AC/DC Fundamentals

AC/DC Fundamentals

This five-day course begins with a fundamental review of conductors and insulators, electric current, resistance, Ohm's and Kirchhoff's Laws, electrical power, and magnetism. AC circuit fundamentals are also covered, including inductive and capacitive circuits. Other topics include test equipment, semiconductors and diodes, transistors, and silicon controlled rectifiers.

I. Conductors and Insulators

- The Atom
- The Nucleus
- Electrical Charges
- Categories of Matter

II. EMF and Electric Current

- EMF
- Current Flow
- Voltage Potential

III. Resistance

- Characteristics of Resistance
- Ohm's Law

IV. Resistive Circuits

- Resistance in Series
- Resistance in Parallel
- Simplified Formulas
- Series-Parallel Circuits

V. Applying OHM's Law

- Current in Series Circuits
- Voltage & Current In Parallel Circuits
- Voltage & Current in Series-Parallel Circuits

VI. Kirchhoff's Laws

- Kirchhoff's Current Law
- Kirchhoff's Voltage Law
- Loop Equations

VII. Electrical Power

- The Unit of Power
- Power Equations
- Power Rating of Resistors

VIII. Magnetism

- Characteristics of Magnetism
- Magnetic Field Around a Current-Carrying Conductor
- Left-Hand Rule for a Conductor
- Magnetic Field of a Coil

IX. AC Power

- Sine Wave Generation
- Sine Wave Terminology

X. AC Phase Relationships

- Phase Concepts
- Phase Angle
- Phase Angle Diagrams

XI. Resistance in AC Circuits

XII. Inductance in AC Circuits

- Inductance
- Factors Affecting Inductance
- Voltage & Current in an Inductive AC Circuit
- Inductive Reactance

Air Conditioning and Refrigeration

Air Conditioning and Refrigeration

Air Conditioning and Refrigeration is a five-day, lecture-based course that covers the basic mechanical refrigeration cycle, the different refrigerants available, major refrigeration system components, and system operation. The portion of the course on air conditioning deals mainly with air conditioning service techniques. This is a technician-level course for both operating and maintenance personnel, providing the knowledge base necessary to begin working on the equipment and to get the most out of equipment-specific training.

I. Matter and Heat Behavior

- Motion of Molecules
- Changes of State
- Measuring the Amount of Heat Energy
- Removing Heat - Cooling
- Conservation of Energy
- Heat Flow
- Refrigeration Effect - "Ton"

II. Fluids and Pressures

- Expansion of Gases
- Gas Laws
- Density of Materials
- Specific Volumes of Materials
- Mixtures of Gases

III. Refrigerants

- Refrigerant Characteristics
- Refrigerant Properties
- Refrigerants and Water
- Leak Detection
- Effect on Materials
- Refrigerant Performance
- Refrigerant Storage
- Refrigerant Safety Precautions

IV. Refrigeration System Components

- Basic Mechanical Refrigeration Cycle
- Compressors
- Condensers
- Refrigerant Flow Controls
- Evaporators

V. Refrigeration Piping and Accessories

- Refrigeration Piping
- Hot Gas, Liquid, and Suction Lines
- Types of Accessories
- Valves

VI. Refrigeration Oils

- Classification
- Properties
- Oil Specifications

VII. Air Conditioning

- Definition of Air Conditioning
- Air-Atmosphere
- Physical Properties of Air
- Psychrometric Properties of Air
- Air Movement

VIII. Air Conditioning Service Techniques

- Installing a Gauge Manifold
- Gauge Manifold
- Evaluating Performance of System
- Removing Refrigerant
- Open and Make Repairs
- Pressure Testing
- Evacuating a System
- Charging a Repaired System
- Evaluate Repair

Air Conditioning and Refrigeration for Electricians

Air Conditioning and Refrigeration for Electricians

This five-day, lecture-based course is designed to cover the fundamentals of AC&R equipment, systems, and controls. The course is particularity oriented around troubleshooting controls and electrical equipment, such as compressors, fans, and valves.

I. Fundamentals of Refrigeration

- Overview of Refrigeration Development
- AC & R Terminology
- Heat, Cold, Heat Transfer
- Measurements
- Units of Heat, BTUs
- Change of State
- Link to Food Industry
- Safety

II. Refrigeration Tools and Materials

- Common Tools
- Piping and Tubing
- Instruments and Gauges
- Measuring Tools

III. Basic Refrigeration Systems

- Controlled Expansion Systems
- Ice Makers
- Compression Systems w/Expansion Valves
- Defrost Systems

IV. Compression Systems

- Laws of Refrigeration
- Compression Cycle
- Components

V. Electromagnetic Fundamentals

- AC & R Circuit Fundamentals
- Electrical Motors
- Motor Circuits
- Hermetic System Motors
- Motor Protection
- Fan Motors
- Servicing Electrical Motors
- Motor Testing

VI. Electrical Circuits and Controls

- Wiring Diagrams
- Ladder Diagrams
- Control Systems
- Refrigeration and Freezer Controls
- Pressure Sensing Controls
- Motor Safety Controls
- Automatic Defrost Controls
- Remote Temperature Sensing Elements

VII. Refrigerants

- Requirements of Refrigerants
- Temperature Curves
- Refrigerant Temperatures
- Food Freezants

VIII. Small Hermetic Systems

- Instruments Tools and Supplies
- Troubleshooting Refrigeration Units
- Diagnosing Component Problems
- Evacuating Systems With a Vacuum Pump

IX. Commercial Systems

- Mechanical Cycle
- Motor Controls
- Commercial Evaporators
- Refrigerant Controls

- Valves, Pressure Regulating
- Electrical Heater Defrost Systems

X. Servicing and Installing Commercial Systems

- Electrical Connections
- Starting a System
- Servicing Condensing Units
- Locating Troubles

XI. Fundamentals of Air Conditioning

- Physical Properties of Air
- Humidity
- Climate
- Air Movement

XII. Control Systems

- Control Mechanisms
- Thermostats
- Electronic Thermostats
- Controllers
- Primary Controls
- Sequential Operating Controls
- Limit Controls

XIII. Servicing and Troubleshooting

- Troubleshooting Techniques
- Troubleshooting Procedures
- Troubleshooting Charts

Air Conditioning & Refrigeration Troubleshooting

Air Conditioning & Refrigeration Troubleshooting

This five-day course is designed to provide experienced HVAC technicians with advanced training on some of the more complex topics in this field. Topics such as control circuits, air balancing, and heat load calculation are discussed in detail in this course.

I. Refrigerant Controls

- Compression System Refrigerant Controls
- Comparing Refrigerant Controls
- Check Valve
- Suction Pressure Valves

II. Electrical - Magnetic Fundamentals

- Generating Electricity
- Types of Electricity
- Circuit Fundamentals
- Electrical Materials
- Magnetism
- Electronics
- Electrical Power
- Electrical Codes
- Circuit Protection

III. Electric Motors

- Electric Motor Applications
- The Motor Structure
- Types of Electric Motors
- Motor Speeds
- Starting and Running Windings
- Starting Current
- Motor Connections
- Hermetic System Motors
- Direct Current and Universal Motors
- Motor Horsepower and Motor Characteristics
- Electric Motor Grounding
- Motor Protection
- Motor Temperature
- Standard Motor Data
- Fan Motors
- Shaded-Pole Motors
- Electronic Variable Speed Motors
- Servicing Electric Motors
- Pulleys
- Belts
- Motor Testing Stand
- Servicing and Repairing Hermetic Motors

IV. Electric Circuits and Controls

- Electrical Circuits-Complete Wiring Diagram
- Electrical Circuits-Ladder Diagram
- Control Systems-Fundamentals
- Refrigerator and Freezer Controls
- Ice Maker Controls
- Comfort Cooling Air Conditioning Controls
- Central Air Conditioning Controls
- Water Cooler Controls
- Remote Temperature Sensing Elements
- Pressure Motor Controls
- Motor Safety Controls
- Motor Starting Relays
- Automatic Defrost Controls
- Semiautomatic Defrost Controls
- Hot-Gas Defrost Controls
- Ice Bank Controls
- Humidity Controls
- Defrosting Timers

V. Commercial Systems - Heat Loads and Piping

- Heat Load
- Thermodynamics
- Evaporator and Condensing Unit Capacities
- Evaporator Installations
- Water-Cooling Loads
- Ice Cream Freezing and Storage Load
- System Capacity
- Compressor Capacities
- Cascade System
- Two-Stage Compressor
- Bypass Cycle
- Refrigerant Lines and Piping
- Seasonal Energy Efficiency Ratio (SEER)

VI. Air Conditioning and Heating Control Systems

- Controls
- Thermostats
- Controllers
- Total Energy Management Systems
- Energy Management System Types and Functions
- Control System Diagnostics

VII. Air Conditioning Systems - Heat Loads

- Heat Loads
- Design Temperatures
- Insulation and Vapor Barriers
- Energy Conservation
- Construction Types and Designs

VIII. Servicing and Troubleshooting Simplified

- Servicing and Troubleshooting
- Troubleshooting Procedure
- Troubleshooting Charts

Advanced Air Conditioning & Refrigeration Troubleshooting

Advanced Air Conditioning & Refrigeration Troubleshooting

This five-day course is designed to provide experienced HVAC technicians with advanced training on some of the more complex topics in this field. Topics such as control circuits, air balancing, and heat load calculation are discussed in detail in this course.

I. Refrigerant Controls

- Compression System Refrigerant Controls
- Comparing Refrigerant Controls
- Check Valve
- Suction Pressure Valves

II. Electrical - Magnetic Fundamentals

- Generating Electricity
- Types of Electricity
- Circuit Fundamentals
- Electrical Materials
- Magnetism
- Electronics
- Electrical Power
- Electrical Codes
- Circuit Protection

III. Electric Motors

- Electric Motor Applications
- The Motor Structure
- Types of Electric Motors
- Motor Speeds
- Starting and Running Windings
- Starting Current
- Motor Connections
- Hermetic System Motors
- Direct Current and Universal Motors
- Motor Horsepower and Motor Characteristics
- Electric Motor Grounding
- Motor Protection
- Motor Temperature
- Standard Motor Data
- Fan Motors
- Shaded-Pole Motors
- Electronic Variable Speed Motors
- Servicing Electric Motors
- Pulleys
- Belts
- Motor Testing Stand
- Servicing and Repairing Hermetic Motors

IV. Electric Circuits and Controls

- Electrical Circuits-Complete Wiring Diagram
- Electrical Circuits-Ladder Diagram
- Control Systems-Fundamentals
- Refrigerator and Freezer Controls
- Ice Maker Controls
- Comfort Cooling Air Conditioning Controls
- Central Air Conditioning Controls
- Water Cooler Controls
- Remote Temperature Sensing Elements
- Pressure Motor Controls
- Motor Safety Controls
- Motor Starting Relays
- Automatic Defrost Controls
- Semiautomatic Defrost Controls
- Hot-Gas Defrost Controls
- Ice Bank Controls
- Humidity Controls
- Defrosting Timers

V. Commercial Systems - Heat Loads and Piping

- Heat Load
- Thermodynamics
- Evaporator and Condensing Unit Capacities
- Evaporator Installations
- Water-Cooling Loads
- Ice Cream Freezing and Storage Load
- System Capacity
- Compressor Capacities
- Cascade System
- Two-Stage Compressor
- Bypass Cycle
- Refrigerant Lines and Piping
- Seasonal Energy Efficiency Ratio (SEER)

VI. Air Conditioning and Heating Control Systems

- Controls
- Thermostats
- Controllers
- Total Energy Management Systems
- Energy Management System Types and Functions
- Control System Diagnostics

VII. Air Conditioning Systems - Heat Loads

- Heat Loads
- Design Temperatures
- Insulation and Vapor Barriers
- Energy Conservation
- Construction Types and Designs

VIII. Servicing and Troubleshooting Simplified

- Servicing and Troubleshooting
- Troubleshooting Procedure
- Troubleshooting Charts

Advanced Pump Maintenance

Advanced Pump Maintenance

This five-day course is designed for plant personnel responsible for the maintenance and Installation of positive displacement and centrifugal pumps. Hands-on exercises account for approximately 50% of this course, where concepts such as soft-foot, pipe strain, and alignment are emphasized. This course is ideal for maintenance personnel from apprentice level to journeyman.

I. Pump Design

- Standards
- Applications
- Classifications

II. Pump Operation and Theory

- Centrifugal Pumps
- Design Aspects
- Pump Laws
- Positive Displacement Pumps
- Pump Performance Comparisons
- Special Purpose Pumps
- Pump Characteristic Curves
- Performance Testing

III. Rotary Pump Troubleshooting and Maintenance

- Pump Performance
- Pump Tests
- Rotary Pump Problems
- Maintenance

IV. Reciprocating Pump Troubleshooting & Maintenance

- Steam Pumps
- Power Pumps
- Metering Pumps
- Piston Pumps

V. Centrifugal Pump Troubleshooting and Maintenance

- Centrifugal Pump Problems
- Troubleshooting
- Inspections

VI. Pump Alignment Methods

- Visual Line-Up
- Straight Edge and Feeler Gage
- Rim and Face
- Reverse Dial Indication
- Cross Dialing
- Laser Alignment

VII. Soft Foot Correction

- Definition
- Effects
- Types
- Measuring Soft Foot
- Correcting Soft Foot
- Tolerances

VIII. Alignment Calculation

- Mathematical Formula
- Graphical Solutions

Advanced Welding

Advanced Welding

This ten-day course is designed to give experienced welders advanced welding skills in arc and gas welding, resistance welding, resistance spot welding, resistance seam welding, projection welding, thermit welding, pulse arc, flux cored, plasma arc cutting, and pipe welding. Also, various welding problems are identified and corrected, and the weld failure analysis process is explained.

