactive, on-line lessons that address AC and DC motor theory. These lessons take approximately 30 to 45 minutes to complete.

### Introduction to AC Components and Motors

*IND401, Duration: 30 minutes*

**Summary:**

This is the first lesson in the AC/DC Motor Theory Series. This lesson identifies the components of an AC motor and explains their functions. Basic magnetic principles, sine waves, methods of increasing magnetic flux in a conductor, and how a rotating field is created in an AC Motor are presented.

**Topics:**

1. Introduction to AC Components
2. Magnetic Principles
3. The Sine Wave
4. Flux Field
5. Increasing Magnetic Flux

**Objectives:**

- Identify the components of an AC Motor and explain their function
- Explain the basic principles of magnetism
- Interpret the characteristics of a current as represented on a sine wave
- Describe the effect of AC current on a conductor
- Describe the methods of increasing magnetic flux in a conductor
- Explain how a rotating field is created in an AC Motor

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

### Advanced AC Motor Principles

*IND402, Duration: 30 minutes*

**Summary:**

The second lesson in the AC/DC Motor Theory Series, this lesson explains synchronous speed and how to calculate it. The lesson demonstrates the relationship between phased current and rotor spin and induction and its effect on a rotor. Slip and how to calculate slip using its formula are also covered.

**Topics:**

1. Current and Rotating Field
2. Synchronous Speed

3. Rotor Movement
4. Rotor Spin
5. Slip

**Objectives:**

- Explain and be able to calculate synchronous speed
- Explain induction and its effect on a rotor
- Explain the relationship between phased current and rotor spin
- Explain slip and know its formula

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Introduction to AC Components and Motors, or knowledge of AC motor components and magnetic principles is recommended.*

### Three-Phase Motors - Part 1

*IND403, Duration: 30 minutes*

**Summary:**

This is the third lesson in the AC/DC Motor Theory Series. This lesson defines and explains the components and functions of various three-phase motors. The lesson also defines torque and explains its role in motor operation.

**Topics:**

1. Squirrel Case Motors
2. Wound Rotors
3. Induction Characteristics
4. Reluctance Synchronous

**Objectives:**

- Describe the design of a squirrel cage rotor
- Explain the function of a squirrel cage rotors components
- Describe the design of a wound rotor
- Explain the function of a wound rotors components
- Define torque and explain its role in motor operation
- Explain the design of a reluctance motor and how it works

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

### Three-Phase Motors - Part 2

*IND404, Duration: 30 minutes*

**Summary:**

This is the fourth lesson in the AC/DC Motor Theory Series. This lesson defines and explains the components and functions of externally excited motors, starters, and variable speed drives. There is also a review topic to reinforce the information covered in the lesson, Three-Phase Motors - Part 1.

**Topics:**

1. Externally Excited Motors
2. Starters
3. Variable Speed Drives
4. Three-Phase Review

**Objectives:**

- Explain the design of an externally excited motor
- Explain how an externally excited motor works
- Explain the function of a motor starter
- Describe the most common types of motor starters
- Describe a variable speed drive and its effect on voltage and frequency

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Completion of the lesson, Three-Phase Motors - Part 1, is recommended.*

## Single-Phase Motors

*IND405, Duration: 30 minutes*

### Summary:

This is the fifth lesson in the AC/DC Motor Theory Series. This lesson trains the participants to distinguish single-phase motors from three-phase motors. Split-phase motors and capacitance start motors are discussed.

### Topics:

1. Single-Phase Motors
2. Split-Phase Motors
3. Capacitor Start Motors
4. Summary

### Objectives:

- Distinguish a single-phase motor from a three-phase motor
- Explain the design of a split-phase motor and how it works
- Explain the design of a capacitance start motor and how it works

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Completion of the lessons, Three-Phase Motors - Part 1 and Part 2, is recommended.*

## Introduction to DC Motors

*IND406, Duration: 30 minutes*

### Summary:

This is the sixth lesson in the AC/DC Motor Theory Series. This lesson introduces the learner to DC Motors and their basic components.

### Topics:

1. History of DC Motors
2. Basic Components
3. Armature Components
4. Brushes

### Objectives:

- Identify the general characteristics of a DC motor
- Identify the advantages of a DC motor
- Identify the basic components of a DC motor
- Explain the function of DC motor components
- Identify the components of the armature and explain their function
- Identify the components of the brush assembly and explain their function

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Introduction to DC Motor Theory

*IND407, Duration: 30 minutes*

### Summary:

This is the seventh lesson in the AC/DC Motor Theory Series. The lesson introduces participants to DC motor theory.

### Topics:

1. Flux Interaction
2. Commutation
3. Multiple Windings

### Objectives:

- Explain the effect of armature current on the main flux field and how it results in motor action
- Explain the process of commutation and how it maintains direct current in a DC motor
- Describe how the number of windings and commutator segments impacts torque and mechanical power of a DC motor

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of DC motor components and magnetic principles or Review of the lessons: Introduction to AC Components and Motors and Introduction to DC Motors is recommended.*

## Armature Reaction, Compensation, and Induced Voltage

*IND408, Duration: 30 minutes*

### Summary:

The eighth lesson in the AC/DC Motor Theory Series, this lesson demonstrates armature reaction, compensation, and induced voltage.

### Topics:

1. Armature Reaction
2. Compensation
3. Induced Voltage

### Objectives:

- Explain how armature reaction shifts the neutral plane in a DC motor
- Explain how armature reaction affects motor operation
- Explain what measures will correct armature reaction
- List the requirements for induced voltage in a motor
- Explain counter-EMF

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of DC motor components and Review of the lesson: Introduction to DC Motor Theory is recommended.*

## Series, Shunt, and Compound DC Motors

*IND409, Duration: 30 minutes*

### Summary:

This is the ninth lesson in the AC/DC Motor Theory Series. This lesson instructs the participant in the design of series wound, shunt wound, and compound DC motors and how they work.

### Topics:

1. Series Wound Motors
2. Shunt Wound Motors
3. Compound Motors

### Objectives:

- Explain the design of a series wound DC motor
- Explain how a series wound DC motor works
- Explain the design of a shunt wound DC motor
- Explain how a shunt wound DC motor works
- Explain the design of a compound wound DC motor
- Explain how a compound wound DC motor works

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of DC motor components and Review of the lessons: Introduction to DC Motor Theory and Armature Reaction, Compensation, and Induced Voltage, is recommended.*

## Permanent Magnet, Universal, and Brushless DC Motors

IND410, Duration: 30 minutes

### Summary:

This is the tenth lesson in the AC/DC Motor Theory Series. This lesson instructs the student in the design of permanent magnet, universal, and brushless DC motors and how they work.

### Topics:

1. Permanent Magnet Motors
2. Universal Motors
3. Brushless Motors

### Objectives:

- Explain the design of a permanent magnet DC motor
- Explain how a permanent magnet DC motor works
- Explain how a universal motor runs off of DC power
- Explain the design of a brushless DC motor
- Explain how a brushless DC motor works

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of DC motor components and Review of the lessons: Introduction to DC Motor Theory and Series, Shunt, and Compound DC Motors, are recommended.*

## DC Motor Controls

IND411, Duration: 30 minutes

### Summary:

This is the final lesson in the AC/DC Motor Theory Series. This lesson trains participants in starters, rotation direction, speed control, and drive controls of DC motors.

### Topics:

1. Starting DC Motors
2. Reverse Direction
3. Speed Control
4. DC Drives

### Objectives:

- Explain why a reduced voltage starter is sometimes needed in a motor
- Explain how a reduced voltage starter works
- Explain what determines the direction of rotation of a DC motor
- Explain how a reverse contactor works
- Explain how to control the speed of a DC motor
- Explain how a tapped resistor works
- Explain how a field rheostat works
- Explain a DC drive's control system
- Explain how a DC drive control system works

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of schematics is recommended as well as Review of the lessons: Introduction to DC Motor Theory and Series, Shunt, and Compound DC Motors.*

## Conduit Installation Series

This series consists of 3 interactive, on-line lessons. These lessons were designed for the training of electricians as well as for the multi-craft training needs of process and manufacturing facilities. It trains participants on identifying and applying the basic materials of a conduit system.

## Conduit System Materials

*IND501, Duration: 30 minutes*

### Summary:

This is the first lesson in the Conduit Installation Series. This lesson introduces the learner to conduit systems and components, and instructs in the use of trade size and fill charts.

### Topics:

1. Introduction to Conduit Systems
2. Trade Size and Fill Charts
3. Conduit Properties
4. Boxes, Fittings, and Specialized Pieces

### Objectives:

- Define conduit and types
- Explain how conduit trade size is measured
- Read and use a conduit fill chart
- Determine the uses for types of conduit
- Identify boxes and their purpose
- Explain how boxes are sized
- Identify fittings and their uses
- Explain the purpose of ELLs and T-conduits

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Conduit Bending

*IND502, Duration: 30 minutes*

### Summary:

This is the second lesson in the Conduit Installation Series. This lesson instructs the learner in the proper methods of cutting, cleaning, and bending conduit. The lesson also demonstrates how to make various bends and when different bends are used.

### Topics:

1. Cutting, Cleaning, and Threading
2. Benders
3. 90 Degree Bends
4. Offset Bends
5. Three and Four Bend Saddle

### Objectives:

- Explain the methods for cutting conduit
- Explain the methods and reasons for cleaning conduit
- Explain the methods for threading conduit
- Identify benders and their uses
- Define the common markings of a hand bender
- Measure for and make a 90° bend
- Identify an offset bend and its uses
- Make an offset bend using an offset chart
- Identify a saddle bend and its uses
- Make and use a three and four bend saddle

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of conduit system materials, trade size, and use of fill charts is recommended.*

## Conduit Layout and Installation

*IND503, Duration: 30 minutes*

### Summary:

This final lesson in the Conduit Installation Series explains the procedure used to plan, measure, and install a conduit system.

### Topics:

1. Planning the Conduit Layout
2. Installing Conduit
3. Supports
4. Installing Conductors

### Objectives:

- Plan a layout of a conduit installation
- Measure for a conduit installation
- Explain the methods for installing conduit
- Support a conduit system
- Explain the methods for installing conductors

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of conduit system materials and conduit bending is recommended.*

## Electrical Print Reading Series

This series was designed to provide training for electricians, mechanics, and others, wanting to know more about electrical print reading. This series consists of eight interactive, on-line. These lessons take approximately 30 to 45 minutes each to complete.

### Introduction to Electrical Schematics

*IND601, Duration: 30 minutes*

### Summary:

This is the first lesson in the Electrical Print Reading Series. This lesson teaches about input, logic, and output devices, and the state in which symbols are drawn on electrical schematics.

### Topics:

1. Input
2. Logic
3. Output
4. Schematics

### Objectives:

- Name the three groups of input devices
- Describe the function of the input element of a control circuit
- Describe the function of the logic element of a control circuit
- Describe the function of the output element of a control circuit
- Describe the state in which symbols are drawn on electrical schematics

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Electrical Schematic Symbols - Input Devices

IND602, Duration: 30 minutes

### Summary:

This is the second lesson in the Electrical Print Reading Series. The lesson presents the symbols for various manually and process actuated input devices and how they are represented on an electrical schematic.