I. Arc Welding

- Metal Electrode
- Carbon Electrode

II. Gas Welding / Oxyfuel Cutting

III. Resistance Welding

IV. Thermit Welding

V. Pulse Arc

VI. Flux Cored

VII. Plasma Arc Cutting

VIII. Pipe Welding

IX. Warpage

- Cause
- Stress Reduction Around Weld Area

X. Pitting

- Cause
- Correction

XI. Cracking

- Causes
- Stress Relief

XII. Fracture

- Types of Fractures
- Cause
- Stress Relief

XIII. Arc Blow

- Cause
- Correction

IX. Wild Failure Analysis

- Areas of Interest
- Classification of Failures

Air Compressor Maintenance

Air Compressor Maintenance

This two-day course introduces participants to the operating principles of air compressors, their construction and classification, auxiliary components, and maintenance requirements.

I. Principles of Operation

- Gas Laws
- Volume – Pressure Relationship
- Volume – Temperature Relationship

II. Compressors Construction and Classification

- Single/Double Acting
- Single Multi-Staged
- Dynamic
- Axial
- Centrifugal

III. Rotary Compressors

- Positive Displacement Rotary
- Sliding Vane Rotary
- Lobe Rotary
- Liquid Ring Rotary

IV. Reciprocating Compressors

- Compression Cycles
- Compressor Components
- Compressing Element
- Lubrication System
- Cooling System
- Control System
- Unloaders/Unloading Valves

V. Compressor Auxiliaries

- Silencers
- Traps
- Receivers
- Moisture Separators, Dryers & Filters
- Safety Features

VI. Compressor Maintenance

- Troubleshooting Guide
- Preventive Maintenance
- Corrective Maintenance

Air Conditioning and Refrigeration for MTA Technicians

Air Conditioning and Refrigeration for MTA Technicians

This course covers the design, construction, operation, and maintenance associated with air conditioning and refrigeration units, with a review of environmental concerns associated with commonly used refrigerants, as well as the recent restrictions placed upon the handling and disposal of these refrigerants by the EPA in accordance with the Clean Air Act. This course is designed for all maintenance personnel involved in the upkeep and repair of air condition unitsas part of their daily routine.

I. Fundamentals of Refrigeration

- Overview of Refrigeration Development
- AC & R Terminology
- Heat, Cold, Heat Transfer
- Measurements
- Units of Heat, BTUs
- Change of State
- Link to Food Industry
- Safety

II. Refrigeration Tools and Materials

- Common Tools
- Piping and Tubing
- Instruments and Gauges
- Measuring Tools

III. Basic Refrigeration Systems

- Controlled Expansion Systems
- Ice Makers
- Compression Systems w/Expansion Valves
- Defrost Systems

IV. Compression Systems

- Laws of Refrigeration
- Compression Cycle
- Components

V. Electromagnetic Fundamentals

- AC & R Circuit Fundamentals
- Electrical Motors
- Motor Circuits
- Hermetic System Motors
- Motor Protection
- Fan Motors
- Servicing Electrical Motors
- Motor Testing

VI. Electrical Circuits and Controls

- Wiring Diagrams
- Ladder Diagrams
- Control Systems
- Refrigeration and Freezer Controls
- Pressure Sensing Controls
- Motor Safety Controls
- Automatic Defrost Controls
- Remote Temperature Sensing Elements

VII.Refrigerants

- Characteristics
- Types
- Properties
- Moisture Effects
- Oil Effects
- Leak Detection
- Performance
- Storage

VIII. Small Hermetic Systems

- Instruments Tools and Supplies
- Troubleshooting Refrigeration Units
- Diagnosing Component Problems
- Evacuating Systems With a Vacuum Pump

IX. Commercial Systems

- Mechanical Cycle
- Motor Controls
- Commercial Evaporators
- Refrigerant Controls
- Valves, Pressure Regulating
- Electrical Heater Defrost Systems

X. Servicing and Installing Commercial

Systems

- Electrical Connections
- Starting a System
- Servicing Condensing Units
- Locating Troubles

XI. Fundamentals of Air Conditioning

- Physical Properties of Air
- Humidity
- Climate
- Air Movement

XII. Control Systems

- Control Mechanisms
- Thermostats
- Electronic Thermostats
- Controllers
- Primary Controls
- Sequential Operating Controls
- Limit Controls

XIII. Servicing and Troubleshooting

- Troubleshooting Techniques
- Troubleshooting Procedures
- Troubleshooting Charts

Ammonia Refrigeration Unit Operation and Maintenance

Ammonia Refrigeration Unit Operation and Maintenance

This is a three-day, lecture and hands on course that covers the basic mechanical refrigeration cycle, the control and handling of ammonia, major installed system components, and system operation. The maintenance portion of the course deals mainly with service techniques for the installed equipment. This is a technician-level course for both operating and maintenance personnel, providing the knowledge base necessary to begin working on the equipment and to get the most out of equipment-specific training.

I. Ammonia Refrigeration Basics

- Ammonia Characteristics
- Single stage Ammonia Systems
- Two-Stage Ammonia Systems

II. Suction Accumulators and Intercoolers

- Need for suction accumulators
- Accumulator design features
- Liquid/vapor separation
- Intercoolers
- Shell-and-coil vs. flash-type intercoolers
- Alternate intercoolers

III. Liquid Overfeed (Recirculation) Systems

- Liquid overfeed
- Recirculation systems purpose and design
- Recirculation system advantages and disadvantages
- Recirculation vessel design
- Pumper drum system
- Controlled pressure receiver system

IV. Positive-Displacement Compressors

- Reciprocating Compressors
- Sliding Vane Rotary Booster Compressors
- Oil Flooded Screw Compressors
- Screw Compressor Units
- Ammonia Systems Lubrication/Oil Management

V. Evaporators, Condensers, and Controls

- Liquid Ammonia Evaporator Supply Methods
- Evaporators
- Air Unit Defrost Systems
- Evaporative Condensers
- Control Valves and Switches

VI. Purging, Piping, and Safety

- Purging Air and other Non-condensables
- Ammonia System Piping
- Ammonia System Safety Codes and Guidelines
- OSHA Process Safety Management
- EPA Regulations and Ammonia Safety

VII. Site Service Techniques

- Leak Detection
- Installing a Gauge Manifold
- Gauge Manifold
- Evaluating Performance of System
- Removing Refrigerant
- Open and Make Repairs
- Pressure Testing
- Evacuating a System
- Charging a Repaired System
- Evaluate Repair· Pressure Testing
- Evacuating a System
- Charging a Repaired System
- Evaluate Repair

Ammonia Refrigeration Systems

Ammonia Refrigeration Stsyems

This is a four-day, lecture-based course that covers the basic mechanical refrigeration cycle, the different refrigerants available, major refrigeration system components, system operation, service, and troubleshooting with a focus on ammonia systems. This is a technician-level course for both operating and maintenance personnel, providing the knowledge base necessary to work on ammonia refrigeration equipment.

I. Refrigeration Fundamentals

- The Refrigeration Cycle
- Physical Properties Of Various Refrigerants
- Refrigerant Performance Tables
- Compressor Types
- Cooling Units
- Lubrication
- Secondary Refrigerants

II. Ammonia Systems

- Ammonia Refrigeration Plant Safety
- Basic Ammonia Refrigeration Principles
- Component Identification

III. Operation of Industrial Ammonia Refrigeration Systems

- Starting the System and Putting On-Line
- Operate the System and Achieve Stability
- Purging Non-Condensable Gases
- Changing Operating Parameters
- Determining the System Load
- Determining Operating Efficiencies
- Automated Operation
- System Shutdown
- Pumpdown Procedures

IV. Sub-Systems and Components

- Compressors
- Evaporators
- Pumped Liquid Recirculation Systems
- Condensers and High-Pressure Receivers
- Two-Stage Systems and Defrost Systems
- AC Frequency Drives
- Sensors: Temperature, Pressure, and Liquid Levels: Use and Calibration

V. System Installation and Maintenance

- Compressor Installation Fundamentals
- Compressor Alignment
- Compressor Service and Maintenance
- Evaporative Condensers
- Unwanted Liquid Slop
- Oil Filling and Draining Procedures
- Installing a Gauge Manifold
- Removing Refrigerant
- Pressure Testing
- Evacuating a System
- Charging a Repaired System
- Evaluate Repair

Air Condition Systems: Automotive A/C Theory, Diagnosis, Service, and Recovery

Air Condition Systems:Automotive A/C Theory, Diagnosis, Service, and Recovery

Air Conditioning and Refrigeration is a five-day, lecture-based course that covers the basic mechanical refrigeration cycle, the different refrigerants available, major refrigeration system components, and system operation. The portion of the course on air conditioning deals mainly with air conditioning service techniques. This is a technician-level course for both operating and maintenance personnel, providing the knowledge base necessary to begin working on the equipment and to get the most out of equipment-specific training.

I. Air Condition Systems: An Overview

II. Electrical Circuits

- Blower Circuits
- Compressor Clutch Circuits - Typical
- Coolant Fan Circuits - Typical

III. Theory of Operation

- Heat Transfer
- Change of State
- Latent Heat
- Boiling Temperature/Pressure Relationship
- Introducing R-12
- R-12 Temperature/Pressure Relationship
- R-12 Boiling Point/Pressure Relationship
- Basic Air Conditioning System

IV. Component Operation

- Expansion Valve Operation
- Orifice Tubes
- Receivers/Dryers and Accumulators
- Compressors
- Regulating Evaporator Pressure
- Compressor Control Valve
- Personal Safety

V. Diagnostic Procedures

- System Function Tests
- Gauge Hook-Up
- System Service Valves
- System Performance Test

VI. System Servicing

- Service Tools
- Refrigerant Recovery: Draining the System
- Evacuating the System
- Leak Testing
- Oil Level
- Gauge Diagnosis
- Low Refrigerant Charge
- Moisture in the System
- Bad or Misadjusted Cycling Clutch Switch
- Clogged Expansion Valve
- Expansion Valve Flooding or Stuck Open
- High-Side Restriction
- EPR, POA, or STV Sticks Open or Closed
- Compressor Problem
- Condenser Problem, System Overcharged, Engine Overheating, or Engine Cooling Fan Not Working Properly

VII. Repair Procedures

- O-Rings and Gaskets
- Orifice Tube Replacement
- Orifice Tube Repair Kit
- Accumulator Replacement
- Receiver/Dryer Replacement
- Rubber Hose Repairs
- Filter Installation
- VIR Desiccant Bag Replacement
- Expansion Valve Replacement
- Evaporator Pressure Regulator Valve Replacement
- Compressor Clutch Replacement
- Compressor Replacement

VIII. Environmental Regulations

- Refrigerant Recovery
- HFC-134a
- Chrysler/AMC Service Bulletins
- Ford Service Bulletins
- General Motors Service Bulletins
- European Import Service Bulletins
- Miscellaneous Japanese Service Bulletins

Basic Mechanisms and Conveyors

Basic Mechanisms and Conveyors

This five-day course provides technicians with an understanding of the most common mechanical devices used for the production and application of motive force. The course covers the following major topics including fasteners, bearings, couplings, gears, drives, lubrication, alignments, and steel structures. In addition, the course covers common maintenance procedures.

I. Fasteners

- Classes of Fit
- Mechanical Properties
- Fastener Materials
- Torque and Tension
- Tightening Methods
- Measuring Fastener Torque
- Overview of Bolted Joints

II. Bearings

- Bearing Design and Construction
- Bearing Types
- Bearing Lubrication
- Bearing Inspections
- Bearing Removal
- Overview of Journal Bearings
- Bearing Care
- Bearing Failure Analysis

III. Couplings

- Purpose of Couplings
- Types of Couplings
- Terminology

IV. Gears, Drives, and Lubrication

- Gear Terminology
- Shaft Positions
- Type of Gears
- Gear Lubrication
- Belt Drive Selection
- Belt Drive Principles
- V-Belts
- Variable Speed Belt Drives
- Sheaves
- Chain Functions
- Chain Drive Principles
- Chain Types
- Principles of Lubrication
- Types of Lubrication
- Lubrication Programs
- Storage and Handling
- Sampling

V. Alignment

- Fundamentals
- Tools
- Methods of Alignment
- Correcting Soft Foot
- Pre-alignment Check List
- Types of Alignment

VI. Structural Steel

- Types of Structural Steel
- Mechanical Treatment of Steel
- Heat Treating Operations
- Commercial Steels
- Tool Steels
- Stainless Steels
- Special Alloy Steels
- Wire Sheets and Bars

Bearing Maintenance

Bearing Maintenance

This is an in-depth, two-day course covering the design, construction, and installation procedures associated with the major types of bearings used in industry today. Hands-on training is the primary focus of this course, with approximately 60% of the class time spent performing laboratory exercises. This course is designed for all maintenance personnel involved with the installation of anti-friction bearings, performing bearing failure analysis, and selecting lubricants as part of their daily routine.

I. Bearing Design and Construction

- Bearing Requirements
- Bearing Types
- Anti-Friction Bearings
- Friction Bearings

II. Bearing Maintenance

- Bearing Lubrication
- Bearing Inspections
- Roller Bearing Installation
- Roller Bearing Removal
- Journal Bearing
- Bearing Care

III. Bearing Failure Analysis

- Normal and Abnormal Load Patterns
- Maintenance-Related Failures
- Lubrication-Related Failures
- Operational-Related Failures

Belt Drives

Bearing Maintenance

This is an in-depth, two-day course covering the design, construction, and installation procedures associated with the major types of bearings used in industry today. Hands-on training is the primary focus of this course, with approximately 60% of the class time spent performing laboratory exercises. This course is designed for all maintenance personnel involved with the installation of anti-friction bearings, performing bearing failure analysis, and selecting lubricants as part of their daily routine.

I. Belt Drives

- Selection Considerations
- Drive Principles
- V-Belts
- Poly V-Belts
- Variable Speed Belts
- Positive Drive Belts
- Sheaves
- Troubleshooting

Boiler Systems

Boiler Systems

This three-day course provides a strong introduction to the operation and design theory surrounding boilers and boiler control systems. Students leave the classroom with an in-depth knowledge of boiler systems, including topics such as combustion theory, fuel quality, air pollution control, and boiler operation. This course maintains a steady focus on the environmental concerns surrounding the operation and maintenance of boilers, including a thorough discussion of governmental laws and guidelines that pertain to this area.

I. Air Pollution Fundamentals

- Fuel Dependant Air Pollutants
- Combustion Dependant Air Pollutants
- Smoke and Particulate
- Steam Generators
- Laws and Regulations
- Regulatory Requirements

II. Boiler Fundamentals

- Boiler Fundamentals
- Package Boilers
- Combustion Process
- Fans
- Fuel Supply Systems
- Burner Arrangements - Natural Gas Burners
- Oil Fired Boilers
- Atomization
- Operation
- Burner Arrangements
- Boiler Design Parameters

III. Fossil Fuels

- Natural Gas
- Fuel Oil
- Liquid Fuel Characterization
- Fuel Oil Properties

IV. Combustion Principles

- Basic Combustion Reactions
- Products of Combustion
- Incomplete Combustion
- Undesirable Products of Combustion

V. Normal Operation

- Maintaining Suitable Combustion Conditions
- Monitoring Combustion
- Combustion Fuel
- Maintaining Steam Temperature and Pressure
- Controlling the Steam Temperature
- Startup Procedures
- Shutdown Procedures

VI. Automatic Control Systems

- Automatic Analog Control System Elements
- Automatic Combustion Control Systems

VII. Continuous Emission Monitoring

- General Classification of CEM□s
- Components of CEM□s
- Usage of CEM□s in Utility/Industrial Boilers
- Sulfur Oxides
- Nitrogen Oxides Control Overview
- Control of NOx Emissions

Burner & Igniter Systems

Burner & Igniter Systems

This two-day course covers basic burner and igniter fundamentals and theory, construction, and maintenance. The course starts with fuels and combustion theory, followed by burner and igniter operation and system controls. Maintenance of the burners and igniters closes out the course with labs of typical maintenance activities associated with the burners and igniters. Although this course is designed for anyone tasked with the operation or maintenance of the following burner/igniter systems, site-specific information can be incorporated into the course,including: I-Jet Lighters, Mark IV Dual Register Burners, Flamon Flame Detectors, LC 200 Lighter Control System, and Bailey 762 Control Package.

I. Fuels and Combustion

- Fuels and Fuel Characteristics
- Combustion
- Basic and Ideal Combustion
- Components of a Burner Port
- Factors Affecting Combustion

II. Systems / Operations

- Fuel Oil System
- Pulverized Coal Burning
- Equipment
- I-Jet Lighters
- Mark IV Dual Register Burners
- Flamon Flame Detectors
- LC 200 Lighter Control System
- LC 200 Lighter Control Logic Sequence

III. Bailey 762 Controls

- Air Flow
- Fuel Flow
- 762 Functional Description
- 762 Unit Description
- Purge
- Furnace Firing Permissives
- Pulverizer Group Start Sequence
- Maintained Lighters
- Pulverizer Group Operation
- Pulverizer Group Stop Sequence
- Inert and Clearing System
- Pulverizer Group Trips
- Pulverizer Group Sequence Permissives

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Compressor Maintenance

Compressor Maintenance

This three-day course introduces technicians to the different types of compressors, their operation, and general maintenance.

I. Introduction

II. Compressor Types

- Rotary
- Reciprocating

III. Operating Description

- Rotary Screw
- Rotary Vane
- Lobe Type
- Reciprocating

IV. Common Problems and Troubleshooting

- Abnormal Interstage Pressures
- Cylinder Lubrication
- Air / Water Cooling

V. General Maintenance

- Valves
- Lubrication
- Overhaul

Chillers

Chillers

This three-day course introduces chillers used in air conditioning systems, including their components, function, operation, and maintenance.

I. Properties of Matter

- Molecular Theory
- States of Matter
- Heat Transfer

II. Gases

- Expansion
- Gas Laws
- Densities and Specific Volumes
- Gas Mixtures

III. Air Conditioning

- Definition
- Properties of Air
- Using the Psychometric Chart
- Measuring Air Movement

IV. Refrigerants

- Characteristics
- Types
- Properties
- Moisture Effects
- Oil Effects
- Leak Detection
- Performance
- Storage

V. Refrigerant Oils

- Classification
- Properties
- Specifications

VI. System Components

- Vapor Compression Cycle
- Compressors
- Condensers
- Evaporators
- Receiver
- Flow Controls

VII. Auxiliary Components

- Piping
- Separators
- Filters
- Mufflers
- Moisture Indicators
- Valves

VIII. Chiller Controls

- Types of Control Systems
- Automatic Controls
- Adjustments

IX. System Operation

- Normal Operation
- Abnormal Operation

X. Maintenance and Troubleshooting

- Troubleshooting Techniques
- Performance Evaluations
- Equipment Use

Continuous Emission Monitoring System

Continuous Emission Monitoring System

CEM is the continuous measurement of pollutants emitted into the atmosphere in exhaust gases from combustion or industrial processes. The EPA has established requirements for continuous monitoring of SO2, volumetric flow, NOx, diluent gas, and opacity for units regulated under the Acid Rain Program. In addition, procedures for monitoring or estimating carbon dioxide (CO2) are specified. The CEM rule also contains requirements for equipment performance specifications, certification procedures, and recordkeeping and reporting.

I. Introduction and Overview

- Terms and Acronyms
- General Safety Requirements
- Air Pollution Fundamentals

II. Continuous Emission Monitoring

- General Classifications of CEMS
- Components of CEMS Systems
- Usage of CEMS Systems
- Miscellaneous Discussion Items

Conveyor Systems

Conveyor Systems

This three-day course is designed to cover the construction, operation, maintenance, and troubleshooting of various conveyor systems, including power-and-free, inverted power-and-free, chain-on-edge, unibelt, and SKUK.

I. Power-and-Free System

- Construction
- Operation
- Carrier
- Maintenance
- Troubleshooting

II. Inverted Power-and-Free System

- Construction
- Operation
- Carrier
- Maintenance
- Troubleshooting

III. Chain-on-Edge System

- Construction
- Operation
- Carrier
- Maintenance
- Troubleshooting

IV. Unibelt System

- Construction
- Operation
- Carrier
- Maintenance
- Troubleshooting

V. SKUK System

- Construction
- Operation
- Carrier
- Maintenance
- Troubleshooting

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Coupling Alignment

Coupling Alignment

This three-day course begins with a safety review. Next, the various types and purposes of couplings are discussed. Alignment processes are introduced and the hands-on exercises begin here. Finally, methods of measuring misalignment in rotating machinery conclude the course.

I. Introduction and Accident Prevention

- Safety
- Housekeeping
- Tag Out

II. Coupling Purposes and Types

- Couplings
- Types of Flexible Couplings
- Coupling Lubrication
- Coupling Installation
- Keys and Keyways

III. Alignment Introduction

- Shaft Alignment
- Measuring and Correcting Misalignment
- Typical Alignment Tools
- Preliminary Preparation for Alignment
- Coupling Alignment
- Preparing for Alignment, Part 1
- Foundations, Baseplates, and Machine Casings
- Preparing for Alignment, Part 2

IV. Methods for Measuring Misalignment in Rotating Machinery

- Rough Alignment Method
- Dial Indicator Method
- Making the Corrections
- Do's and Don'ts of Moving Machinery

Desulfurization Preliminary Outlines

I. Desulfurization System
- Old Desulf System
- New Desulf System
- Operations Overview of New Desulf
- Component General Description

II. Desulfurization Facility Specs
- Spectrometer Description
- Locomotive
- De-Skulling Machine
- Skimming
- Reladling
- Storage Facility Fire Protection System

III. Print Reading & Troubleshooting
- P&IDs
- Electrical One Line Diagrams
- Schematics
- General Troubleshooting Techniques

IV. Electrical System
- Facility Electrical Distribution
- Switchgear
- Motor Control Centers

V. Oxygen Injectors
- Old System Components
- New System Components
- System Operations
- Basic Maintenance

VI. Hydraulics
- Hydraulics Overview
- System Specific Components
- System Operations
- System Maintenance

VII. Skimming
- Skimming System Overview

VIII. Reladling
- Old Reladling System Overview
- New Reladling System

IX. Hydraulics
- Hydraulics Overview
- System Operations
- System Specific Components

X. Spectrometer
- Description
- Operation
- Basic Care & Maintenance

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Diesel Engines

Diesel Engines

This course provides a strong introduction to the operation and maintenance of the Caterpillar Model 16C M32 diesel engine. Students leave the classroom with an in-depth knowledge of basic four-cycle engine operation, engine construction, operating guidelines, pre-start checks, engine operating procedures, and troubleshooting.

I. Overview of Four-Cycle Engines

II. Basic Four-Cycle Engine Operation

- Intake Stroke
- Compression Stroke
- Power Stroke
- Exhaust Stroke

III. Engine Construction

- Engine Housing
- Oil Pan
- Cylinder Head
- Pistons
- Connecting Rods
- Cylinder Liner
- Crankshaft
- Vibration Damper
- Flywheels
- Bearings
- Lubrication Systems
- Fuel System
- Cooling System
- Governor

IV. Operating Procedures

- Engine Operating Guidelines
- Pre-Start Checks
- Engine Operating Procedures
- Troubleshooting

V. Maintenance

- Maintenance System
- Safety Instructions
- Periodic Maintenance Schedule – Heavy Fuel
- Engine Maintenance
- Cylinder Head Maintenance
- Cylinder Liner Maintenance
- Crankcase Relief Valve Inspection/Checking
- Piston and Connecting Rod Maintenance
- Bearing Maintenance
- Crankshaft Web Deflection Check
- Bearing Shells and Bearing Bushes
- Camshaft Maintenance
- Compressed Air System Maintenance
- Fuel System Maintenance
- Turbocharger, Charge Air Cooler, and Exhaust Manifold
- Lubricating Oil System Maintenance
- Engine Auxiliary Equipment Maintenance

Diesel Fundamentals

Diesel Fundamentals

This five-day course is designed to provide students with a thorough knowledge of diesel mechanics. Topics include engine design, classification, construction, operation, and maintenance.

I. Introduction

- Diesel Applications
- Types of Engines
- Advantages of Diesels
- Diesel Performance

II. Basic Types of Engines

- External Combustion Engine
- Four-Stroke
- Two-Stroke
- Basic Engine Components
- Engine Valves
- Crankshaft
- Valve Operating Mechanism
- Block
- Construction and Basic Design

III. Basic Measurements

- Heat-Energy
- Temperature
- Heat Transfer
- Work

IV. Diesel Fuels

- Production
- Properties of Diesel Fuel
- Heat Value
- Specific Gravity
- Flash Point and Fire Point
- Viscosity
- Volatility
- Cetane
- Commercial Diesel Fuel
- Smoke and Pollution Control

V. Combustion Chamber Types

- Open Combustion Chambers
- Turbulence Chamber
- Precombustion Chamber
- Energy Cell

VI. Classification of Diesel Engines

- Power
- Arrangement of Cylinders
- Fuel Usage

VII. Fuel Injectors & Injection System

- Air Injection
- Mechanical Injection
- Common Rail System
- Pump Control (Jerk Pump)
- Unit Injection System
- Distribution
- Atomizing Fuel

VIII. Scavenging, Supercharging, and Turbocharging

- Method of Scavenging
- Port Direct
- Valve Uniflow Scavenging
- Opposed Engine Scavenging

- Crankcase Scavenging
- Blowers
- Turbocharger

IX. Details of Engine Parts

- Block, Cylinder, and Piston
- Valves and Valve Seat
- Camshaft and Crankshafts

EMD Locomotive

EMD Locomotive

This five-day course is designed to provide students with a thorough knowledge of the EMD locomotive mechanics.