### Topics:

1. Manually Actuated Devices
2. Process Actuated Devices
3. Equipment Actuated Devices

### Objectives:

- Identify the symbols for various manually operated input devices
- Explain how various manually operated input devices are used
- Identify symbols for various process actuated input devices
- Explain how various process actuated input devices are used
- Given an electrical schematic, identify a process actuated device
- Identify symbols for two-position actuated input devices
- Explain how and two-position actuated input devices are used

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Introduction to Electrical Schematics is recommended.*

## Electrical Schematic Symbols - Logic and Output Devices

IND603, Duration: 30 minutes

### Summary:

This is the third lesson in the Electrical Print Reading Series. This lesson defines the function of logic and output elements of a control circuit and presents the symbols for various logic and output devices.

### Topics:

1. Logic Devices
2. Control and Latching Relays
3. Time Delay Relays
4. Output Devices

### Objectives:

- Describe the function of the logic element of a control circuit
- Describe the function of the output element of a control circuit
- Identify the symbol for a relay and the associated contacts
- Identify various logic symbols and state how they are used
- Identify the symbol for a motor starter and state how it is used
- Identify various output symbols and state how they are used

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Introduction to Electrical Schematics is recommended.*

## Interpreting Electrical Schematics

IND604, Duration: 30 minutes

### Summary:

This is the fourth lesson in the Electrical Print Reading Series. This lesson describes the steps for interpreting the relationships among the input, logic, and output components of an electrical schematic.

### Topics:

1. Schematic Structure
2. Labels and Margin Notes
3. Steps in Analyzing the Schematic

#### 4. Analyzing the Schematic

##### Objectives:

- List and define the two basic parts of an electrical schematic
- Describe the layout of a typical electrical schematic
- List and describe various conventions for labeling schematics
- Describe the steps for interpreting schematics
- Given a device in an electrical schematic, state the function of that device
- Given a rung in an electrical schematic, interpret the function of that rung
- Given the margin notes in an electrical schematic, determine what rungs are associated with the output device
- Interpret an electrical schematic

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of electrical schematic symbols for input, logic, and output devices.*

### Introduction to Electrical Diagrams

*IND605, Duration: 30 minutes*

##### Summary:

This is the fifth lesson in the Electrical Print Reading Series, and the first lesson covering electrical diagrams. This lesson presents information about the purpose of various types of electrical diagrams and how to interpret the information in the title block. It also explains how to make electrical drawing revisions.

##### Topics:

1. Purpose of Drawings
2. Diagram Organization
3. Title Page
4. Revisions

##### Objectives:

- Explain the purpose and types of electrical drawings
- Describe the layouts of electrical diagrams
- Explain the information given in a title block in an electrical diagram
- Explain how to make electrical drawing revisions

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of electrical schematic symbols is recommended.*

### Building Electrical Diagrams

*IND606, Duration: 30 minutes*

##### Summary:

This is the sixth lesson in the Electrical Print Reading Series. This lesson presents the different views used in electrical diagrams as well as how to identify components, cables, and conduits. The cable chart is also presented.

##### Topics:

1. Floor Plan View
2. Elevation View
3. Equipment, Cable, and Conduit Identification
4. Cable Charts

##### Objectives:

- Describe the floor plan view of an electrical diagram
- Describe the elevation view of an electrical diagram
- Identify components in a building electrical diagram
- Identify cables and conduits in a building electric diagram
- Identify the cable chart in a building electrical diagram

*Audience: All employees and employers*  
*Primary Regulations: None*  
*Related Regulations: None*  
*Prerequisites: Introduction to Electrical Diagrams*

## Single-Line Electrical Diagrams

*IND607, Duration: 30 minutes*

### Summary:

This is the seventh lesson in the Electrical Print Reading Series. This lesson presents information regarding how to identify loads, equipment, and isolation breakers on a single-line electrical diagram.

### Topics:

1. Voltage Conventions
2. Symbology
3. Loads
4. Isolation Breakers

### Objectives:

- Explain the purpose of single-line diagrams
- Identify voltage conventions in a single-line diagram
- Identify symbology in a single-line diagram
- Identify loads in a single-line diagram
- Identify isolation breakers in a single-line diagram

*Audience: All employees and employers*  
*Primary Regulations: None*  
*Related Regulations: None*  
*Prerequisites: Introduction to Electrical Diagrams*

## Wiring Diagrams

*IND608, Duration: 30 minutes*

### Summary:

This is the final lesson in the Electrical Print Reading Series. The lesson presents information how to identify components, equipment, wires and cables on a wiring diagram. It also explains how to relate a wiring diagram to the installed hardware and how to use diagrams for maintenance and troubleshooting problems.

### Topics:

1. Components
2. Terminal and Wiring Conventions
3. Wiring Bundles
4. Relation to Actual Hardware and Wires
5. Troubleshooting with Wiring Diagrams

### Objectives:

- Identify components in a wiring diagram
- Identify terminal conventions in a wiring diagram
- Identify wiring conventions in a wiring diagram
- Identify and interpret bundles in a wiring diagram
- Relate the wiring diagram to actual hardware
- Relate the wiring diagram to actual wires
- Troubleshoot a circuit using wiring diagram

*Audience: All employees and employers*  
*Primary Regulations: None*  
*Related Regulations: None*  
*Prerequisites: Introduction to Electrical Diagrams*

## Electrical Safety Series

Eight individual lessons make up the Electrical Safety Series. The Electrical Safety Series was specifically developed for employees in all disciplines that require knowledge in basic electrical safety awareness. Each lesson is a self-paced comprehensive training program, and is divided into individual topic areas.

### Working Safely with Electricity

*IND701, Duration: 30 minutes*

#### Summary:

This is the first lesson in the Electrical Safety Series. This lesson forms the foundation for the other lessons in Electrical Safety Series. The lesson explains safe work habits and basic safety rules that should be used when working around electricity. The importance of safely using circuits, the dangers of static electricity and the methods used to control it, is discussed. The use of fire extinguishers and how to identify the correct type of fire extinguisher to use on an electrical fire is also presented.

#### Topics:

1. Electricity and Safe Work Habits
2. Work Safety
3. Overloading a Circuit
4. Basic Safety Rules
5. Static Electricity and Bonding
6. Electrical Fire

#### Objectives:

- Describe the need to make electrical safety habits second nature
- Describe the safe loading of circuits
- List basic rules when working around electricity
- Describe the dangers of static electricity
- Describe the methods for controlling static electricity
- Identify the correct type of fire extinguisher to use on an electrical fire

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

### Electrical Circuits and Supplies

*IND702, Duration: 30 minutes*

#### Summary:

This is the second lesson in the Electrical Safety Series. This lesson explains the relationship between voltage, current and resistance. It also demonstrates the correct method for selecting, inspecting, and handling extension cords and portable electric hand tools, and the purpose of ground fault interrupters is explained.

#### Topics:

1. Extension Cords
2. Ground Fault Interrupters (GFI)
3. Portable Power Tools
4. Mobile Equipment
5. Electrical Circuits

#### Objectives:

- Describe how voltage, current, and resistance are related
- Identify safety considerations when using an extension cord
- Select the correct extension cord by rating
- Demonstrate the correct method of inspecting and handling extension cords
- Identify the proper procedure for inspecting portable electric hand tools
- Define the purpose of a Ground Fault Interrupter (GFI)
- Describe the proper procedure for operating mobile equipment around energized circuits

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Working Safely with Electricity, is recommended.*

## Electrical Shock

*IND703, Duration: 30 minutes*

### Summary:

This is the third lesson in the Electrical Safety Series. This lesson describes the effects electrical current has on the human body. Proper methods of removing a victim from an energized circuit are discussed. Who is "qualified" to perform a particular task and alerting techniques are introduced.

### Topics:

1. Cause of Electrical Shock
2. Preventing Shock
3. De-energizing Energy Sources
4. Removing a Victim from a Circuit

### Objectives:

- Describe how accidental electric shock can occur
- Describe the affects various amounts of current have on the human body
- Identify the factors that influence body resistance to electric shock
- Describe how various current paths through the body affect the severity of an electric shock
- Describe how the amount of time spent in contact with an electrical circuit will affect the severity of an electric shock
- Identify alerting techniques warning of electrical hazards
- Describe the need to lock and tag a de-energized circuit before working on the circuit
- Describe who is "Qualified" according to OSHA
- Identify proper methods of removing a victim from an energized circuit

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Working Safely with Electricity, is recommended.*

## Electrical Personal Protective Equipment

*IND704, Duration: 30 minutes*

### Summary:

This is the fourth lesson in the Electrical Safety Series. This lesson defines personal protective equipment. The need for various alerting techniques, barriers, and attendants, and their roles is discussed, as well as the importance of following safe work habits. In addition, the lesson reinforces the requirements for being "qualified" for a particular task introduced in lesson 3, Electrical Shock.

### Topics:

1. What is PPE?
2. Who is Qualified?
3. Safe Work Practices
4. Alerting Techniques

### Objectives:

- Define PPE
- Follow safe work habits
- Identify and use alerting techniques
- Properly use barriers
- Identify the need for an attendant
- Identify the requirements for being "Qualified"

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lessons: Working Safely with Electricity and Electrical Shock, is recommended.*

## Protective Gloves and Sleeves

*IND705, Duration: 30 minutes*

### Summary:

This is the fifth lesson in the Electrical Safety Series. This lesson discusses the types and classes of protective gloves and sleeves used when working around electricity. The lesson identifies the proper practices for inspecting, repairing, wearing, and maintaining gloves and sleeves.

### Topics:

1. Gloves and Sleeves
2. Class and Type, Inspection
3. Repair and Testing
4. Wearing Gloves and Sleeves
5. Care of Gloves and Sleeves

### Objectives:

- Describe the hazards for which gloves should be worn and the factors to consider when selecting gloves
- Identify proper practices for inspecting gloves and sleeves prior to use
- Identify proper practices for repairing gloves and sleeves
- Identify proper practices for wearing gloves and sleeves
- Identify proper practices for caring for gloves and sleeves

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Working Safely with Electricity, is recommended.*

## Eye and Face Protection

*IND706, Duration: 30 minutes*

### Summary:

This is the sixth lesson in the Electrical Safety Series. This lesson explains the importance of eye and face protection, as well as the proper practices for its inspections, care, and wear.

### Topics:

1. Eye and Face Protection
2. Inspection of Eye and Face Protection
3. Care of Eye and Face Protection

### Objectives:

- Identify approved protective eyewear and the types of hazards for which it offers protection
- Identify proper practices for putting on and taking off protective eyewear
- Identify proper practices for inspecting protective eyewear
- Identify proper practices for caring for protective eyewear

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Working Safely with Electricity, is recommended.*

## Protective Helmets

*IND707, Duration: 30 minutes*

### Summary:

This is the seventh lesson in the Electrical Safety Series. This lesson explains the protection provided by helmets, and the proper methods of inspection, wearing, and maintaining a helmet.