I. General Description

- Locomotive Operation
- Auxiliary Equipment
- Operating Controls
- Engineman□s Control Panel
- Switches
- Engine Room
- Air Brake Equipment
- Miscellaneous Equipment

II. Engine Starting and Cab Controls

- Engine Starting Controls
- Switch and Fuse Panel
- Circuit Breaker Panel
- Engine Control Panel
- Locomotive Control Console
- Mechanical Interlocks on the Controller
- Air Brake Equipment
- Brake Equipment Positions

III. Operation

- Preparation for Service
- Starting the Diesel Engine
- Trailing Unit Cab Inspection
- Starting the Trailing Unit Diesel Engines
- Placing Units on the Line
- Precautions Prior to Moving the Locomotive
- Handling Light Locomotive
- Draining Air Reservoirs and Strainers
- Engine Air Box Drain
- Engine, Air Compressor, and Cab Heater Water Drain Valves
- Coupling Locomotive Units Together
- Coupling Locomotive Units to Trains
- Pumping Up Air
- Brake Pipe Leakage Test
- Kicking Cars
- Starting a Train
- Accelerating a Train
- Slowing Down for Grades
- Air Braking With Power
- Operating Over Rail Crossing
- Running Through Water
- Wheel Slip Light Indications
- Locomotive Speed Limit
- Hump Speed Control
- Multiple Unit Operation
- Double Heading
- Isolating a Unit
- Changing Operating Ends
- Stopping the Engine
- Securing the Locomotive for Layover
- Towing Locomotive in Train
- Freezing Weather Precautions

IV. Cooling, Lubricating Oil, Fuel Oil, and Air Systems

- Operating Water Level
- Lubricating Oil System
- Fuel Oil System
- Air System

V. Electrical Equipment

- Basic Electrical Equipment
- Main Generator
- Traction Motors
- Reversing the Locomotive
- Electrical Control Cabinet
- Relay Operation
- Wheel Slip Relay Operation
- Ground Relay (GR)
- Current Limit Relay (CLR)
- Voltage Regulator
- Reverse Current Relay
- ER Relay (If Used)

Electric Overhead Traveling (EOT) Crane

Electric Overhead Traveling (EOT) Crane

This two-day course introduces the electric overhead traveling (EOT) crane including the safety requirements and boarding procedure, crane operation and inspection, and troubleshooting requirements.

I. Introduction to EOT Crane Operations and Safety

- Eliminating Injuries and Incidents In and Around Operating Cranes
- Importance of Cranes in the Steel Industry
- History of Cranes

II. Basic Safety Requirements and Crane Boarding Procedures

- Crane Status Light
- Crane Operator Boarding Procedures
- One Shop Maintenance Man Boarding Procedure
- Group and/or Planned Maintenance Procedure

III. Operational Inspection of Crane Equipment

- Various Operating Parts of the Crane
- Inspection Procedures of Overhead/ EOT Pendant-Controlled and RadioControlled Cranes
- Crane Operator Daily Report-Sheet

IV. Crane Operations and Coordination

- Working Relationship Between The Crane Operator And Hooker
- Various Controls and Functional Parts of Cranes (Hoist, Bridge, and Trolly)
- Hazards of Remote and Pendant Cranes

V. Lifting Device Descriptions and Requirements

- Cables (Wire Rope)
- Chains
- Slings

VI. Troubleshooting Possibilities

Industrial Hydraulic Fundamentals

Industrial Hydraulic Fundamentals

This three-day course provides participants with an excellent understanding of hydraulic theory, hydraulic components, and hydraulic systems.

I. Hydraulic Theory

- Hydraulic Development
- Physics of Hydraulics
- Hydraulic Symbols

II. Hydraulic Components

- Hydraulic Liquids
- Piping and Connectors
- Sealing Devices
- Hydraulic Reservoirs
- Accumulators
- Hydraulic Pumps
- Control Valves
- Cylinders/Actuators

III. Hydraulic Systems

- Basic Hydraulic System
- Hydraulic Circuits

IV. Common Causes of Failure

- Dirt
- Heat
- Misapplication
- Improper Fluids
- Maintenance
- Improper Design or Installation

V. Plant-specific Applications

HVAC Programmable Logic Controllers

HVAC Programmable Logic Controllers

This course teaches the fundamentals of how to use the Allen Bradley software to edit, document, maintain, and troubleshoot the Allen Bradley PLC. The goal of this course is to givethe HVAC technician a stronger understanding of the strengths, limitations, and workings of the Allen Bradley PLC. The course consists of two days of classroom instruction and one day of hands-on training.

I. Basic Programmable Controller Review

- PLC Components
- PLC Addressing
- PLC Ladder Logic Basics

II. Configuring "SMART" Modules (Functional Overview)

- Analog Input Modules
- Analog Output Modules
- Thermocouple Modules

III. PLC Communications

- Communications on the Data Highway +
- Communication Via the Ethernet Port
- Communication with PLC's in Adapter Mode

IV. Advanced Editing

- Advance Searching
- Using the AFI Instructions

V. Process Controls and PLCs

- Control and Analog Outputs of PLCs
- Feedback Loops Using PLCs
- Tuning Loops With PLCs

VI. Labs

Failure Mode Effects Analysis

Failure Mode Effects Analysis

This two-day course teaches participants how to do process failure mode analysis using storyboards. The course gives an overview of techniques that support development of Failure Mode Effects Analysis (FMEA). These techniques include block diagrams, experiments, and fault tree analysis to produce a design FMEA. Participants practice performing failure mode effects analysis using a computer software program called FORMUSER.

I. Introduction

- Quality and Reliability
- Failure Mode and Effects Analysis
- A Systematic Process
- History
- Purpose/Benefits
- DFMEA and PFMEA

II. DFMEA

- When are DFMEA's Performed?
- What Characterizes a Candidate?
- Who Performs DFMEA's?
- What Resources and Tools are Used?
- How is the Process Performed and Documented?

III. PFMEA

- When are PFMEA's Performed?
- Who Performs PFMEA's?
- What Resources and Tools are Used?
- How is the Process Performed and Documented?
- The PFMEA Form

IV. Examples/Activities

V. Tools

- DFMEA
- Capability Studies

VI. FORMUSER Software

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Fans & Blowers

Fans & Blowers

This two-day course provides an overview of how fans and blowers operate and compares them with centrifugal pumps. Hands-on training is the primary focus of this course, with approximately 50% of class time performing laboratory exercises. This course is designed to be conducted in conjunction with Anti-Friction Bearing Maintenance and Precision Tools course.

I. Fan Types

- Classifications
- Characteristics
- Centrifugal Fans
- Axial Fans

II. Components

- Materials of Construction
- Shafts and Seals
- Bearings
- Shafts
- Housings
- Dampers and Ductwork
- Lubrication Systems
- Valves

III. Operation

- Efficiency
- Power Requirements
- Speed
- Measuring Air Movement
- Fan Laws
- Normal Operation
- Abnormal Operation

IV. Maintenance

- Large Fan Maintenance
- Installing Belt Drives
- Bearing Installation
- Foundations
- Coupling Installation and Alignment
- Preventive Maintenance

V. Troubleshooting

- Troubleshooting Techniques
- Performance Evaluations
- Equipment Use

Fans & Filters

I. Fan Types
- Classifications
- Characteristics
- Centrifugal Fans
- Axial Fans

II. Components
- Materials of Construction
- Shafts and Seals
- Bearings
- Shafts
- Housings
- Dampers and Ductwork
- Lubrication Systems
- Valves

III. Operation
- Efficiency
- Power Requirements
- Speed
- Measuring Air Movement
- Fan Laws
- Normal Operation
- Abnormal Operation

IV. Maintenance
- Large Fan Maintenance
- Installing Belt Drives
- Bearing Installation
- Foundations
- Coupling Installation and Alignment
- Preventive Maintenance

V. Filters
- Purpose
- Types
- Ratings
- Selection
- Care and Maintenance
- Flow Controls

VI. Maintenance and Troubleshooting
- Troubleshooting Techniques
- Performance Evaluations
- Equipment Use

Fossil Power Generation

Fossil Power Generation

This five-day overview course describes the portion of the sub-systems that support the plant gas turbine operation. This is a technician-level course for both operating and maintenance personnel, providing the knowledge base necessary to begin working on equipment.

I. Steam Basics

- Thermodynamic Fundamentals
- Non-Flow Processes
- Liquid-Vapor Systems
- Heat Engines
- Turbines
- Steam Power

II. Boiler Fundamentals

- Boiler Fundamentals
- Package Boilers
- Combustion Process
- Fans
- Fuel Supply Systems
- Burner Arrangements - Natural Gas Burners
- Oil Fired Boilers
- Atomization
- Operation
- Burner Arrangements

III. Simple and Combined Cycle Overview

- Energy in the Simple Cycle Power Station
- Gas Turbine Cycle
- Plant Operator's Responsibilities
- Plant Safety
- Environmental Aspects
- Power Station Types and Comparisons
- Power Demand Growth
- Transmission System
- Simple Cycle Gas Turbine Plant
- Combined Cycle Gas Turbine Plant
- Major Systems and Components

IV. Heat Recovery Steam Generator (HSRG) System

- Flowpath Descriptions
- Major Equipment

V. Fossil Fuels

- Natural Gas
- Fuel Oil
- Liquid Fuel Characterization
- Fuel Oil Properties

VI. Combustion Principles

- Basic Combustion Reactions
- Products of Combustion
- Incomplete Combustion
- Undesirable Products of Combustion

VII. Air Pollution Fundamentals

- Fuel Dependant Air Pollutants
- Combustion Dependant Air Pollutants
- Smoke and Particulate
- Steam Generators
- Laws and Regulations
- Regulatory Requirements

VIII. Continuous Emission Monitoring

- General Classification of CEM's
- Components of CEM's
- Usage of CEM's in Utility/Industrial Boilers
- Sulfur Oxides
- Nitrogen Oxides Control Overview
- Control of NOx Emissions

Fuels and Combustion

Fuels and Combustion

This three-days course is designed to provide participants with a working knowledge of the combustion process used in modern power plant applications. Different fuels, the equipment used to burn these fuels, and the monitoring of the emissions is covered in detail. Emission

I. Fuels

- Fuel Characteristics
- Solid Fuels
- Gaseous Fuels
- Safety
- Liquid Fuels

II. Combustion

- Coal Oil and Gas
- Combustion Process

III. Basic and Ideal Combustion

- Basic Combustion
- Ideal Combustion
- Combustion Control

IV. Components of a Burner Port

- Diffuser
- Air Register
- Burner Throat
- Ignitor
- Flame Detectors

V. Factors Affecting Proper Combustion

- Flame Characteristics
- Oil Flame
- Gas Flame
- Smoke

VI. Performance Monitoring

- Checking Combustion Efficiency
- Performance Monitoring
- Corrosion, Deposits, and Emissions Control
- Boiler Efficiency Related Factors
- Combustion Related Factors
- Stack Gas Waste Heat Losses
- Combustible Losses
- Radiation Losses
- Waterside Losses
- Steam Heat Loss Factors
- Boiler Maintenance Practices
- Blower Factors
- Air Heaters
- Boiler Auxiliaries

VII. Furnace Safeguards Supervisory System (FSSS)

- Overview
- FSSS Role in Steam Generating Process
- Unintentional Fires External to Furnace

VIII. Plant Emissions and Clean Air Act

- Emissions
- Particulate
- Sulfur Oxide

- Nitrogen Oxide
- Fly Ash
- Optical Properties of Flyash

IX. Overview of Continuous Emission Monitoring (CEM)

- SO2 Monitoring
- NOX Monitoring
- Volumetric Flow
- Opacity
- Diluent Gas (O2 or CO2)
- Records

Hand Tools

Hand Tools

This three-day course describes various hand tools, including their intended uses, cautions against misuse, and telltale signs for repair or replacement of tools. Also discussed in this course are the required maintenance actions used to keep tools safe and efficient. The course can be tailored to include your specific tools or presented as is. This course is designed for facility maintenance personnel.