### Topics:

1. Protective Helmets
2. Inspection
3. Wearing the Helmet
4. Care of the Helmet

### Objectives:

- Explain the protection provided by helmets

- Identify the level of protection offered by Class A and Class B helmets
- Identify proper methods for inspecting a helmet
- Identify proper methods for wearing a helmet
- Identify proper methods for maintaining a helmet

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Working Safely with Electricity, is recommended.*

## General Protective Equipment

*IND708, Duration: 30 minutes*

### Summary:

This is the eighth lesson in the Electrical Safety Series. This lesson presents information about safeguards, other than Personal Protective Equipment worn on the body, used when working with or around electricity. Inspection, repair, and care of general protective equipment, and proper use of this equipment are presented.

### Topics:

1. Introduction to General Protective Equipment
2. Line Covers and Blankets
3. Inspection, Repair and Care of Rubber Insulation
4. Matting
5. Insulated Tools
6. Ropes and Hand lines

### Objectives:

- Identify safeguards other than PPE worn on the body
- Identify proper methods for using rubber insulating equipment such as line protectors, covers, and blankets
- Identify proper uses of matting
- Identify the safety features provided by insulating tools and how to use them properly
- Identify proper methods for using fuse pullers
- Identify proper methods for using barriers
- Identify proper methods for using ropes and hand lines

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Working Safely with Electricity, is recommended.*

## Electrical Theory for Troubleshooters Series

This series consists of 12 interactive, on-line lessons. These lessons are excellent for the training of electricians and electronic technicians as well as for the multi-craft training needs of process and manufacturing facilities. The first four lessons in this series cover basic electrical concepts including Ohm's Law and Kirchhoff's Law, as well as the use of these laws to determine voltage, current, and resistance in series and parallel circuits.

### Introduction to Electricity

*IND801, Duration: 30 minutes*

#### Summary:

This is the first lesson in the Electrical Theory for Troubleshooters Series. This lesson uses animation to demonstrate atomic structure, electricity, and how a simple circuit operates. The lesson also explains the characteristics of good conductors and insulators.

#### Topics:

1. Atomic Structure
2. What is Electricity?
3. Conductors and Insulators

#### 4. Circuits

##### Objectives:

- Describe the atomic structure of matter
- Describe the characteristics of good conductors and insulators
- Define electricity
- Describe how a simple circuit operates

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

### Basic Electrical Properties

*IND802, Duration: 30 minutes*

##### Summary:

This is the second lesson in the Electrical Theory for Troubleshooters Series. This lesson covers Ohm's Law, as well as the use of Ohm's Law to calculate an unknown value. The lesson also defines voltage, current, resistance, and power.

##### Topics:

1. Voltage
2. Current
3. Resistance
4. Ohm's Law
5. Power

##### Objectives:

- Define voltage
- Define current
- Define resistance
- Describe voltage and current relationships
- State Ohm's Law
- Use Ohm's Law to calculate an unknown value
- Define power and how to use power values with Ohm's Law

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Completion of the lesson, Introduction to Electricity, is recommended.*

### Series Circuits

*IND803, Duration: 30 minutes*

##### Summary:

This is the third lesson in the Electrical Theory for Troubleshooters Series. The lesson presents the operation of a series circuit and trains participants in the identification of simple schematic symbols used to represent components in a series circuit. The behavior of current, resistance, and current in a series circuit, and the used of Kirchhoff's Voltage Law to find total voltage are also covered.

##### Topics:

1. Series Circuit Operation
2. Schematic Symbols
3. Series Resistance
4. Voltage Drop
5. Kirchhoff's Law
6. Troubleshooting

##### Objectives:

- Define a series circuit
- Properly identify simple schematic symbols for a battery, switch, lamp, resistor, and conductor
- Describe how current and resistance behave in a series circuit

- Describe how voltage behaves in a series circuit
- Use Kirchoff's Voltage Law to find total voltage in a series circuit

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Basic understanding of electrical circuits and a solid understanding of Ohm's law is recommended.*

## Parallel Circuits

*IND804, Duration: 30 minutes*

### Summary:

This is the fourth lesson in the Electrical Theory for Troubleshooters Series. This lesson describes the behavior of voltage, current, and resistance in a parallel circuit. The learner is also instructed in the identification of the series and parallel portions of a series-parallel circuit.

### Topics:

1. Voltage in Parallel Circuits
2. Current in Parallel Circuits
3. Resistance in Parallel Circuits
4. Series - Parallel Circuits

### Objectives:

- Describe how voltage and current behave in a parallel circuit
- Describe how resistance behaves in a parallel circuit
- Identify the series portions of a series-parallel circuit
- Identify the parallel portions of a series-parallel circuit
- Simplify a series-parallel circuit to determine how voltage, current and resistance behave

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Understanding Ohm's Law, Kirchoff's Law, and series circuits are recommended.*

## Alternating Current

*IND805, Duration: 30 minutes*

### Summary:

This is the fifth lesson in the Electrical Theory for Troubleshooters Series. This lesson teaches the basic AC characteristics of voltage, including how voltage changes over time. The participant is also instructed in using sine waves to interpret the frequency of AC voltage.

### Topics:

1. Overview
2. Polarity and Magnitude
3. Sine Wave
4. Frequency
5. Troubleshooting

### Objectives:

- State the basic operating AC Characteristics of voltage
- Explain how AC voltage changes over time
- Define sine wave and cycle
- Interpret the frequency of AC voltage using a sine wave
- Explain RMS voltage vs. peak voltage

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: This lesson was designed for participants familiar with Ohm's Law.*

## Electromagnetism

*IND806, Duration: 30 minutes*

### Summary:

This sixth lesson in the Electrical Theory for Troubleshooters Series uses animations and demonstrations to explain the principles of magnetism, including flux density and electromagnetic induction. The lesson also shows how to plot a sine wave using a graph.

### Topics:

1. Understanding Magnetism
2. Principles of Magnetism
3. Flux Density
4. Electromagnetic Induction
5. Induced Voltage Sine Wave

### Objectives:

- Describe the principles of magnetism
- Describe flux and flux density
- Describe how electromagnetic induction takes place
- Describe how a magnetic field is generated by passing current through a conductor
- Plot a sine wave using a graph

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: This lesson was designed for participants familiar with AC characteristics.*

## Inductance

*IND807, Duration: 30 minutes*

### Summary:

This is the seventh lesson in the Electrical Theory for Troubleshooters Series. This lesson builds on the information presented in the lesson, Electromagnetism. Types of induction, phase, and the effect of induction in AC circuits are covered.

### Topics:

1. Current Flow
2. Self-Inductance & Mutual Induction
3. Coils - Mutual Induction
4. Transformer Induction
5. Transformer Taps
6. Effect of Inductance & Phase Relationships

### Objectives:

1. Describe how a magnetic field is generated by passing current through a conductor
2. Explain self-induction
3. Explain counter-electromagnetic field
4. Describe how current is induced in a coil-type conductor
5. Explain mutual induction
6. Explain the principle of transformer function
7. Explain the function of a tap in transformer construction
8. Describe the effect of inductance in AC circuits

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: This lesson was designed for participants familiar with alternating current and electromagnetism.*

## Capacitance

*IND808, Duration: 30 minutes*

### Summary:

This is the eighth lesson in the Electrical Theory for Troubleshooters Series. This lesson explains capacitors, their function, and how capacitance affects AC circuits.

### Topics:

1. Capacitor-Defined
2. Charging a Capacitor
3. Discharging a Capacitor
4. Effects of Capacitance

**Objectives:**

- Define capacitance and identify its schematic symbol
- Explain how a capacitor becomes charged
- Explain how a capacitor becomes discharged
- Explain how capacitance affects AC circuits

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: This lesson was designed for participants familiar with alternating current, electro-magnetism, and induction.*

### Three-Phase AC Circuits

*IND809, Duration: 30 minutes*

**Summary:**

This is the ninth lesson in the Electrical Theory for Troubleshooters Series. This lesson defines 3-phase AC, describes the components and operating principle of 3-phase generators, and using the formula for frequency, shows how rotor speed and the number of poles is related to frequency.

**Topics:**

1. Definition of 3-Phase
2. 3-Phase Generators
3. 3-Phase Sine Wave
4. Frequency

**Objectives:**

- Define 3phase AC
- Differentiate between 3phase and 1phase AC
- Describe the components and operating principle of a 3phase generator
- Use a sine wave to show how 3phase voltage changes over time
- Explain the relationship between frequency and rotor speed
- State and apply the formula for frequency
- Describe how rotor speed and the number of poles related to frequency

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: The lesson requires a fundamental knowledge of electrical theory and technology.*

### Wye and Delta Connections

*IND810, Duration: 30 minutes*

**Summary:**

The tenth lesson in the Electrical Theory for Troubleshooters Series, this lesson discusses Wye and Delta configurations and explains the relationship between phase and line voltages in various connections, and demonstrates the application of the formula that shows this relationship.

**Topics:**

1. 3-Wire Wye Configuration
2. 4-Wire Wye Configuration
3. Delta Configuration

**Objectives:**

- Describe the relationship between phase and line voltages in a 3wire wye connection
- Describe the relationship between phase and line voltages in a 4wire wye connection
- Describe the relationship between phase and line currents in a delta connection
- Calculate power in a 3phase load

- Apply the formula that shows the relationship between phase and line currents in a 3wire wye connection
- Apply the formula that shows the relationship between phase voltage and single-phase load voltage in a 4wire wye connection
- Describe the relationship between phase and line voltages in a delta connection

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: The lesson requires a fundamental knowledge of electrical theory and technology. Basic knowledge of 3-phase circuits is recommended.*

## Introduction to Transformers

*IND811, Duration: 30 minutes*

### Summary:

The eleventh lesson in the Electrical Theory for Troubleshooters Series, this lesson presents the basic parts of a transformer and their function. The lesson explains turns ratio and its relationship to a transformer's input and output voltages. The participant is also cautioned regarding the dangers of improper transformer connections.

### Topics:

1. Transformer Parts
2. Turns Ratio
3. Avoiding Improper Connections

### Objectives:

- Identify and describe the functions of the basic transformer parts
- Explain the relationship between a transformer's turns ratio and its input and output voltages
- Describe the danger in reversing or stepping up the voltage

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: The lesson requires a fundamental knowledge of electrical theory and technology.*

## Transformers

*IND812, Duration: 30 minutes*

### Summary:

This is the final lesson in the Electrical Theory for Troubleshooters Series. This lesson builds on the information presented in the lesson, Introduction to Transformers. How to determine primary current and voltage, secondary current and voltage, and load is taught. The function of various transformers is also explained.