I. Wrenches

- Sockets-
- Handle-Type Wrenches
- Combination Box/Open-End Wrenches
- Box Wrenches
- Open-End Wrenches
- Adjustable Wrenches
- Torque Wrenches
- Spanner Wrenches

II. Pliers

- Linemen's Side Cutting Pliers
- Ironworkers Pliers
- Long Nose Pliers
- Diagonal Cutting Pliers
- Flat-Nose Pliers
- End-Cutting Pliers
- Slip Joint Pliers
- Tongue and Groove Pliers
- Locking Pliers-Wrenches
- Cutters
- Retaining Ring Pliers

III. Striking Tools

- Nail Hammers
- Ball Peen Hammers
- Riveting and Setting, Hammers
- Scaling or Chipping Hammer
- Bricklayers' Hammers
- Prospecting Picks
- Soft Face/Non-Ferrous Hammers and Mallets
- Magnetic Hammers
- Engineers Hammers/Sledges, Double Face
- Blacksmiths' Hand Hammers and Sledges
- Stone Sledges and Spalling Hammers
- Hand Drilling or Mash Hammers
- Bush Hammers
- Woodchoppers' Mauls
- Axes and Hatchets

IV. Struck or Hammered Tools

- Cold and Hot Chisels
- All-Steel Wood and Ripping Chisels
- Hand Punches
- Blacksmiths' Round/Backing Out Punches
- Drift Pins
- Star Drills
- Brick Chisels and Brick Sets
- Wood Splitting Wedges
- Nail Puller Bars
- Ball Sets

V. Redressing Instructions

- Screwdrivers
- Vises
- Clamps
- Snips
- Tool Boxes, Chests and Cabinets
- Automotive Tools
- Pipe Tools

Heat Transfer and Thermodynamics

I. Thermodynamic Properties Measurements and Conversions

- Energy Transfer Systems
- Properties of Working Fluids
- Forms of Energy
- Work and Heat
- Energy and Power Equivalencies
- Enthalpy
- Phases of Matter
- Property Diagrams

II. Thermodynamics

- The Study of Thermodynamics
- The First Law of Thermodynamics
- Applications of the General Energy Equation
- The Second Law of Thermodynamics
- Steam Tables
- Use of Saturated Steam Tables
- Use of Superheated Steam Tables
- Liquid Heat Capacity
- Mollier Diagram

III. Heat Transfer Methods

- Modes of Heat Transfer
- Fundamentals of Heat Transfer
- Conduction
- Convection
- Combined Heat Transfer
- Radiation
- Boiling Heat Transfer

IV. Heat Cycles

- Types of Cycles
- Carnot Cycles
- Rankine Cycles
- Moisture Separator Reheaters and
- Feedwater Heaters
- Power Plant Components
- Typical Power Cycle
- Overall Plant Efficiency

V. Heat Exchangers

- Types of Heat Exchangers
- Operation of Heat Exchangers
- Steam Generator Heat Transfer
- Condenser Heat Transfer

VI. Reactor Heat Generation and Transfer

- Power Operation In the Reactor Core
- Factor Affecting Power Distribution
- Indications of Core Power and Heat Generation

VII. Reactor Fuel Heat Transfer

- Fuel Rod Temperature Profiles
- Temperature Profiles Across Coolant Channels
- Factors Affecting Reactor Heat Transfer

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HVAC Fundamentals

HVAC Fundamentals

This five-day course covers the design, construction, operation, and maintenance associated with air conditioning and refrigeration units. Special attention is placed on the environmental concerns associated with commonly used refrigerants, as well as the recent restrictions placed upon the handling and disposal of these refrigerants by the EPA in accordance with the Clean Air Act. This course is designed for all maintenance personnel involved in the upkeep and repair of air condition units as part of their daily routine.

I. Properties of Matter

- Molecular Theory
- States of Matter
- Heat Transfer

II. Gases

- Expansion
- Gas Laws
- Densities and Specific Volumes
- Gas Mixtures

III. Air Conditioning

- Definition
- Properties of Air
- Using the Psychometric Chart
- Measuring Air Movement

IV. Refrigerants

- Characteristics
- Types
- Properties
- Moisture Effects
- Oil Effects
- Leak Detection
- Performance
- Storage

V. Refrigerant Oils

- Classification
- Properties
- Specifications

VI. System Components

- Vapor Compression Cycle
- Compressors
- Condensers
- Evaporators
- Receiver
- Flow Controls

VII. Auxiliary Components

- Piping
- Separators
- Filters
- Mufflers
- Moisture Indicators
- Valves

VIII. Chiller Controls

- Types of Control Systems
- Automatic Controls
- Adjustments

IX. System Operation

- Normal Operation
- Abnormal Operation

X. Maintenance and Troubleshooting

- Troubleshooting Techniques
- Performance Evaluations
- Equipment Use

HVAC Fundamentals and Testing

HVAC Fundamentals and Testing

This five-day course is ideal for anyone tasked with ensuring the proper operation and maintenance of industrial HVAC units. The course provides a background in basic air laws, application information, and the refrigeration cycle, as well as a practical knowledge of the various types of instrumentation used in HVAC testing. Minimum testing requirements for over a dozen different applications are detailed, along with balancing testing procedures, air conditioner servicing techniques, and sound and vibration testing.

I. HVAC Systems Construction and Applications

- Basic Air Laws
- Purpose of HVAC
- Fans
- Ductwork
- Basic Refrigeration Cycle
- Types of Air Systems
- Hydronic Systems

II. Field Instrumentation Overview

- Airflow Measurement Devices
- Hydronic Measuring Equipment
- Temperature Measuring Instruments
- Humidity Measuring Devices
- Electrical Measuring Devices
- Minimum Values and Frequency of Insulation Resistance Test
- Rotation Measuring Instruments
- Vibration Measurement

III. Equipment Test and Balance Requirements

- Heating and Ventilating Units
- Built-Up Units – Low-Pressure and High- Pressure Single Duct

IV. Test and Balance Procedures

V. Testing and Balancing Air/ Water Systems

VI. Sound and Vibration Testing

- Sound
- Field Vibration Testing
- Vibration Testing Procedure

VII. HEPA Filter and Charcoal Absorber Requirements and Testing

- HEPA Filter History
- HEPA Filter Testing
- Charcoal Absorber Requirements and Testing

Hydraulics (Hands-On)

Hydraulics (Hands-On)

This five-day course provides participants with an excellent understanding of the principles of hydrostatics and hydrodynamics which serve as the foundation for discussions of hydraulic system component functions and operations. The course then progresses to troubleshooting methodology as applied to hydraulic systems, both complex and simple.

I. Introduction to Hydraulic Components

- System Familiarization
- Introduction to Hydraulic Systems
- Hydraulic Fluids
- Filtration Systems
- Hydraulic Pumps
- Pressure Control Devices
- Manual Directional Control Valves
- Check Valves
- Needle Valves
- Hydraulic Cylinders
- Hydraulic Flow Control Valves

II. Hydraulic Applications Laboratories

- Paired Cylinders in a Circuit
- Hydraulic Press Application
- Hydraulic Jack Application
- Hydraulic Positioner Application
- Hydraulic Symbols and Schematics

III. Physical Properties of Hydraulic Systems

- Flow Rate in Hydraulic Systems
- Force In Hydraulic Systems
- Hydraulic Force Transformers
- Work Done with Hydraulic Systems
- Power in Hydraulic Systems
- Energy in Hydraulic Systems
- Pressure Drop in Pipes and Components

IV. Hydraulic Pump Design

- Standards
- Applications
- Pump Classifications
- Basic Pump Types
- Dynamic (Kinetic)
- Centrifugal Pump Classes
- Terminology

V. Pump Operation and Theory

- Centrifugal Pumps
- Design Aspects
- Pump Laws
- Positive-Displacement Pumps
- Pump Performance Comparisons
- Special Purpose Pumps
- Pump Characteristic Curves
- Performance Testing of Centrifugal Pumps

VI. Rotary Pump Troubleshooting and Maintenance

- Pump Performance
- Pump Tests
- Weigh Liquid
- Rotary Pump Problems
- Rotary Pump Maintenance

VII. Reciprocating Pump Troubleshooting and Maintenance

- Steam Pumps
- Troubleshooting Pumps
- Metering Pumps
- Axial- and Radial-Piston Pumps
- Hydraulic Pump Maintenance
- Axial-Piston Pump Maintenance
- Radial Piston Pumps

Hydraulics/Pneumatics (Hands-On)

Hydraulics/Pneumatics (Hands-On)

This five-day course provides participants with an excellent understanding of the principles of hydrostatics and hydrodynamics operation and maintenance principles involved with hydraulic and pneumatic systems, including pipes and piping components. The course then progresses to a hands-on application of hydraulic and pneumatic systems, including troubleshooting methodology as applied to both complex and simple systems.

I. Hydraulic/Pneumatic Theory

- Advantages of Fluid Power
- Transmission of Forces
- Force and Pressure
- Computing Force, Pressure, and Area
- Force and Pressure in Fluid Power
- Compressibility and Expansion of Gases
- Work and Energy
- Work and Power
- Factors Involved in Flow
- Bernoulli's Principle
- Hydraulic and Pneumatic Applications
- Hydraulic and Pneumatic Symbols

II. Hydraulic Components

- System Familiarization
- Introduction to Hydraulics
- Hydraulic Fluids
- Filtration Systems
- Hydraulic Pumps
- Pressure Control Devices
- Manual Directional Control Valves
- Check Valves and Needle Valves
- Hydraulic Cylinders
- Hydraulic Flow Control Valves

III. Pneumatic Components

- System Familiarization
- Introduction to Pneumatics
- Filtration Systems
- Pressure Control Devices
- Directional Control Valves
- Purification Equipment
- Check Valves and Needle Valves
- Pneumatic Cylinders
- Pneumatic Flow Control Valves

IV. Physical Properties of Hydraulic Systems

- Flow Rate in Hydraulic Systems
- Force In Hydraulic Systems
- Hydraulic Force Transformers
- Work Done with Hydraulic Systems
- Power in Hydraulic Systems
- Energy in Hydraulic Systems
- Pressure Drop in Pipes and Components

V. Physical Properties of Pneumatic Systems

- Flow Rate in Pneumatic Systems
- Force in Pneumatic Systems
- Work Done with Pneumatic Systems
- Energy in Pneumatic Systems
- Pressure Drop in Pipes and Components

VI. Pipes and Piping Components

- Metal Piping
- Forged Pipe and Welded Pipe
- Non-metallic Piping
- Tubing
- Welded Connections
- Flanged Connections
- Threaded Connections
- Joint Preparation and Fit-Up
- Expansion Joints
- Moisture Separators and Lubricators
- Temperature Measuring Devices
- Flow Measuring Devices
- Pressure Measuring

Industrial Hydraulics

Industrial Hydraulics

This five-day course primarily focuses on hydraulic system troubleshooting. A comprehensive study of hydraulic system components and their major causes of failure will be examined in detail. Plant maintenance personnel will be asked to bring plant-specific prints for review and study during the print reading section of the course. In addition, a detailed study of hydraulic system contamination control is included, with an emphasis on component and system design changes that should be incorporated into all existing and future systems.

I. Hydraulic Components

- System Familiarization
- Introduction to Hydraulic Systems
- Hydraulic Fluids
- Filtration Systems
- Hydraulic Pumps
- Pressure Control Devices
- Manual Directional Control Valves
- Check Valves
- Needle Valves
- Hydraulic Cylinders
- Hydraulic Flow Control Valves

II. Hydraulic Laboratories

- Paired Cylinders in a Circuit
- Hydraulic Press Application
- Hydraulic Jack Application
- Hydraulic Positioner
- Hydraulic Symbols and Schematics

III. Physical Properties

- Flow Rate in Hydraulic Systems
- Force in Hydraulic Systems
- Hydraulic Force Transformers
- Work Done with Hydraulic Systems
- Power in Hydraulic Systems
- Energy in Hydraulic Systems
- Pressure Drop

IV. Hydraulic Pump Design

- Standards
- Applications
- Pump Classifications
- Basic Pump Types
- Dynamic (Kinetic)
- Centrifugal Pump Classes
- Terminology

Industrial Mathematics

Industrial Mathematics

This five-day course is designed to give industrial technicians the mathematical skills required to effectively accomplish jobs requiring mathematics. The course consists of classroom instruction as well as labs using real-world examples where these skills are applied. The examples used are tailored to the specific industry of the client.

I. Decimals

- Decimal System
- Placeholders
- Exercises

II. Basic Operations

- Calculators
- Addition
- Subtraction
- Multiplication
- Division
- Exercises
- Applications

III. Order of Operations

- Standard Order
- Parentheses and Brackets
- Exercises
- Applications

IV. Variables and Equations

- Variables
- Equations
- Applications

V. Problem Solving Techniques

- Draw a Picture
- Collect the Facts
- Identify the Unknown
- Write Equations
- Substitute and Solve
- Reality Check
- Applications

VI. Negative Numbers

- Meaning of Negative Numbers
- Negative Numbers on Calculators
- Basic Operations on Negative Numbers
- Exercises
- Applications

VII. Ratios

- Relationships of Numbers
- Cross Multiplication
- Transformer Windings
- Exercises
- Applications

VIII. Fractions

- Common Fractions
- Mixed Numbers
- Converting between Fractions and Decimals
- Basic Operations on Fractions
- Complex Fractions
- DC Circuit Analysis
- Exercises
- Applications

IX. Percentages

- Meaning of Percent
- Converting among Percentages, Decimals, and Fractions
- Basic Operations on Percentages
- Tolerances
- Motor Efficiencies
- Exercises
- Applications

X. Exponents

- Meaning of Exponents
- Exponents on Calculators
- Exercises
- Applications

XI. Roots

- Meaning of Roots
- Roots on Calculators
- RMS Voltage
- Exercises
- Applications

XII. Scientific Notation

- Powers of 10
- Scientific Notation on Calculators
- Exercises
- Applications

XIII. Logarithms

- Log10
- Ln
- Logarithms on Calculators
- Decibels
- Exercises
- Applications

XIV. Units of Measurement

- Prefixes
- Conversions
- Exercises
- Applications

XV. Perimeter, Area, and Volume

- Perimeter
- Area
- Volume
- Tanks
- Exercises
- Applications

XVI. Averages

- Meaning of Average
- Exercises
- Applications

XVII. Algebraic Equations

- Balance Rule
- Rearranging in Variable Form
- Substitution
- Ohm's Law and Power
- Exercises
- Applications

XVIII. Trigonometric Functions

- Angles
- Right Triangles
- Sine, Cosine, and Tangent
- True Power and Apparent Power
- Exercises
- Applications

Industrial Mechanical Skills

Industrial Mechanical Skills

Industrial Mechanical Skills is a two-week course designed to teach the basic concepts mechanical equipment. All maintenance personnel from apprentice level to journeyman are encouraged to attend this course as it will provide them with the terminology and understanding of mechanical equipment basics and equipment interaction.