### Topics:

1. Determining Secondary Current
2. Determining Power
3. Determining Primary Current
4. 3 Phase Transformers
5. Multi-tap and Autotransformers

### Objectives:

- Given the secondary voltage and load, determine the primary current
- Given the primary voltage and load, determine the secondary current
- Given the turns ratio and voltage and current from either the primary or secondary, determine the power
- Given power and primary voltage, determine primary current
- Given primary voltage, determine secondary voltage in a 3phase transformer
- Describe the configuration of a 3phase transformer
- State some applications and maintenance precautions for a 3phase transformer
- Explain the functions and uses of multi-tap transformer and autotransformers

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: The lesson requires a fundamental knowledge of electrical theory and technology. Completion of the lesson, Introduction to Transformers, is required.*

## Limit Switches Series

This series consists of four lessons designed to provide training for the multi-craft training needs of process and manufacturing facilities.

### Overview

*IND901, Duration: 30 minutes*

#### Summary:

This is the first lesson in the Limit Switches Series. This lesson describes limit switches, how they work, how to recognize them, and typical applications in which they are used.

#### Topics:

1. Purpose and Function
2. Types of Limit switches
3. Safety Consideration
4. Replacement Compatibility

#### Objectives:

- Define the purpose, function, and types of limit switches
- Explain and visually identify each of the limit switches
- Describe safety considerations when working with limit switches
- Know how to ensure that a replacement switch will work correctly

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

### Lever-Actuated

*IND902, Duration: 30 minutes*

#### Summary:

This is the second lesson in the Limit Switches Series. This lesson describes limit switches, how they work, how to recognize them, and typical applications they are used in.

#### Topics:

1. Function Possible
2. Malfunctions
3. Maintenance and Troubleshooting

#### Objectives:

- Describe the internal function of a lever-actuated limit switch and its function in a control circuit
- Maintain, troubleshoot, repair, and adjust a lever-actuated limit switch
- Describe the possible malfunctions of a lever-actuated limit switch

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of limit switches. Completion of the lesson, Limit switches: Overview.*

### Solid State

*IND903, Duration: 30 minutes*

#### Summary:

This is the third lesson in the Limit Switches Series. This lesson describes solid state limit switches, how they work, how to recognize them, and typical applications in which they are used.

#### Topics:

1. Photoelectric switches
2. Proximity switches
3. Function in a Circuit
4. Possible Malfunctions
5. Troubleshooting and Repair
6. Adjustment

**Objectives:**

- Describe the function of solid state limit switches
- Maintain, troubleshoot, repair, and adjust solid state limit switches
- Describe the possible malfunctions of solid state limit switches

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of limit switches. Completion of the lesson, Limit switches: Overview.*

## Torque and Geared

*IND904, Duration: 30 minutes*

**Summary:**

This is the final lesson in the Limit Switches Series. This lesson describes geared limit switches and torque switches. This lesson also discusses maintenance, troubleshooting, and adjustment requirements for these switches.

**Topics:**

1. Internal Function
2. Function in a Circuit
3. Malfunctions and Maintenance
4. Troubleshooting and Repair
5. Adjustment

**Objectives:**

Explain the internal function of a geared limit switch and torque switch in a control circuit

Maintain, troubleshoot, repair, and adjust solid state limit switches

Describe the possible malfunctions of a geared limit switch and torque switch

Troubleshoot, maintain and repair these switches

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lesson: Limit switches: Overview is recommended.*

## Multimeters Series

This series consists of 5 interactive, on-line lessons. These lessons take approximately 30 to 45 minutes to complete. These lessons were designed to provide training for persons working with electrical or electronic test equipment. These lessons present general information about multimeters.

### Digital Multimeters

*IND2101, Duration: 30 minutes*

**Summary:**

This is the first lesson in the Multimeters Series. The lesson presents the types of multimeters. The lesson describes the display area, function switch, and leads and jacks on a digital multimeter.

**Topics:**

1. Types of Multimeters
2. Digital Display
3. Function Switch
4. Leads and Connectors

## 5. Special Feature Buttons

### Objectives:

- Identify and describe the display area of a digital multimeter
- Identify and describe the function **switch** on a digital multimeter
- Identify and describe the leads/jacks on a digital multimeter

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Analog Multimeters

*IND2102, Duration: 30 minutes*

### Summary:

This is the second lesson in the Multimeters Series. This lesson demonstrates various aspects of an analog multimeter, including how to adjust mechanical zero, how to interpret a reading on the voltage and resistance scales, and how to set the function and range switches.

### Topics:

1. Zeroing
2. Range Switch
3. Voltage Scales
4. Measuring Resistance
5. Zero Ohms Adjust
6. Summary

### Objectives:

- Adjust the mechanical zero of an analog multimeter
- Interpret a reading on the voltage scale of an analog multimeter
- Interpret a reading on the resistance scale of an analog multimeter
- Given an expected measurement, set the function and range switches of an analog multimeter
- Adjust the zero on the ohms scale of an analog multimeter

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Multimeter Selection and Inspection

*IND2103, Duration: 30 minutes*

### Summary:

This is the third lesson in the Multimeters Series. This lesson trains the learner in the inspection of a multimeter, the steps that should be taken before using a multimeter, and how to perform a continuity check.

### Topics:

1. Inspection and Safety
2. Continuity Check
3. Electrical Measurements

### Objectives:

- Identify the steps in inspecting a multimeter
- List the steps you should take before using a multimeter
- Define continuity
- Perform a continuity check

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Review of the lessons Digital Multimeters and Analog Multimeters is recommended.*

## Using Multimeters

IND2104, Duration: 30 minutes

### Summary:

This is the fourth lesson in the Multimeters Series. This lesson trains the learner to use a multimeter to measure resistance, AC voltage, DC voltage, current, frequency, and capacitance.

### Topics:

1. Interpreting a Voltage Reading
2. Measuring Resistance
3. Voltage Measurement
4. Measuring AC and DC Voltage
5. Testing Current
6. Frequency and Capacitance

### Objectives:

- Use a multimeter to measure resistance
- Measure AC voltage using a multimeter
- Measure DC voltage using a multimeter
- Use a multimeter to measure current
- Use a multimeter to measure frequency
- Use a multimeter to measure capacitance

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of multimeter components and continuity checks is recommended.*

## Advanced Features of Digital Multimeters

IND2105, Duration: 30 minutes

### Summary:

The final lesson in the Multimeters Series, this lesson instructs the participant in the use of the advanced features of digital multimeters.

### Topics:

1. Hold
2. Relative
3. Range
4. Min/Max

### Objectives:

- Describe and use the hold button on a digital multimeter
- Describe and use the relative button on a digital multimeter
- Describe and use the range button on a digital multimeter
- Describe and use the min/max button on a digital multimeter
- Explain when the shift button is used

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of basic multimeter inspection and use is recommended.*

## Oscilloscopes Series

Nine individual lessons make up Oscilloscopes Series. These lessons were designed for the training of electricians and electronic technicians as well as for the multi-craft training needs of process and manufacturing facilities.

## Introduction to Oscilloscopes

*IND1001, Duration: 30 minutes*

### Summary:

This is the first lesson in the Oscilloscopes Series. This lesson explains the purpose of oscilloscopes, introduces waveforms, and presents analog and digital oscilloscope systems using a flowchart.

### Topics:

1. Purpose of Oscilloscopes
2. Introduction to Waveforms
3. Analog Oscilloscopes
4. Digital Oscilloscopes

### Objectives:

- Define the purpose of an oscilloscope
- List some of the uses of an oscilloscope
- Explain the vertical and horizontal axes of a waveform represent
- List what can be learned about a signal from a waveform
- Recognize the positive and negative peaks on a waveform
- Name and describe the purpose of an analog oscilloscope's systems using a flowchart
- Name and describe the purpose of a digital oscilloscope's systems using a flowchart

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A basic understanding of electronic devices and circuits is recommended*

## The Display

*IND1002, Duration: 30 minutes*

### Summary:

This is the second lesson in the Oscilloscopes Series. This lesson explains the functions of the display and display controls on an analog and digital oscilloscope. The lesson also explains how divisions are used.

### Topics:

1. Display Controls
2. Analog Scope Display
3. Digital Scope Display
4. Divisions

### Objectives:

- Explain the functions of an analog oscilloscope's display controls
- Explain the functions of a digital oscilloscope's display controls
- Explain how divisions are used

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A basic understanding of electronic devices and circuits and Review of the lesson: Introduction to Oscilloscopes is recommended.*

## Vertical System Controls

*IND1003, Duration: 30 minutes*

### Summary:

This is the third lesson in the Oscilloscopes Series. This lesson explains the vertical system controls on analog and digital oscilloscopes.

### Topics:

1. Vertical System Controls
2. Analog Scope Vertical System Controls
3. Digital Scope Vertical System Controls

### Objectives:

- Explain the function of the oscilloscope vertical controls

- Explain the vertical system controls of an analog oscilloscope
- Explain the vertical system controls of a digital oscilloscope

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A basic understanding of electronic devices and circuits and Review of the lessons: Introduction to Oscilloscopes, and This Display, is recommended.*

## Horizontal System Controls

*IND1004, Duration: 30 minutes*

### Summary:

This is the fourth lesson in the Oscilloscopes Series. This lesson explains the horizontal system controls on analog and digital oscilloscopes.

### Topics:

1. The Horizontal System
2. Horizontal Controls
3. Analog Scope Horizontal System Controls
4. Digital System Horizontal System Controls

### Objectives:

- Explain the function of an oscilloscope's horizontal system
- Explain the function of an oscilloscope's horizontal controls
- Explain the function of an analog oscilloscope's horizontal system controls
- Explain the function of a digital oscilloscope's horizontal system controls

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A basic understanding of electronic devices and circuits and Review of the lessons: Introduction to Oscilloscopes, This Display, and Vertical System Controls, is recommended.*

## The Trigger System

*IND1005, Duration: 30 minutes*

### Summary:

This is the fifth lesson in the Oscilloscopes Series. This lesson explains the functions and controls of the trigger system on analog and digital oscilloscopes.

### Topics:

1. Trigger Controls
2. Hold-off
3. Digital Trigger System

### Objectives:

- Describe the function of an oscilloscope's trigger system
- Describe the controls of an oscilloscope's trigger system

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A basic understanding of electronic devices and circuits and Review of the lesson: Introduction to Oscilloscopes and knowledge of the vertical and horizontal systems is recommended.*

## Probes

*IND1006, Duration: 30 minutes*

### Summary:

This is the sixth lesson in the Oscilloscopes Series. This lesson explains the purpose and use of probes, and trains the participant to match the probe/scope combination to the application.

### Topics:

1. Purpose of Probes
2. 10x Attenuator Probe
3. Types of Probes

#### 4. Scope & Probe Selection

##### Objectives:

- Explain the reason for probe compensation
- Describe other common probe types
- Describe the applications of common probe types
- Match a probe/scope combination to the application

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A basic understanding of electronic devices and circuits and Review of the lesson: Introduction to Oscilloscopes is recommended.*

## Setup

*IND1007, Duration: 30 minutes*

##### Summary:

This is the seventh lesson in the Oscilloscopes Series. This lesson trains the participant to safely setup an oscilloscope for use, how to adjust the controls, and compensate the probe.

##### Topics:

1. Adjust Display Controls
2. Adjust Trigger Settings
3. Adjust Vertical and Horizontal Controls
4. Probe Compensation

##### Objectives:

- Describe the safety rules related to using an oscilloscope
- Adjust the display controls on an oscilloscope
- Adjust the trigger controls to display a given waveform
- Adjust the vertical and horizontal controls to display a given waveform
- Compensate the probe

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A basic understanding of electronic devices and circuits and familiarity with oscilloscope control systems and probe types is recommended.*

## Waveforms

*IND1008, Duration: 30 minutes*

##### Summary:

This is the eighth lesson in the Oscilloscopes Series. This lesson teaches participants to recognize the various waveform types and how to analyze waveforms.

##### Topics:

1. Waveform Types
2. Analyzing Waveforms

##### Objectives:

- Identify a sine waveform
- Identify a square waveform
- Identify a rectangular waveform
- Identify a sawtooth waveform
- Identify a triangle waveform
- Identify a pulse signal
- Identify a step signal
- Identify a complex waveforms
- Explain what factors influence differences between source documentation of signals and displayed signals

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A basic understanding of electronic devices and circuits and familiarity with the various oscilloscope functions, probes, and controls is required.*

## Measurement

*IND1009, Duration: 30 minutes*

### Summary:

This is the final lesson in the Oscilloscopes Series. This lesson teaches how to determine various measurements taken with an oscilloscope.

### Topics:

1. Voltage
2. Period and Frequency
3. Rise time
4. Pulse Width
5. Phase Shift

### Objectives:

- Measure voltage using a waveform
- Measure the period and frequency of a waveform
- Define pulse rise time and pulse width
- Measure rise time
- Measure pulse width
- Measure phase shift

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A basic understanding of electronic devices and circuits and familiarity with the various oscilloscope functions, probes, and controls, as well as knowledge of waveform types is required.*

## Troubleshooting Skills: Developing Logical Thinking Series\*

This series teaches strategic troubleshooting skills that can be applied to the analysis of problems in any type of industrial system. The series teaches participants how to develop logical thinking and create a personal troubleshooting outlook that will prove valuable under any troubleshooting situation.

*\*This entire series is also included in the Industrial/Mechanical Library.*

## Introduction to Troubleshooting

*IND1101, Duration: 30 minutes*

### Summary:

This is the first lesson in the Troubleshooting Skills: Developing Logical Thinking Series. This lesson defines root cause problem solving and troubleshooting. The lesson also describes the basic steps in a general troubleshooting procedure.

### Topics:

1. Root Cause Problem Solving
2. Definition of Troubleshooting
3. Developing a Logical Plan

### Objectives:

- Define root cause problem solving
- Define troubleshooting
- Describe the basic steps involved in a general troubleshooting procedure

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Information Gathering

*IND1102, Duration: 30 minutes*

### Summary:

This is the second lesson in the Troubleshooting Skills: Developing Logical Thinking Series. This lesson presents the steps involved in interviewing and researching to obtain information about a malfunctioning system and the importance of investigating the normal operation and history of the system. The relationship between symptom and cause is also explained.

### Topics:

1. Investigate - Interview
2. Investigate - Inspect
3. Research - Technical Manuals
4. Research - Maintenance Records
5. Symptoms

### Objectives:

- Describe how to obtain information about a malfunctioning system
- Explain the importance of comparing the symptoms of a problem to the characteristics for normal operation
- Describe sources of information concerning normal operations
- Describe sources of information concerning the background of a problem
- State the relationship between a symptom and a cause

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Introduction to Troubleshooting*

## Troubleshooting

*IND1103, Duration: 30 minutes*

### Summary:

This is the third lesson in the Troubleshooting Skills: Developing Logical Thinking Series. This lesson teaches participants to develop a troubleshooting plan to evaluate problems. The importance of schematics in troubleshooting, steps necessary to repair the problems, and prevention of future trouble is discussed.

### Topics:

1. Evaluation
2. Using Schematics to Troubleshoot
3. Repairs
4. Documentation and Preventive Measures

### Objectives:

- Describe how to develop a troubleshooting plan
- Describe the importance of using schematics while troubleshooting
- Describe steps necessary to repair the problem

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Information Gathering.*

## Improving Skills

*IND1104, Duration: 30 minutes*

### Summary:

This is the final lesson in the Troubleshooting Skills: Developing Logical Thinking Series. This lesson uses the information taught in the previous lessons in the library to assist in improving the learner's troubleshooting skills. The learner will be instructed in the steps needed to prevent future trouble, what is required when it is necessary to troubleshooting under pressure, and the importance of gaining troubleshooting experience.

### Topics:

1. Analyzing the Root Cause
2. Troubleshooting Under Pressure
3. Developing a Troubleshooting Outlook

**Objectives:**

- Describe steps that can be taken to prevent future trouble
- Explain the importance of a troubleshooting outlook
- Describe how to troubleshoot under pressure
- Describe the importance of experience in troubleshooting

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Information Gathering and Troubleshooting.*

## Office Security Series\*

This series consists of 1 interactive, on-line lesson. This lesson was designed to provide training for anyone using computers in the workplace. This lesson will provide some practical measures to help protect your computer system from threats that may harm it.

*\*This series is also included in the Industrial/Mechanical Library.*

### Office Security

*IND2000, Duration: 30 minutes*

**Summary:**

Office Computer Data Security lesson was designed to provide training for anyone using computers in the workplace. This lesson will provide some practical measures to help protect your computer system from threats that may harm it.

**Topics:**

1. Introduction
2. Your Data
3. Handling Sensitive Data
4. Your Equipment
5. System Access
6. Laws and Policies

**Objectives:**

- Explain how to protect your computer system resources.
- Explain how to comply with appropriate use policies.
- Explain how to react to a security violation.
- Explain monitoring and auditing.
- Explain how to comply with copyright laws.

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Bearings Series

This series contains three lessons which will take 30 to 45 minutes each to complete.

### Introduction to Bearings

*IND1201, Duration: 30 minutes*

#### Summary:

This lesson was designed for employees in all disciplines as well as for the multi-craft training needs of process and manufacturing facilities. The lesson describes the purpose and the basic components of bearings. The lesson also introduces the identification and proper usage of bearing types.

#### Objectives:

- Describe bearings and their importance in machinery operation
- Introduce the concept of load and how it effects bearings
- Explain the purpose of housings
- Explain the use of PLAIN bearings
- Explain the use of ANTIFRICTION bearings
- Explain the use of THRUST bearings

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

### Analyzing Bearing Failure

*IND1202, Duration: 30 minutes*

#### Summary:

This lesson explains the purpose of bearings and demonstrates how bearings reduce friction and maintain the alignment of operating equipment. The basic operation of anti-friction bearings and plain journal bearings is demonstrated as well as the importance of full fluid film lubrication and proper lubrication clearance. Additionally, indications of various premature bearing failures are discussed.

#### Objectives:

- Dismount antifriction bearings using a bearing press and/or a bearing puller
- Inspect the bearing for signs of failure
- Clean the shaft and check for taper and out-of-round using the proper measuring instruments
- Clean the housing and check for damage
- Select the proper bearing for replacement, if necessary
- Properly orient a bearing prior to installation
- Mount a bearing using an induction heater and/or an arbor press
- Measure the bearings inner and outer clearances during installation
- Properly lubricate bearings per manufacturer's recommendations

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

### Maintaining Bearings

*IND1203, Duration: 30 minutes*

#### Summary:

This lesson explains and demonstrates how to clean and disassemble bearing housings and how to dismount, inspect, and mount common types of bearings. The importance of cleanliness and following manufacturers' instructions are stressed throughout each demonstrated procedure.

#### Objectives:

- Dismount antifriction bearings using a bearing press and/or a bearing puller
- Inspect the bearing for signs of failure

- Clean the shaft and check for taper and out-of-round using the proper measuring instruments
- Clean the housing and check for damage
- Select the proper bearing for replacement, if necessary
- Properly orient a bearing prior to installation
- Mount a bearing using an induction heater and/or an arbor press
- Measure the bearing's inner and outer clearances during installation
- Properly lubricate bearings per manufacturers' recommendations
- Measure the bearing's inner and outer clearances during installation
- Properly lubricate bearings per manufacturers' recommendations

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Centrifugal Pump Repair Series

This series consists of six lessons. This series is designed for all levels of maintenance personnel as well as for the multi-craft training needs of process and manufacturing facilities. Participants should be familiar with the basic operation of centrifugal pumps.

### Troubleshooting Excessive Leakage

*IND1301, Duration: 30 minutes*

#### Summary:

This is the first lesson in the Centrifugal Pump Repair Series. This lesson introduces the components and operating principles of a typical centrifugal pump. Normal operating conditions for the pump are described and guidelines for troubleshooting excessive leakage are provided.

#### Topics:

1. Sealing Surfaces
2. Packing
3. The Lantern Ring
4. Mechanical Seals
5. Troubleshooting the Leak

#### Objectives:

- Identify and describe the sealing surfaces on a centrifugal pump
- Explain the purpose and conditions under which packing would be used
- Explain the purpose of the lantern ring
- Explain the purpose and conditions under which a mechanical seal would be used
- Explain how to determine whether centrifugal pump leakage is excessive
- Recognize causes and symptoms of excessive leakage

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Participants should be familiar with the basic operation of centrifugal pumps.*

### Troubleshooting Excessive Temperature

*IND1302, Duration: 30 minutes*

#### Summary:

This is the second lesson in the Centrifugal Pump Repair Series. This lesson introduces the components and operating principles of a typical centrifugal pump. Normal operating conditions for the pump are described and guidelines for troubleshooting excessive temperature are provided.

#### Topics:

1. Flow through the Pump
2. Bearings
3. Operating Temperature

#### 4. Air Binding

##### Objectives:

- Explain the purpose of bearings in a centrifugal pump
- Explain how normal operating temperature is maintained in a centrifugal pump
- Recognize causes of symptoms of excessive temperature in a centrifugal pump
- Discuss causes of symptoms of excessive temperature in a centrifugal pump

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Completion of the lesson Troubleshooting Excessive Leakage is recommended.*

### Troubleshooting Loss of Capacity

*IND1303, Duration: 30 minutes*

##### Summary:

This is the third lesson in the Centrifugal Pump Repair Series. This lesson introduces the components and operating principles of a typical centrifugal pump. Normal operating conditions for the pump are described and guidelines for troubleshooting loss of capacity/loss of head are provided.