I. Piping Systems

- Terminology
- Safety
- Piping Identification
- Symbology

II. Piping Tools

- Basic Tools
- Pipe Bending

III. Piping and Tubing

- Metal Piping
- Forged Pipe
- Welded Pipe
- Non-metallic Piping
- Tubing

IV. Fittings

- Welded Connections
- Flanged Connections
- Threaded Connections
- Joint Preparation

V. Valves

- Valve Characteristics
- Valve Types
- Valve Operators
- Valve Actuator Terms
- Steam Traps

VI. Pumps

- Terminology
- Centrifugal
- Positive Displacement

VII. Components

- Expansion Joints
- Moisture Separators
- Lubricators
- Temperature Measuring
- Flow Measuring
- Pressure Measuring

VIII. Brazing and Welding

- ASME Section IX
- Welding Processes
- Welding Equipment
- Brazing and Cutting

IX. Pipe Supports

- Design
- Hanger Types
- Snubbers

X. Insulation

- Principles of Insulation
- Types of Insulation
- Installation

XI. Alignment Fundamentals

- Types of Misalignment
- Causes of Misalignment
- Effects of Misalignment
- Misalignment Indications
- Alignment Tools

Industrial Pneumatics

Industrial Pneumatics

Industrial Pneumatics is a three-day course designed to give maintenance personnel a complete understanding of the operation and maintenance principles involved with pneumatic systems. Topics such as compressed air safety, component design and installation, and system cleanliness will be the primary focus of this course. All maintenance personnel who work on compressors or are involved with the daily repair and operation of pneumatic systems are strongly encouraged to attend this course.

I. Introduction

- Industrial Safety
- Accident Prevention
- Stored Energy System Safety

II. Pneumatic Theory

- Advantages of Fluid Power
- Transmission of Forces
- Force and Pressure
- Computing Force, Pressure, and Area
- Force and Pressure in Fluid Power Systems
- Multiplication of Forces
- Compressibility and Expansion of Gases
- Work and Energy
- Work and Power
- Factors Involved in Flow
- Bernoulli's Principle
- Advantages of Pneumatics
- Pneumatic Applications
- Pneumatic Symbols

III. Pneumatic Components

- Purification Equipment
- Piping and Connectors
- Pneumatic Cylinders
- Pneumatic Control Valves
- Compressors
- Pneumatic Motors
- Pneumatic Tools

IV. Pneumatic Circuits

- Basic Pneumatic System
- Simple Circuits
- Pneumatic Circuits

Industrial Rigging

Industrial Rigging

This two-day course covers the basic principles of lifting and handling equipment used by plant personnel. The primary focus of this course is safety. OSHA and ANSI standards will be discussed as they apply to the types of rigging equipment used at your facility. Participants will learn how to determine load weights, select the proper rigging hardware, and safely use the equipment to move heavy loads.

I. Wire Ropes and Slings

- Grades
- Classifications
- Rope Lay
- Measuring Lay Length
- Cores
- Safety Factors
- Non-Rotating Ropes
- Inspections
- End Fittings
- Chains
- Slings
- Hitches
- Safe Working Loads
- Fiber Slings

II. Rigging Hardware

- Hooks
- Shackles
- Eyebolts
- Hoists
- Electric Hoists
- Blocks and Tackle
- Mechanical Advantage
- Friction

III. Cranes, Derricks, and Hoists

- Tower Cranes
- Tower Configurations
- Jib Configurations
- Mounting Configurations
- Overhead Cranes
- Crane Replacement
- Wire Rope Lubrication
- Mounting Types
- Mobil Cranes
- Crane Operation
- Clamshell Attachment
- Load Dropping Attachments
- Magnet Cranes
- Rock Tongs and Grabs
- Crane Set-Up
- Helpful Hints

Insulation Installation & Repair

Insulation Installation & Repair

This five-day course is designed to provide participants with the basic knowledge and skills to safely complete pipe insulation repairs, removal and installation at the job site. The course provides both theory and practical application. The course is designed for 8-10 participants.

I. Introduction

II. Theory of Heat Transfer and Moisture Effects

- Methods of Heat Transfer
- Moisture Migration
- Application of Various Types of Insulation

III. Tools of the Trade

- Insulation Tools
- Proper Use and Care
- Safety Procedures

IV. Material Handling and Storage

- Receiving
- Stacking
- Storage
- Movement

V. Pipe Characteristics

- Types
- Sizes
- Uses
- Relationship of Pipe Size and Insulation Size

VI. Installing Calcium Silicate Pipe Insulation

- Safe Handling
- Storage
- Making Accurate Cuts
- Install Single-Layer and Double-Layer Pipe Insulation

VII. Installing Flexible Foam Insulation

- Proper Tool Use
- Procedures for Installing

VIII. Installing Fiberglass Pipe Insulation

- Insulation Characteristics
- Sizing Requirements
- Characteristics of ASJ Jacketing

IX. Installing Rigid Foam Insulation

- Proper Tool Use
- Insulation Handling and Storage
- Measuring, Cutting, Installing, and Sealing
- Cryogenic Installation
- Expansion Joints
- Contraction Joints
- Vapor Stops

X. Cement and Fabric Finishes and Mastics

- Proper Use of Finishing Tools
- Cleanup and Protection Procedures
- Limitations of Cements, Fabric Finishes, and Mastics

XI. Adhesives and Their Uses

- Identification
- Application
- Uses

XII. Sheet Metal Lagging

- Sheet Metal Tools Identification and Application
- Fabrication and Installation Methods
- Flashing and Sealing Techniques

Introduction to Predictive Maintenance

Introduction to Predictive Maintenance

The Introduction to Predictive Maintenance is a three-day seminar designed to give workers an introduction to the methods, procedures, and philosophies used in Predictive Maintenance. The student will be introduced to the various techniques used to predict and prevent failure of various types of industrial equipment found in the workplace.

I. Establishing a Predictive Maintenance Program

- Program Organization
- Elements of Program
- Philosophy
- Personnel Requirements
- Budget Estimates

II. Implementation and Operation

- Overview
- Plant Equipment Selection
- Task Selection
- Determining Predictive Method
- Task Frequency
- Procedures and Training
- Data Tracking
- Trend Analysis
- Diagnostic Analysis

III. Insulation and Monitoring

- Theory
- Properties of Insulation
- Factors Affecting Insulation Resistance
- Measuring Insulation Resistance (and Interpretation)

IV. Oil Analysis

- Properties of Lubricating Oils
- Analysis of Oil Samples

V. Vibration Monitoring

- Terminology
- Sensors and Applications
- Vibration Monitoring vs. Analysis
- Vibration Severity
- Causes of Vibration

VI. Thermography

- Heat Transfer Concepts
- Imaging Radio Meters
- Applications
- Accuracy
- Frequency

VII. Non-Destructive Evaluation

- Liquid Penetrant
- Particle Inspection
- Eddy Current Testing
- Radiography
- Ultrasonics
- Comparing NDE Inspection Methods

14497 N. Dale Mabry Hwy Ste 120-N Tampa, FL 33618 Phone: (813) 908-1100 Fax: (813) 908-1200 www.techtransfer.com

Laser Alignment

Laser Alignment

This two-day course teaches this highly specialized alignment technique used in industry today. Vibration problems are the cause of 50-70% of all rotating mechanical equipment failures. Most vibration problems can be traced back to the alignment condition of the machine.

I. Alignment Fundamentals

- Alignment Conditions
- Effects of Misalignment
- Alignment Methods

II. Laser Alignment Method and Equipment

- Laser System Components
- Optalign Alignment Process
- Turning On the Optalign System
- Measurement Procedure

III. Soft Foot

- What is Soft Foot?
- Types of Soft Foot
- Soft Foot Determination Using the Optalign System

IV. Determining and Correcting Shaft Misalignment

- Zero-Zero Alignment
- Alignment Adjustments
- Other Optalign Functions

Lubrication Fundamentals

Lubrication Fundamentals

This three-day course is designed for plant personnel responsible for the proper lubrication of industrial equipment. The primary focus of this course is the proper selection and application of lubricants. In addition, oil testing and system cleanliness will be discussed with an emphasis placed on the major causes of lubrication-related failures. Machinery in industrial applications are required to perform at higher speeds and pressures. For this very reason, industrial facilities are monitoring their lubrication programs very closely. Maintenance supervisors are strongly recommended to attend this course as maintenance philosophies relating to lubrication and lubricating systems are also discussed.

I. Lubrication

- Solid Friction
- Lubrication of Rubbing Surfaces
- Boundary Lubricants
- Interaction Between Metals & Lubricants
- Modes of Full Film Lubrication Viscosity

II. Lubricants

- Mineral Oils
- Additives
- Machinery Lubricants
- Oil Deterioration and Maintenance
- Synthetic Oils
- Solid Lubricants
- Greases

III. Types of Wear and Erosion

- Abrasive Wear
- Adhesive Wear
- Surface Fatigue
- Fretting
- Particle and Droplet Erosion
- Cavitation Erosion
- Spark Erosion
- Thermal Softening
- Impact Wear
- Corrosive Wear

IV. Lubrication of Plain Bearings

- High and Low Speed Limits
- Allowances for Deflection in Plain Journal Bearings
- Journal Bearings With Reciprocating Loads
- Methods of Oil Supply
- Open Systems
- Continuous Lubricators
- Closed System
- Thrust Bearings
- Flat Land Thrust Bearings
- Tapered Land Thrust Bearing
- Kingsbury Thrust Bearing
- Oil Grooving
- Journal Bearing Vibrations
- Turbulence in Lubrication
- Grease Lubrication

V. Lubrication of Roller Bearings

- General
- Lubricating Correctly

VI. Lubricating Specific Components

- Lubricating Gears
- Types of Gear Lubricants
- Piston Ring Lubrication
- Reciprocating Air Compressors
- Rotary Compressors
- Hydrocarbon Compressors
- Industrial Diesel and Gas Engines
- Gas Turbines

VII. Oil Tests

- Viscosity
- Viscosity Index
- Cloud and Pour Points
- Gravity
- Flash/Fire Point
- Color
- Neutralization Number
- Total Base Number
- Precipitation Number
- Foaming
- Oxidation
- Lubricity
- Synthetic Fluids

Machinery Diagnostics

Machinery Diagnostics

This three-day course is designed for plant personnel responsible for the maintenance and repair of vibration problems in industrial equipment. The primary focus of this course is the formats for vibration plotting and malfunction identification. Machinery in industrial applications is required to perform at higher speeds and pressures. For this very reason, industrial facilities
are closely monitoring their equipment vibration problems.

I. Machinery Diagnostic - Vibration Plot Formats

- Machines, Maintenance, and Monitoring
- Basic Principles of Vibration Monitoring
- Concepts of Statics, Kinematics, and Dynamics
- Basic Vibration Theory
- Transducers
- Data Acquisition and Signal Processing
- Machinery Fault Diagnosis and Discussion

II. Machinery Diagnostic - Malfunction Identification

- Experimental Protocol
- Transducer Calibration and Mounting
- Baseline Signature and Data Collection
- MFS Reconfiguration for Various Fault Studies
- Data Collection for Various Faults (Unbalance, Eccentricity, Bent Shaft, Looseness, Misalignment, Bearings, Resonance/Critical Speed, Gearbox, Belt Drives, Under Different Speeds and Loading)
- Comparison of Fault Signatures to Baseline to Determine Cause and Effect
- Validate Common Fault Guidelines
- Discussion Concerning Troubleshooting and Correcting Real Life Problems

MAXIMO

Maximo

This three-day course begins with an overview of and introduction to the MAXIMO environment. Database login requirements and main menus are then described. Also included are the basics of creating PMs and job plans, and lessons on setting up and maintaining an organization's location and equipment hierarchies. An in-depth look at the work order processing, labor reporting, and entering purchase requisitions.