##### Topics:

1. Pressure and Flow Rate
2. Loss of Capacity and Loss of Head
3. Cavitation
4. Worn Components

##### Objectives:

- Explain how pressure and flow rate are affected by the system in which a pump operates
- Recognize and discuss causes of symptoms of loss of capacity/loss of head
- Explain what occurs during cavitation
- Explain the causes and symptoms of worn components

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Completion of the lesson Troubleshooting Excessive Temperature is recommended.*

### Disassembly

*IND1304, Duration: 30 minutes*

##### Summary:

This is the fourth lesson in the Centrifugal Pump Repair Series. This lesson demonstrates how to disassemble a typical end-suction pump. The locations and functions of pump components are described as well.

##### Topics:

1. Main Pump Components
2. Preparation for Disassembly
3. Disassembly

##### Objectives:

- Identify main components of a typical end suction pump
- Explain the function of the components of a typical end suction pump
- List and demonstrate the preparation for pump disassembly
- Disassemble a typical end suction pump

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: A familiarity with troubleshooting procedures as well as the proper use of hand tools and precision measuring instruments is required.*

## Inspection

*IND1305, Duration: 30 minutes*

### Summary:

This is the fifth lesson in the Centrifugal Pump Repair Series. This lesson demonstrates how to inspect a typical end-suction pump. The procedures for measuring and inspecting pump parts and the steps for checking impeller clearance are described.

### Topics:

1. Bearing Seat Diameter
2. Shaft Run-out
3. Impeller Inspection

### Objectives:

- Inspect the components of a centrifugal pump
- Measure the bearing seat on the shaft of a centrifugal pump
- Measure shaft run-out
- Recognize evidence of cavitation on an impeller
- Explain the importance noting measurements in a maintenance log

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Completion of the lesson Disassembly is required. Familiarity with troubleshooting procedures as well as the proper use of hand tools and precision measuring instruments is required.*

## Reassembly

*IND1306, Duration: 30 minutes*

### Summary:

This is the final lesson in the Centrifugal Pump Repair Series. This lesson demonstrates how to reassemble a typical end-suction pump. General guidelines for installing a mechanical seal are also provided.

### Topics:

1. Bearings and Shaft
2. End Plate
3. Impeller Installation
4. Impeller Clearance
5. Shims
6. Bearing Cover
7. Mechanical Seals

### Objectives:

- Reassemble a typical end suction pump
- Check impeller clearance
- Calculate the thickness of shims needed to correct impeller clearance
- Determine the gasket size needed in the bearing end cap
- Install a mechanical seal

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Completion of the lesson Inspection is required. Familiarity with troubleshooting procedures as well as the proper use of hand tools and precision measuring instruments is required. A familiarity with mechanical seals is recommended.*

## Hand Tools Series

This series consists of four lessons. This series is designed for employees in all disciplines as well as for the multi-craft training needs of process and manufacturing facilities. Upon completion of this lesson, participants will be able to improve their on-the-job performance through the proper use hand tools.

## Clamps, Vises, and Pliers

IND1401, Duration: 30 minutes

### Summary:

This is the first lesson in the Hand Tools Series. This lesson introduces and demonstrates the proper use of tools used for holding.

### Topics:

1. Tools Used for Holding
2. Vises
3. C-Clamps
4. Pliers

### Objectives:

- Describe three types of vises and explain when each type should be used
- Identify the basic components of a machinist's vise
- Explain how to use a c-clamp to hold an object
- Explain how to choose the right size c-clamp needed for a job
- Describe four types of pliers and explain how they are used
- List four things that should be done before using any tool: determine the correct tool for the job, inspect the tool for damage, ensure the tool is in good working order, and follow facility safety procedures

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Screwdrivers

IND1402, Duration: 30 minutes

### Summary:

This is the second lesson in the Hand Tools Series. This lesson introduces and demonstrates the proper use of screwdrivers.

### Topics:

1. Screwdrivers
2. Using a Screwdriver
3. Offset Screwdriver

### Objectives:

- Identify three types of screwdrivers
- Explain when each of the above three screwdrivers should be used
- Describe the damage that may be caused to a screw if the wrong size screwdriver is used
- Demonstrate the proper technique for inserting and removing a screw

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Wrenches

IND1403, Duration: 30 minutes

### Summary:

This is the third lesson in the Hand Tools Series. This lesson introduces and demonstrates the proper use of wrenches.

### Topics:

1. Non-Adjustable Wrenches
2. Socket Set
3. Torque Wrench
4. Adjustable Wrenches

### Objectives:

- Describe three basic types of nonadjustable wrenches and identify when each should be used

- Identify the components of a socket wrench set
- Assemble a socket wrench and use it to remove a bolt
- Identify and describe how three types of torque wrenches are used
- Assemble and use a deflecting beam torque wrench to torque a series of bolts according to specifications
- Identify and describe three types of adjustable wrenches

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Hammers, Mallets, and Sledges

*IND1404, Duration: 30 minutes*

### Summary:

This is the final lesson in the Hand Tools Series. This lesson introduces and demonstrates the proper use of tools used for striking.

### Topics:

1. Hammers, Mallets, and Sledges
2. Using Tools for Striking

### Objectives:

- Describe five types of hammers
- Explain the differences between hammers, mallets, and sledges
- Explain what parts of a hammer should be inspected
- Discuss in what situation the hammers in this lesson should be used
- Discuss general guidelines for using a hammer correctly

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Industrial Hydraulic Power Series

Thirteen individual lessons make up the Industrial Hydraulic Power Series. Industrial Hydraulic Power Series was specifically developed for beginning hydraulics technicians, mechanics, electricians, and operators who need to know about industrial hydraulic power.

### Introduction to Hydraulic Systems

*IND1501, Duration: 30 minutes*

### Summary:

This is the first lesson in the Industrial Hydraulic Power Series. This lesson identifies the basic components of an industrial hydraulic system and explains their functions. Formulas, including Pascal's Law, are presented and their use in determining values in a hydraulic system is explained.

### Topics:

1. Power Transmission
2. Actuators
3. Reservoirs
4. Pumps
5. Directional Control Valves
6. Pressure Relief Valves
7. Pascal's Law
8. Horsepower
9. Speed and Pressure

### Objectives:

- Visually identify the basic components of an industrial hydraulic system
- Describe the function of the basic components of an industrial hydraulic system
- Understand Pascal's Law
- Use Pascal's Law to determine the pressure and flow at a given point in a simple hydraulic system
- Describe the transmission of power through the system using a diagram of a simple hydraulic system
- Describe conditions necessary for normal operation of a pressure relief valve
- Define work and power as they relate to hydraulics
- Describe the conversion of power through the hydraulic system
- Calculate electrical horsepower and piston speed, given the appropriate variables

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Hydraulic Schematics

*IND1502, Duration: 30 minutes*

### Summary:

This is the second lesson in the Industrial Hydraulic Power Series. This lesson introduces the schematic symbols that represent the basic components of a hydraulic system. It explains the use of color-coding used to identify pressure and how to identify the flow path through the system using schematics.

### Topics:

1. Reservoir and Filter
2. Pump and Motor
3. Piston Actuator and Valve
4. Directional Control Valve
5. Piston Positions
6. Flow Lines
7. Same Housing Components

### Objectives:

- Identify the schematic symbols for the basic components of a hydraulic system
- Identify the pressure at a given point in a hydraulic system using color-coding
- Identify the flow path through a simple hydraulic system, given a schematic for a simple hydraulic system

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of hydraulic systems is required. Review of the lesson: Introduction to Hydraulic Systems is recommended.*

## Hydraulic Fluids

*IND1503, Duration: 30 minutes*

### Summary:

This is the third lesson in the Industrial Hydraulic Power Series. The lesson discusses the types, properties, and functions of hydraulic fluids and the components in which they are used.

### Topics:

1. Piston Actuator Lubrication
2. Directional Control Valve
3. Fluid Characteristics
4. Fluid Types
5. Contamination
6. Reservoirs
7. Strainers and Filters
8. Bypass Check Valve

## 9. Piping

### Objectives:

- Describe the types, properties, and functions of hydraulic fluid that make power transmission possible
- List sources of fluid contamination and ways to avoid contamination
- List the purposes of a hydraulic reservoir
- Identify the components of a hydraulic reservoir and describe their functions
- Describe the conditions necessary for proper functioning of a hydraulic reservoir
- Identify the location of hydraulic filters at various points in a schematic representation of a hydraulic system
- Describe the purposes of hydraulic filters
- Describe the purpose and function of the bypass valve
- Describe the functions of hydraulic piping
- Describe the conditions necessary for proper functioning of hydraulic piping and connections and identify common indicators of malfunction

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of hydraulic schematics is required. Review of the lesson: Hydraulic Schematics, is recommended.*

## Hydraulic Pump Applications

*IND1504, Duration: 30 minutes*

### Summary:

The fourth lesson in the Industrial Hydraulic Power Series, this lesson discusses the various hydraulic pumps and their applications. It also describes symptoms of pump malfunction.

### Topics:

1. Role of the Pump
2. Pressure Principles: Pumping
3. Cavitation and Aeration
4. Variable Volume System
5. High-Low Pumps
6. Variable Volume Pumps
7. Reversible Pumps

### Objectives:

- Describe the role of the pump in hydraulic power transmission given a pictorial drawing or a system schematic
- Calculate the actual flow rate and the volumetric efficiency in a hydraulic system
- Explain the effect of the position of the reservoir in relation to the operation of the inlet side of the pump
- Recognize symptoms of pump malfunction, such as cavitation and aeration, and identify likely causes

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of hydraulic schematics is required. Review of the lesson: Hydraulic Schematics, is recommended.*

## Positive Displacement Pumps

*IND1505, Duration: 30 minutes*

### Summary:

This is the fifth lesson in the Industrial Hydraulic Power Series. This lesson describes various positive displacement pumps and their components. The lesson explains some of the causes of system inefficiencies associated with fixed volume pumps and describes applications in which variable volume pumps are used.

**Topics:**

1. Vane Pumps
2. Vane Pump Components
3. Pressure Compensator Spring
4. Piston Pumps
5. Axial Pumps

**Objectives:**

- Identify the components of fixed and variable volume vane pumps, and describe their functions
- Identify the components of bent axis and axial piston pumps, and describe their functions
- Explain causes of system inefficiencies associated with fixed volume pumps
- Describe applications for variable volume pumps

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of hydraulic systems is recommended.*

## Hydraulic Accumulators

*IND1506, Duration: 30 minutes*

**Summary:**

This is the sixth lesson in the Industrial Hydraulic Power Series. This lesson describes the common accumulators and their schematic symbols. It also describes the application and operation of an accumulator in a hydraulic system. Safety considerations for depressurizing and pre-charging an accumulator are discussed.