I. Introduction to MAXIMO

II. Database Login

III. MAXIMO Main Menus

- Work Orders
- PM's
- Inventory
- Equipment
- Purchasing
- Job Plans
- Labor
- Calendars
- Resources
- Custom Applications
- Setup
- Utilities

IV. MAXIMO Navigation

- Definitions
- Screens
- Query
- Drilldown
- Long Descriptions
- MAXIMO Hints

V. Work Orders

- Work Order Tracking Screen
- Work Order Status
- Job Plans

VI. Labor Reporting

- Labor Reporting in Work Order Tracking Screen
- Labor Reporting in Labor Module

VII. Entering Purchase Requisitions

Mechanical Fundamentals

Mechanical Fundamentals

This five-day course provides participants with a working knowledge of blueprints and mechanical drawings, measuring devices, hydraulics, pneumatics, mechanical drive systems, fasteners, and bearings.

I. Blueprints and Mechanical Drawings

- Blueprints
- Mechanical Drawing Views
- Arrangement of Views
- Thread Dimensioning
- Tapered & Machined Surface Dimensioning
- P&ID Drawings

II. Mechanical Measuring Devices

- Rules
- Calipers
- Micrometers
- Dial Indicators

III. Hydraulics

- Hydraulic Theory
- System Components
- Hydraulic Symbols
- System/Circuit Troubleshooting

IV. Pneumatics

- Pneumatic Theory
- System Components
- Pneumatic Symbols
- System/Circuit Troubleshooting

V. Mechanical Drive Systems

- Belts
- Chain Drives
- Gear Systems
- Conveyors

VI. Fasteners

- Classes of Fit
- Mechanical Properties
- Fastener Materials
- Torque and Tension
- Tightening Methods
- Measuring Fastener Torque
- Overview of Bolted Joints

VII. Bearings

- Bearing Design and Construction
- Bearing Types
- Bearing Lubrication
- Bearing Inspections
- Bearing Removal
- Overview of Journal Bearings
- Bearing Care
- Bearing Failure Analysis

Mechanical Level I

Mechanical Level I

This five-day course is the first level of a fifteen-day training program designed to give plant technicians a greater depth of knowledge and skill in various mechanical equipment job functions. Major course topics include basic soldering, basic tools (hand/power), bearing maintenance, bolting and torque, hydraulics, industrial rigging, lubrication, mechanical (power)transmission, orifice meters, pneumatics, power plant fundamentals, precision measuring instruments, print reading, fans and blowers, technical math, troubleshooting, and valve maintenance.

I. Basic Soldering

- Soldering Equipment
- Soldering Techniques

II. Basic Tools

- Accident Prevention
- Types of Hand Tools

III. Bearing Maintenance

- Basic Concept of Bearings
- Major Bearing Classifications
- Bearing Maintenance

IV. Bolting

- Screw Threads
- Fastener Materials
- Torque and Tension

V. Hydraulics

- Hydraulic Development
- Physics of Hydraulics
- Hydraulic Symbols
- Hydraulic Components
- Hydraulic Systems

VI. Industrial Rigging

- Rigging Safety
- Rigging Equipment
- Rigging Fundamentals
- Moving and Manipulating Loads

VII. Lubrication Fundamentals

- Basics of Lubrication
- Lubricants
- Operating Machinery Wear and Erosion
- Bearing Lubrication
- Methods of Oil Supply
- Proper Lubrication
- Lubrication Testing and Sampling

VIII. Mechanical Transmission

- Gears
- Clutches
- Belt Drives
- Chain Drives

IX. Orifice Meters

- Why Measurement Is So Critical
- Orifice Measurement Theory
- Measurement Components

X. Pneumatics

- Pneumatic Theory
- Pneumatic Components
- Pneumatic Circuits

XI. Power Plant Fundamentals

- Simple Power Plants
- Basic Energy Processes and Equipment
- Boiler Feedwater Cycle
- Pressure and Flow
- Temperature and Heat
- Properties of Water

XII. Precision Measuring Instruments

- Gauging Fundamentals
- Metrology
- Standard Tools for Measuring and Inspection

XIII. Print Reading

- Blueprints
- Fluid Power Drawings
- Piping and Instrumentation Diagrams

XIV. Fans and Blowers

- Fans
- Blowers

XV. Technical Math

- Decimals, Percentage, and Square Roots
- Algebraic Operations
- Algebraic Operations II
- Algebraic Equations
- Algebraic Word Problems
- Exponents and Radicals
- Logarithms and Scientific Notation
- Geometry
- Geometry II
- Trigonometry

XVI. Troubleshooting Philosophy and Practices

- Troubleshooting Documentation
- Seven-Step Troubleshooting Philosophy
- Troubleshooting With Flowcharts
- Five Action Steps for Systematic Troubleshooting
- Deriving Logical Troubleshooting Flowcharts and Strategies
- Cause and Effect Diagrams

XVII. Valve Maintenance

- Valve Types
- Identification, Marking, and Symbols
- Valve Installation
- Valve Packing and Sealing
- Valve Maintenance and Repair

Mechanical Level II

Mechanical Level II

This ten-day course is the second level of a fifteen-day training program designed to give plant technicians a greater depth of knowledge and skill in various mechanical equipment job functions. Major course topics include compressor maintenance, cranes and hoists, emergency diesels, pipes and pipefitting, pump maintenance, shaft alignment, static and dynamic sealing, and welding fundamentals.

I. Compressor Maintenance

- Air Compressors
- Compressor Air System Maintenance
- Maintenance of Compressed Air Systems
- Pneumatic System Troubleshooting

II. Cranes and Hoists

- Hydraulic Truck Cranes
- Mobile Floor Crane

III. Emergency Diesels

- Diesel Engines
- Fundamentals of the Diesel Cycle
- Diesel Engine Speed, Fuel Controls, and Protection
- Operation of Diesel Engines
- Diesel Engine Maintenance

IV. Pipefitting

- Piping Components
- Piping Materials
- Pipe Manufacturing Methods
- Pipe Insulation
- Pipe Hangers and Supports

V. Pump Maintenance

- Pump Classifications
- Pump Terminology
- Pump Operation
- Rotary Pumps
- Reciprocating Pumps
- Centrifugal Pumps

VI. Shaft Alignment

- Alignment Fundamentals
- Alignment Preparation
- Alignment Stages
- Precision Alignment

VII. Static and Dynamic Seals

- Operating Principles
- Sealing Basics
- Installation
- Maintenance

VIII. Welding Fundamentals

- Welding Safety
- Basic Welding Fundamentals
- Welding Processes
- Nondestructive Testing

Mechanical Maintenance: Pumps and Shaft Alignment

Mechanical Maintenance: Pumps and Shaft Alignment

This five-day course covers pump design, operating theory, rotary pumps, reciprocating pumps, and centrifugal pumps, compression packing and gaskets, couplings, and alignment

I. Pump Design

- Standards
- Applications
- Pump Classifications

II. Pump Operation and Theory

- Centrifugal Pumps
- Design Aspects
- Pump Laws
- Positive Displacement Pumps
- Pump Performance Comparisons
- Special Purpose Pumps
- Pump Characteristic Curves
- Performance Testing Centrifugal Pumps

III. Rotary Pump Maintenance

- Pump Performance
- Pump Tests
- Rotary Pump Problems
- Rotary Pump Maintenance

IV. Reciprocating Pump Maintenance

- Metering Pumps
- Axial and Radial-Piston Pumps
- Hydraulic Pump Maintenance

V. Centrifugal Pump Maintenance and Troubleshooting

- Factors Affecting Performance
- Troubleshooting
- Inspecting Components for Wear

VI. Compression Packing

- Mechanical Seals Applications
- Packing Materials
- Selecting and Sizing Packing
- Lantern Rings and Throttle Bushings
- Renewal Techniques
- Formed and Molded Packing

VII. Gaskets

- Transformer Gaskets
- Preparation of Surfaces and Gaskets
- O-Ring, Foam Rubber, and Cork Gaskets
- Leak Detection
- Common Gaskets and Materials
- Gasket Replenishment

VIII. Coupling Purposes and Types

- Couplings
- Types of Flexible Couplings
- Coupling Lubrication
- Coupling Installation
- Keys and Keyways

IX. Alignment Introduction

- Shaft Alignment
- Measuring and Correcting Misalignment
- Typical Alignment Tools
- Preliminary Preparation for Alignment
- Coupling Alignment
- Preparing for Alignment, Part 1
- Foundations, Baseplates, and Machine Casings
- Preparing for Alignment, Part 2

X. Methods for Measuring Misalignment in Rotating Machinery

- Rough Alignment Method
- Dial Indicator Method
- Making the Corrections
- Do's and Don'ts of Moving Machinery

Motor-Operated Valve Maintenance

Motor-Operated Valve Maintenance

This three-day course is designed for mechanics and engineers responsible for the operation and maintenance of MOVs at their location. Topics covered include MOV construction, controls, inspection, lubrication, troubleshooting, disassembly, reassembly, preventive maintenance, diagnostic testing, and valve installation. Repair procedures are presented and applied using a Limitorque SMB-000 series operator. Limit switch and torque switch adjustment as well as the selection and interchangeability of valve actuators is also discussed.

I. Introduction

- MOV Failures - Industry Case Histories
- Sizes and Classifications
- Principles of Hand Operations
- Principles of Motor Operations

II. Construction

- Description of Major Subassemblies
- Nameplate Information
- Selection and Sizing Criteria

III. Maintenance Techniques

- Installation
- Overhaul
- Electrical Checkout
- Inspection and troubleshooting
- Performance Testing and Evaluation
- Torque and Limit Switch Adjustment/ Balancing
- Lubrication

Orifice Metering

Orifice Meeting

This three-day course is designed to help technicians better understand the components and equipment that go into making an orifice measurement, and the importance of each of these components.

I. Why Measurement is So Critical

II. Orifice Measurement Theory

- Gas Law Review
- Flow Characteristics
- Bernoulli's Equation

III. Measurement Components

- Meter Tube
- Orifice Plate-Holding and Positioning Device
- Taps
- Straightening Vanes
- Flow Conditioners
- Common Problems with Flow Measurement Using Orifice Plates

P & ID Reading

P & ID Reading

This two-day course introduces technicians to blueprints, why they are used, the information they contain, and types of drawings and their use.

I. The Need to Know How to Read Blueprints

II. Why Blueprints are Used

III. Blueprint Information

- Name
- Scale
- Assembly Drawing Number
- Unit Or Assembly
- Drawing Number
- Part Number
- Required
- Drafting Room Record
- Material
- Limits

IV. Types of Drawings

- Detail Drawing
- Assembly Drawing
- Auxiliary Views
- Sections
- Pictorial Drawings

Pipes & Piping Components

Pipes & Piping Components

This five-day course is designed to teach maintenance mechanics the importance of pipe installation, selection, and testing. This course encompasses the vast types of tubular products that are available for use when transporting fluids. Plant personnel who routinely install pipelines or are involved in the day-to-day maintenance of components in fluid delivery systems should attend this course.

I. Codes and Standards

- Regulatory Agencies
- Codes And Standards
- National Plumbing Code

II. Piping Systems

- Terminology
- Safety &
- Piping Identification
- Symbology

III. Piping Tools

- Basic Tools
- Pipe Bending

IV. Piping and Tubing

- Metal Piping
- Forged Pipe
- Welded Pipe
- Non-metallic Piping
- Tubing

V. Fittings

- Welded Connections
- Flanged Connections
- Threaded Connections
- Miscellaneous Connections
- Joint Preparation and Fit-Up

VI. Components

- Expansion Joints
- Moisture Separators
- Lubricators
- Temperature Measuring Devices
- Flow Measuring Devices
- Pressure Measuring Devices

VII. Insulation

- Principle of Insulation
- Types of Insulation
- Insulation Installation

VIII. Pipe Supports

- Design of Pipe Hangers and Supports
- Hanger Types
- Snubbers
- Traceability

IX. Testing

- Leak Testing
- Pressure Testing
- Plumbing Systems Tests
- Non-Destructive Testing
- Qualification of NDE/NDT Personnel

X. Laboratory Exercises

Piping, Tubing, and Fittings

Piping, Tubing, and Fittings

This three-day course is designed to teach the importance of proper installation and testing of tubular products. The course is comprised of classroom and hands-on training. Plant personnel who routinely install tubing or are involved in the daily maintenance of components in a tubing (piping) system will benefit from this course.

I. Codes and Standards

- Regulatory Agencies
- Codes and Standards

II. Piping and Tubing

- Piping
- Tubing
- Basic Pipe Tools
- Pipe Bending Tools

III. Fittings (Tubing Joints)

- Welded Connections
- Flanged Connections
- Threaded Connections

IV. Tubing Installation

- Tube Cutting
- Tube Bending
- Tube Supports
- Flared Connections
- Flareless Connections (Compression)

V. Testing

- Leak Testing
- Pressure Testing

Industrial Electrical System Distribution Analysis

Industrial Electrical System Distribution Analysis

This course will describe the various disturbances and irregularities that commonly occur on electrical systems. Voltage variations such as surges, sags, impulses are addressed. Also grounding bonding and shielding are explained with references to the National Electrical Code Requirements. This course is designed for those responsible for proper operation of industrial power distribution systems.