**Topics:**

1. Purpose of Accumulators
2. Application
3. Secondary Purposes
4. Depressurizing
5. Gas-Charged Components
6. Bladder Reaction

**Objectives:**

- Identify and describe the application of an accumulator in a system
- Identify common types of accumulators
- Identify safety considerations for depressurizing and pre-charging an accumulator
- Describe how an accumulator operates in a hydraulic system

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of hydraulic schematics is required. Review of the lesson: Hydraulic Schematics, is recommended.*

## Pressure Control Principles

*IND1507, Duration: 30 minutes*

**Summary:**

This is the seventh lesson in the Industrial Hydraulic Power Series. This lesson describes the functions of a pressure relief valve in a hydraulic system and the conditions necessary for normal operation of a pressure relief valve. Pressure characteristics, the relationship of pressure and flow, and depressurization are also discussed.

**Topics:**

1. Pressure Characteristics
2. Pressure / Flow Relationship
3. Depressurization
4. Pressure Control Valves
5. Pressure Differential

**Objectives:**

- Describe the functions of a pressure relief valve in a hydraulic system using a system schematic

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of hydraulic schematics is required. Review of the lesson: Hydraulic Schematics, is recommended.*

## Pressure Control Operation

*IND1508, Duration: 30 minutes*

### Summary:

The eighth lesson in the Industrial Hydraulic Power Series, this lesson presents various pressure control valves, their operation, and components.

### Topics:

1. Direct-Acting Valve
2. Pressure Override
3. Pilot Valve
4. Pilot Valve Components
5. Pilot Valve Operation
6. Shut Off Valve
7. Normally Open Valve
8. Pressure Relief Valve

### Objectives:

- Explain the operation of a direct-acting poppet type pressure control valve
- Explain the operation of a pilot operated pressure control valve
- Explain the operation of a normally open pressure control valve
- Distinguish between the components and operation of direct-acting, pilot operated and normally open pressure control valves

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of pressure control principles is required. Review of the lesson: Pressure Control Principles, is recommended.*

## Pressure Control Valve Applications

*IND1509, Duration: 30 minutes*

### Summary:

This is the ninth lesson in the Industrial Hydraulic Power Series. This lesson describes the proper operation of pressure control valves used in various applications.

### Topics:

1. Pressure Control Valves
2. Counterbalance Valves
3. Sequence Valves
4. Pressure-Reducing Valves

### Objectives:

- Describe how an unloading pressure control valve operates
- Describe how a counterbalance valve operates
- Describe the proper operation of a pressure control valve in a sequencing circuit
- Describe the proper operation of a pressure control valve in a pressure reducing circuit
- Describe the proper operation of a check valve

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of hydraulic schematics and pressure control principles is required. Review of the lesson: Pressure Control Principles, is recommended.*

## Directional Control Principles

IND1510, Duration: 30 minutes

### Summary:

This is the tenth lesson in the Industrial Hydraulic Power Series. This lesson describes various directional control valves. The lesson explains the function of the ports on a directional control valve and instructs the process of tracing the various flow paths through the valve. The lesson also describes the centering conditions and piloting arrangements commonly used with directional control valves.

### Topics:

1. Valves, Ports, and Identification
2. Valve Operation
3. Closed Center and Open Center Valves
4. Tandem Center and Float Center Valves
5. Predetermined Valve Positions
6. Valve Actuation
7. Pilot Operated Valve

### Objectives:

- Identify the schematic symbols for various types of directional control valves
- Identify the functions of the ports on a directional control valve
- Trace the various flow paths through the directional control valve using a system schematic
- Describe how different kinds of directional control valves can be used to control the operation of a hydraulic cylinder using a system schematic
- Describe centering conditions commonly used in directional control valves
- Describe piloting arrangements commonly used with directional control valves

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: It is recommended that you have some knowledge of schematics. You may wish to study Lesson 2, Hydraulic Schematics, from the Industrial Hydraulic Power Series before beginning this lesson.*

## Flow Control Valves

IND1511, Duration: 30 minutes

### Summary:

This is the eleventh lesson in the Industrial Hydraulic Power Series. The lesson demonstrates how to determine speed and flow rates and differential pressure. It describes various valves, their components, and their uses.

### Topics:

1. Speed and Flow Rate Formula
2. Needle Valve
3. Differential Pressure
4. Pressure Compensated Valves
5. Meter-Out and Meter In

### Objectives:

- Explain the conditions that affect flow in a hydraulic system using a system schematic
- Explain how changing the flow rate in a hydraulic system affects the performance of the actuator using a system schematic
- Identify the schematic symbols for flow control valves
- Identify the functions of ports on a flow control valve
- Describe the operation of a needle valve, and trace the path of the fluid through the valve
- Describe the operation of a pressure compensated flow control valve, and trace the path of the fluid through the valve
- Describe the operation of a check valve
- Describe the operation of meter-in and meter-out circuits using a system schematic

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: It is recommended that you have some knowledge of schematics. You may wish to study Lesson 2, Hydraulic Schematics, from the Industrial Hydraulic Power Series before beginning this lesson.*

## Actuator Cylinders

*IND1512, Duration: 30 minutes*

### Summary:

This is the twelfth lesson in the Industrial Hydraulic Power Series. This lesson describes the various cylinders used in hydraulic actuators. It also describes the operation of a cylinder controlled by regulating flow or pressure, and the purpose of a cylinder leak test.

### Topics:

1. Single-Acting Cylinders
2. Double-Acting Cylinders
3. Drill and Clamp Cylinders
4. Flow Control Check Valves
5. Cylinder Operation
6. Cylinder Seals
7. Leakage Test

### Objectives:

- Describe the difference between a single-acting cylinder and a double-acting cylinder
- Identify the schematic symbol and describe the action of a differential cylinder
- Using the schematic symbol, describe the operation and applications of a non-differential cylinder
- Describe the operation of a circuit whose cylinder is controlled by regulating flow or pressure
- Identify the components of a hydraulic cylinder using a cutaway model
- Explain the purpose of a cylinder leak test

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of hydraulic schematics is required. Review of the lesson: Hydraulic Schematics, is recommended.*

## Hydraulic Motors

*IND1513, Duration: 30 minutes*

### Summary:

This is the final lesson in the Industrial Hydraulic Power Series. General knowledge of hydraulic schematics is required. Review of the lesson: Hydraulic Schematics is recommended. This lesson describes various hydraulic motors and their functions. It also describes the operation of various hydrostatic drive circuits and the function of components and flow-path in a braking circuit.

### Topics:

1. Rotary Motion
2. Motor Types
3. Motor Horsepower
4. Motors/Variable Volume Pumps
5. Valves Providing Braking

### Objectives:

- Identify the schematic symbol for an unidirectional and bidirectional hydraulic motor
- Describe the functional similarity between a hydraulic pump and a hydraulic motor
- Describe the flow path through a hydraulic motor, using a cutaway diagram of a vane motor
- Describe the operation of a hydraulic gear motor and a hydraulic piston motor, using a cutaway diagram of each
- Express the output of a hydraulic motor in terms of horsepower
- Describe the operation of various hydrostatic drive circuits from the circuit schematics
- Describe the function of the components and the flow path through the circuit

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: General knowledge of hydraulic schematics is required. Review of the lesson: Hydraulic Schematics, is recommended.*

## Industrial Lubrication Series

This series consists of four lessons. This series is designed for training oilers, mechanics, and millwrights as well as for the multi-craft needs of process and manufacturing facilities. Participants are trained to recognize various types of lubrication systems and their maintenance requirements, including ring, bath, splash, constant level, and forced feed lubrication systems, as well as understand how they operate. Participants also learn the importance of following lubrication schedules, how to change common types of oil filters, and how to properly handle and store lubricants to prevent lubricant contamination.

### Introduction to Industrial Lubrication

*IND1601, Duration: 30 minutes*

#### Summary:

This is the first lesson in the Industrial Lubrication Series. This lesson explains the concept of lubrication and friction, and demonstrates the benefits of a proper lubrication program.

#### Topics:

1. Benefits of a Lubrication Program
2. Friction
3. Types of Lubricant Protection
4. Effects of Friction

#### Objectives:

- Define lubrication
- Explain the benefits of a proper lubrication program
- Define friction
- Identify factors that contribute to friction
- Identify the three basic types of friction
- Describe three types of lubrication applications used to reduce friction

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: This lesson is designed so that no prior knowledge is required. However, knowledge of applied mathematics is recommended.*

### Lubricants

*IND1602, Duration: 30 minutes*

#### Summary:

This is the second lesson in the Industrial Lubrication Series. This lesson explains viscosity as well as the properties of common solid, semi-solid and liquid lubricants are described as well as the benefits associated with synthetic lubricants and the functions of additives and inhibitors. Common types and causes of lubricant contamination are described and proper methods of lubricant storage are demonstrated.

#### Topics:

1. Lubricants
2. Lubricant Contamination
3. Storing Lubricants

#### Objectives:

- Define viscosity
- Describe three types of liquid lubricants and some typical applications
- Describe the properties of liquid lubricants
- Describe types of semisolid lubricants and some typical applications

- Describe conditions or circumstances under which it would be preferable to use grease as a lubricant
- Describe the properties of semisolid lubricants
- Describe types of solid lubricants and some typical applications
- Describe the properties of solid lubricants
- Identify some benefits of using synthetic lubricants
- Explain the function of additives and inhibitors
- Describe types of lubricant contamination
- Describe typical causes of lubricant contamination
- Describe how to prevent lubricant contamination
- Describe proper methods of lubricant storage

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Lubrication Systems

*IND1603, Duration: 30 minutes*

### Summary:

This is the third lesson in the Industrial Lubrication Series. This lesson trains participants to recognize various types of lubrication systems and their maintenance requirements, including ring, bath, splash, constant level, and forced feed lubrication systems, as well as understand how they operate.

### Topics:

1. Natural Feed Lubrication Systems
2. Forced Feed Lubrication Systems
3. Automatic Lubrication Systems
4. Applying Lubrication

### Objectives:

- Explain how ring lubrication systems operate
- Explain how bath lubrication systems operate
- Explain how splash lubrication systems operate
- Explain how constant level lubrication systems operate
- Perform a check on a natural feed lubrication system and determine machine condition
- Describe how to add oil to a natural feed lubrication system
- Describe the operation of forced feed lubrication systems
- Explain the differences between natural feed and forced feed lubrication systems
- Perform a check on a forced feed lubrication system and determine machine condition
- Identify various devices used to apply lubrication manually
- Describe how to apply the proper amount of grease to a bearing

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Filters and Lubrication Maintenance

*IND1604, Duration: 30 minutes*

### Summary:

This is the final lesson in the Industrial Lubrication Series. Participants also learn the importance of following lubrication schedules, how to change common types of oil filters. This lesson explains the purpose of filters and the importance of filter maintenance in lubrication systems. Additionally, the lesson indicates the benefits of oil sampling and analysis and identifies several factors, which can cause lubrication failure.

### Topics:

1. Filters
2. Filter Maintenance

3. Lubrication Schedules
4. Oil Sampling and Analysis
5. Lubrication Failure

**Objectives:**

- Explain the purpose of filters in a lubrication system
- Explain the differences between surface filters and depth-type filters
- Explain why filter maintenance is important
- Recognize indications that a filter must be cleaned or replaced
- Describe how to clean a filter
- Explain the benefits of following a lubrication schedule
- Interpret information on a lubrication schedule
- Explain the benefits of oil sampling and analysis

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Basic knowledge of lubricants and lubrication systems is recommended.*

## Mechanical Print Reading Series

This series consists of 4 interactive, on-line lessons. These lessons take approximately 30 to 45 minutes to complete.

### Introduction to Mechanical Print Reading

*IND1701, Duration: 30 minutes*

**Summary:**

This is the first lesson in the Mechanical Print Reading Library. This introductory lesson trains the learner to identify the various parts of mechanical drawings and their components.

**Topics:**

1. Introduction
2. Assembly Drawings
3. The Title Block
4. The Parts List
5. The Notes
6. Detail Drawings

**Objectives:**

- Identify reasons for using drawings and blueprints
- Recognize an assembly drawing and its components
- Identify the parts of a Title Block
- Identify the Parts List and its components
- Recognize the different types of notes and their purpose
- Recognize a detail drawing and its components

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

### Lines Used in Mechanical Print Reading

*IND1702, Duration: 30 minutes*

**Summary:**

This is the second lesson in the Mechanical Print Reading Library. This lesson explains the types of lines used in mechanical print reading and what they represent.

**Topics:**

1. Introduction to Lines
2. Visible and Hidden Line
3. Phantom Lines

4. Three Break Lines
5. Other Lines

**Objectives:**

- Identify visible lines and hidden lines and what they represent
- Describe three uses for phantom lines
- Describe three different break lines and their function
- Recognize center lines
- Recognize dimension lines
- Recognize cutting plane lines
- Recognize extension lines
- Recognize section lines
- Recognize leader lines

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Basic knowledge of assembly and detail is recommended.*

### Dimensions in Mechanical Print Reading

*IND1703, Duration: 30 minutes*

**Summary:**

This is the third lesson in the Mechanical Print Reading Library. This lesson explains the use of dimension and extension lines in mechanical print reading, and how to calculate dimensions, tolerance, and limits. The use of surface finish designations is also discussed.

**Topics:**

1. Dimension and Extension Lines
2. Calculated Dimensions
3. Dimensions on Circular Features
4. Size Variations - Limits and Tolerances
5. Surface Finish Designations

**Objectives:**

- Recognize and define dimension lines
- Recognize and define extension lines
- Identify and measure dimensions on circular features
- Use calculated dimensions
- Demonstrate how calculated dimensions are used and why
- Define and calculate tolerance
- Define and calculate limits
- Differentiate types of surface finish designations

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Basic knowledge of assembly and detail drawings and lines is recommended.*

### Orthographic Projection

*IND1704, Duration: 30 minutes*

**Summary:**

This is the final lesson in the Mechanical Print Reading Library. This lesson trains participants in the use of orthographic projections in mechanical print reading. Pictorial drawings and various views used in mechanical print reading are demonstrated. The lesson also discusses aspects of sectional views, threaded fasteners, and how to identify thread designations.

**Topics:**

1. Introduction to Orthographic Projection
2. First and Third Angle Projections
3. Pictorial Drawings
4. Sectional Views

5. Types of Sections
6. Threaded Fasteners
7. Thread Designations

**Objectives:**

- Define an orthographic projection
- Identify the purpose of an orthographic projection
- Relate orthographic views to projections
- Relate how first and third angle projections are used
- Describe what a third angle looks like
- Identify the symbol for each angle in the title block
- Define the three types, characteristics, and uses of pictorial drawings: isometric, oblique and perspective
- Recognize sectional views and define why sectional views are used
- Identify the four types of sections
- Describe three ways to represent the threads of threaded fasteners

Identify thread designations

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of assembly and detail drawings, lines, and dimensions is recommended.*

## Mechanical Seals Series

This series consists of 4 interactive, on-line lessons. These lessons were designed for persons with a basic understanding of the operation and maintenance of pumps, agitators, and rotating equipment.

### Introduction to Mechanical Seals

*IND1801, Duration: 30 minutes*

**Summary:**

This is the first lesson in the Mechanical Seals Series. The lesson explains the purpose and basic components of mechanical seals. The participant is instructed in the identification and characteristics of materials commonly used to make seal faces and seal hardware, and to understand the limitations of seals. Characteristics, limitations, and application of packing are also discussed.

**Topics:**

1. Purpose of Mechanical Seals
2. Primary Seals
3. Secondary Seals and Seal Hardware
4. Characteristics and Limits of Mechanical Seals
5. Packing

**Objectives:**

- Explain the purpose of mechanical seals
- Identify the basic components of a mechanical seal
- Identify the types of materials commonly used to make seal faces and elastomers
- Describe the characteristics of materials commonly used to make seal faces
- Identify the types of materials commonly used to make seal hardware
- Describe the characteristics of materials commonly used to make seal hardware
- Identify the primary sealing points of a mechanical seal
- Identify the secondary sealing points of a mechanical seal
- Identify the characteristics and limitations of mechanical seals
- Describe the characteristics of packing
- Identify applications in which packing is installed to control process leakage
- Explain when packing should be replaced by a mechanical seal

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Mechanical Seal Designs

*IND1802, Duration: 30 minutes*

### Summary:

This is the second lesson in the Mechanical Seals Series. It describes various seal designs and their application. The lesson also describes conditions that may affect mechanical seal performance.

### Topics:

1. Seal Designs
2. Single Seals
3. Double Seals
4. Cartridge Seals
5. Fluid, Temperature, and Operating Considerations

### Objectives:

- Describe a single seal and list its uses
- Describe a double seal and list its uses
- Describe a tandem seal and list its uses
- Describe a cartridge seal and list its uses
- Define an inside seal and explain its use
- Define an outside seal and explain its use
- Explain how process fluid affects mechanical seals
- Explain how temperature affects mechanical seals
- Explain how operational conditions affect mechanical seals

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of mechanical seal components is recommended.*

## Failure Analysis

*IND1803, Duration: 30 minutes*

### Summary:

This is the third lesson in the Mechanical Seals Series. This lesson demonstrates the steps necessary to prepare to remove, and to remove, a failed mechanical seal. The lesson trains the participant in failure analysis to determine the cause of seal failure and identify the means to correct the problem or condition that caused the failure.

### Topics:

1. Removing the Seal
2. Causes of Seal Failure
3. Chemical Attack
4. Damage from Heat and Mechanical Action
5. Failure Analysis

### Objectives:

- List the steps necessary to prepare for removing a failed mechanical seal
- List the steps to removing a failed mechanical seal
- Perform a failure analysis to determine the cause of seal failure
- Identify the means to correct the problem or condition that caused seal failure
- List the steps to follow to properly analyze seal failure
- Describe seal damage caused by chemical attack
- Describe seal damage caused by heat
- Describe seal damage caused by mechanical action

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Basic Knowledge of mechanical seal components and design is recommended.*

## Mechanical Seal Maintenance

*IND1804, Duration: 30 minutes*

### Summary:

This, the final lesson in the Mechanical Seals Series, trains the learner in seal disassembly and reassembly, O-ring installation, and seal installation.

### Topics:

1. Seal Disassembly
2. O-Ring Installation
3. Seal Reassembly
4. Seal Installation

### Objectives:

- Remove a failed mechanical seal
- Disassemble a failed mechanical seal
- Identify the correct tool for O-ring extraction
- Remove O-rings from a mechanical seal
- Replace O-rings on a mechanical seal
- Perform the preliminary checks prior to seal installation
- Reassemble and install a new or repaired mechanical seal

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of mechanical seal components and design, and review of the lesson Failure Analysis is recommended.*

## Precision Measuring Instruments Series

This series consists of four lessons. The lessons in this series were designed for employees in all disciplines as well as for the multi-craft training needs of process and manufacturing facilities. This series describes the purpose and the basic components of some common precision measuring instruments.

### Dial Calipers

*IND1901, Duration: 30 minutes*

### Summary:

This is the first lesson in the Precision Measuring Instruments Series. This lesson describes the purpose and the basic components of dial calipers. The lesson also provides procedures for properly using a dial caliper to measure the dimensions of an object.

### Topics:

1. Reading a Dial Caliper
2. Preparing to Use a Dial Caliper
3. Measurements

### Objectives:

- Identify the beam, dial, and nibs of a dial caliper
- Explain how to read a dial caliper
- Zero a dial caliper
- Explain the use of the two sets of nibs on a dial caliper
- Obtain the inside measurement of an object by using a dial caliper
- Obtain the outside measurement of an object by using a dial caliper

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Micrometers

*IND1902, Duration: 30 minutes*

### Summary:

This is the second lesson in the Precision Measuring Instruments Series. This lesson describes the purpose and the basic components of outside micrometers, inside micrometers, and depth micrometers. The lesson also provides procedures for properly using each of these instruments to measure the dimensions of an object.

### Topics:

1. Outside Micrometers
2. Inside Micrometers
3. Depth Micrometers

### Objectives:

- Identify the main components of an outside, inside, and depth micrometer
- Explain how to read a micrometer
- Measure outside dimension using an outside micrometer
- Measure inside dimension using an inside micrometer
- Measure depth by using a depth micrometer

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*

## Telescoping and Thickness Gauges

*IND1903, Duration: 30 minutes*

### Summary:

This is the third lesson in the Precision Measuring Instruments Series. This lesson describes the purpose and the basic components of telescoping gauges and thickness gauges. The lesson also provides procedures for properly using each of these instruments to measure the dimensions of an object.

### Topics:

1. Using a Telescoping Gauge
2. Using a Thickness Gauge
3. Measuring Clearance

### Objectives:

- Measure the inside diameter of an object by using a telescoping gauge in conjunction with an outside micrometer
- Demonstrate the proper way to insert and remove a telescoping gauge
- Measure a clearance with a thickness gauge
- Explain how to double-check your measurements

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: Knowledge of how to take a reading with an outside micrometer is required.*

## Dial Indicators

*IND1904, Duration: 30 minutes*

### Summary:

This is the final lesson in the Precision Measuring Instruments Series. This lesson describes the purpose and the basic components of dial indicators. The lesson also provides procedures for properly using dial indicators to measure the dimensions of an object.

### Topics:

1. Reading a Dial Indicator
2. Indicator Setup

### 3. Using a Dial Indicator

#### Objectives:

- Identify the parts of a gate valve and describe their functions
- Inspect a valve and make adjustments to stop leakage
- Position rising stem and non-rising stem valves to the half-open position
- Remove and disassemble the bonnet assembly of a gate valve
- Use a telescoping gauge to determine if a stuffing box is round
- Perform a run-out to determine if a stem is bent
- Use an outside micrometer to determine if the stem has excessive wear
- Lap a disc and perform a contact check of disc mating surfaces
- Reassemble the bonnet assembly of a gate valve
- Perform a contact check to determine if there is a proper seal between the seat and disc of a gate valve

*Audience: All employees and employers*

*Primary Regulations: None*

*Related Regulations: None*

*Prerequisites: None*