I. Introduction

II. Power System Overview

- Power System Equipment
- Voltage and Current Relationship
- Normal Monitoring of Power Quality

III. Power System Equipment

- Generators
- Transformers
- Capacitors
- Voltage Regulators
- Reactors

IV. Power System Disturbances

- Voltage Surges
- Voltage Sags
- Impulses or Spikes
- Harmonics

V. Power Conditioning

- Filtering Techniques
- Surge Protection
- Lightning Protection
- Motor Starting Control

VI. Grounding, Bonding and Shielding

- Proper Grounding
- NEC Requirements
- Bonding of Conduit and Raceways
- Shielding of Control and Communications Circuits
- Maintenance of the Electrical Grounding System

VII. Monitoring Power System Quality

- Monitoring Equipment
- Frequency of Monitoring
- Location of Monitoring Equipment
- Solutions to Disturbance Problems

VIII. Harmonics

- Description of Harmonics
- How Harmonics Effect Equipment
- Solutions to Harmonics
- Determining Harmonic Effects on Neutral Current
- Sources of Harmonics

IX. Short Circuit Analysis

- Factors that Determine Short Circuit Current
- Transformer KVA and % Z
- Conduit and Raceway Factors
- Calculating Short Circuit Current
- Determining Short Circuit Protection

X. Course Review and Summary

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Power Transmission Systems

Power Transmission Systems

Power Transmission Systems is a three-day course designed for maintenance personnel that are responsible for the upkeep and maintenance of power transmission devices. Gears, belt drives, chain drives , and clutches will be studied in detail with a focus on maintenance principles and troubleshooting techniques designed to increase equipment reliability.

I. Gears

- Terminology
- Shaft Position
- Gear Types
- Selection
- Backlash
- Circulating Systems

II. Clutches

- Classifications
- Engagement Methods
- Clutching Methods
- Installation

III. Belt Drives

- Selection Considerations
- Drive Principles
- V-Belts
- Poly V-Belts
- Variable Speed Belts
- Positive Drive Belts
- Sheaves
- Troubleshooting

IV. Chain Drives

- Functions
- Principles
- Transmission Types
- Roller Chain Sprockets
- Chain Drive Arrangements
- Chain and Sprocket Inspectiononics

Precision Measuring Instruments

Precision Measuring Instruments

This three-day course begins with a look at fundamentals of measurement and errors followed by a review of the principles of metrology. Standard tools used for measuring and inspection are covered, including scales, calipers and dividers, Vernier calipers and dial calipers, micrometers, gauge blocks, mechanical indicators, and dial indicators, as well as a review of torque measurement. The last portion of the course covers fixed gauges.

I. Gauging Overview

- History of Gauging
- Gauging Fundamentals
- Measurement Errors
- Cleanliness
- Care and Handling of Instruments
- Metrology

II. Standard Tools for Measuring and Inspection

- Scales
- Calipers and Dividers
- Vernier Calipers and Dial Calipers
- Gauge Blocks
- Mechanical Indicators
- Torque Measurement

III. Fixed Gauges

- Types of Fixed Gauges
- Limit Gauges for Length Dimensions
- Cylindrical Limit Gauges
- Fixed Gauges for Multiple Dimensions

Print Reading

I. Reading Electrical Diagrams

- Electrical Diagrams
- Schematic Symbols
- Practice Exercise I & II
- Relays
- Special Relays
- Timers
- Counters
- Practice Exercise III

II. Static and Manual Control Switches

- Basic Ladder Diagram
- Static Control Switches

III. Sensing and Timing Control Switches

- Common Pilot Devices
- Limit Switches
- Pressure Switches
- Flow Switches
- Float Switches
- Temperature Switches
- Foot Switches
- Proximity Switches
- Photoelectric Switches
- Fiber Optic Photoelectric Switches
- Plugging Speed Switches
- Reed Switches
- Timers

IV. Electromagnetic Control Switches

- Electromagnetic Principles, Solenoids, and Relays
- Basic Solenoid Components and Their Functions
- Basic Relay Components and Component Functions
- Types and Application of Solenoids and Relays
- Control Relays
- Latch/Unlatch Relays
- Magnetic Contactors
- Motor Starters
- Solenoids
- Fuses and Circuit Breakers
- Overloads

V. Understanding Electrical Control Circuits

- Wiring and Schematic Diagram Symbols
- Electrical Diagrams
- Ladder Diagrams
- Basic Rules of Electrical Ladder Diagrams

Pump and Heat Exchanger Maintenance

Pump and Heat Exchanger Maintenance

This three-day course begins with a review of the cooling system components and operation. Various types of pumps and their design characteristics are described. Fans, gearbox, couplings, and maintenance of these components complete the course.

I. Cooling System

- System Overview
- Component Description

II. Pumps

- Centrifugal Pumps
- Design Aspects
- Pump Laws
- Positive Displacement Pumps
- Pump Performance Comparisons
- Pump Characteristic Curves

III. Motors

- Electrical
- Hydraulic

IV. Fans

- Classification
- Operation
- Terminology
- Characteristic Curve
- Performance Testing

V. Gearbox/Coupling

- Gearbox Operation
- Coupling Alignment

VI. Maintenance

- Pumps
- Motors
- Fans
- Heat Exchanger

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Pump Maintenance

Pump Maintenance

This five-day course is designed to describe pump design, operation, and theory. Various types of pumps are discussed. Hands-on exercises are performed by all participants to reinforce the concepts taught in the classroom. In addition, a discussion of pump maintenance on rotary, reciprocating, and centrifugal pumps will give the participants a complete understanding of typical pump problems and solutions.

I. Pump Design

- Standards
- Applications
- Pump Classifications

II. Pump Operation and Theory

- Centrifugal Pumps
- Design Aspects
- Pump Laws
- Positive Displacement Pumps
- Pump Performance Comparisons
- Special Purpose Pumps
- Pump Characteristic Curves
- Performance Testing Centrifugal Pumps

III. Rotary Pump Maintenance

- Pump Performance
- Pump Tests
- Rotary Pump Problems
- Rotary Pump Maintenance

IV. Reciprocating Pump Maintenance

- Steam Pumps
- Power Pumps
- Metering Pumps
- Axial and Radial-Piston Pumps
- Hydraulic Pump Maintenance

V. Centrifugal Pump Maintenance and Troubleshooting

- Factors Affecting Performance
- Troubleshooting
- Inspecting Components for Wear

Radiation Safety

Radiation Safety

This three-day course begins with a fundamental review of radiation. Methods of measuring radiation and radioactivity, effects of radiation exposure, ways to detect and shield against radiation are presented. Standard operating procedures and emergency procedures of a radiation safety program are also stressed.

I. Radiation Fundamentals

- Atomic and Nuclear Properties
- Radiation and Radioactivity
- Common Terms
- Properties of Radiation
- X-Ray Production
- Half-Life

II. Radioactivity and Radiation

- Radioactivity and Radiation
- Radiation Exposure Effects
- Risk From Exposure
- Doses

III. Radiation Detection and Shielding

- Radiation Detection Equipment
- Bicron Detection Equipment
- Shielding

IV. Site-Specific Training

- Standard Operating Procedures
- Radiation Safety Program
- Emergency Procedures
- Handling and Installing Sources
- Change of Source
- Procedure for Detection of Radioactive Material in Scrap

Reduction in Variance and Root Cause Failure Analysis

Reduction in Variance and Root Cause Failure Analysis

This one-day course is composed of two parts. The first part of this course is focused on the reduction or analysis of variance and quality on your organization. The second section focuses on the methods for evaluating opportunities for improvement.

I. Reduction in Variance

- Check Sheets
- Pareto Charts
- Run Charts
- Control Charts

II. Root Cause Failure Analysis (RCFA)

- Flowcharts
- Cause-and-Effect (Fishbone) Diagrams
- Affinity Diagrams

Refrigeration and Air Conditioning Controls

Refrigeration and Air Conditioning Controls

This four-day course begins with a look at fundamentals of refrigeration systems. An overview of the major refrigeration system components is included. The theory of electromagnetic motors and their use in compressors is covered. The electrical circuit controls used in refrigeration and air conditioning is discussed, along with the electrical troubleshooting of these controls.

I. Refrigeration Fundamentals

- History of Refrigeration
- Temperature, Pressure and Measurement
- Refrigeration Systems and Terminology

II. Refrigeration System Components

- Compressors
- Condenser
- Evaporators
- Refrigeration Flow Controls
- Refrigerants

III. Scanner Cards

- Electricity and Circuit Fundamentals
- Magnetism and Electrical Components
- Transformers and Motor Circuits
- Electrical Components and Computers

IV. Electrical Motors

- Types of Electric Motors
- Identification of Electrical Motors
- Compressor Winding Identification
- Applications of Motors
- Troubleshooting Electrical Motors

V. Electric Circuits and Controls

- Electrical Circuits
- Electrical Circuits
- Ladder Diagrams
- Pressure Switches
- Temperature Switches
- Timers
- Electromagnetic Control Switches
- Fuses and Circuit Breakers
- Overload Relays

VI. Troubleshooting Techniques

- Use of schematics
- Limit Switches
- Pressure Switches
- Temperature Switches
- Timers
- Electrical Circuit

Refrigeration Systems

Refrigeration Systems

This five-day, lecture-based course covers the basic mechanical refrigeration cycle, the different refrigerants available, major refrigeration system components, system operation, service, and troubleshooting. This is a technician-level course for both operating and maintenance personnel, providing the knowledge base necessary to work on refrigeration equipment.

I. Matter and Heat Behavior

- Motion of Molecules
- Changes of State
- Measuring the Amount of Heat Energy
- Removing Heat - Cooling
- Conservation of Energy
- Heat Flow
- Refrigeration Effect - "Ton"

II. Fluids and Pressures

- Expansion of Gases
- Gas Laws
- Density of Materials
- Specific Volumes of Materials
- Mixtures of Gases

III. Refrigerants

- Refrigerant Characteristics
- Refrigerant Properties
- Refrigerants and Water
- Leak Detection
- Effect on Materials
- Refrigerant Performance
- Refrigerant Storage
- Refrigerant Safety Precautions

IV. Refrigeration System Components

- Basic Mechanical Refrigeration Cycle
- Compressors
- Condensers
- Refrigerant Flow Controls
- Evaporators

V. Refrigeration Piping and Accessories

- Refrigeration Piping
- Hot Gas, Liquid, and Suction Lines
- Types of Accessories
- Valves

VI. Refrigeration Oils

- Classification
- Properties
- Oil Specifications

VII. Air Conditioning

- Definition of Air Conditioning
- Air-Atmosphere
- Physical Properties of Air
- Psychrometric Properties of Air
- Air Movement

VIII. Air Conditioning Service Techniques

- Installing a Gauge Manifold
- Gauge Manifold
- Evaluating Performance of System
- Removing Refrigerant
- Open and Make Repairs
- Pressure Testing
- Evacuating a System
- Charging a Repaired System
- Evaluate Repair

Relief Valve Maintenance

Relief Valve Maintenance

This three-day course covers basic relief valve fundamentals and theory, construction, and maintenance and testing of relief and safety valves. This course is approximately 1 day of classroom with 1½ to 2 days hands-on exercises.

I. Relief and Safety Valve Fundamentals

- Functions and Terminology
- Markings
- Designations
- Theory of Operation

II. Maintenance

- Installation/Removal
- Disassembly
- Inspections/Repairs
- Reassembly
- Gagging

III. Testing and Adjustments

- Setpoint Testing and Adjustment
- Blowdown Testing and Adjustment
- Accumulation Testing and Adjustment
- Seat Leakage Testing
- Hydrostatic Testing
- Temperature Compensation

IV. Regulatory Guidlines

- OSHA
- ASME B&PV
- DOT

Safety, Hand Tools, and Print Reading

Safety, Hand Tools, and Print Reading

This two and a half day course covers the fundamentals of safe work practices and job setup. Maintenance personnel should gain a thorough understanding of how to read prints and select the proper tools for the job. Participants will be asked to bring prints to class for review and study allowing them to compare classroom materials to their day to day job.

I. Safety

- Accident Prevention
- Equipment Layout
- Equipment Lockout
- Personal Safety Equipment
- Rotating Equipment
- Hand Tool Safety
- Welding Safety
- Cutting Operations
- Fire Safety

II. Mechanical Print Reading

- Types of Drawings
- Parts of a Drawing
- Mechanical Drawing Views
- Arrangement of Views
- Dimensions and Drawing Notes
- Standards for Dimensioning
- Construction, Size, and Location
- Dimensions
- Tolerance
- Decimal Dimensions
- Specifying Decimal Tolerances
- Representing & Dimensioning Screw Threads
- Dimensioning Tapers and Machined Surfaces
- Dimensioning with Shop Notes
- Cutting Planes, Section Lining, and Full Sections
- Conventional Breaks
- Flow Diagrams
- Piping Plans and Elevations
- Piping Isometrics

III. Tool Use, Equipment and Maintenance

- Hand Tools
- Power Tools
- Test Equipment
- Special Devices

Rigging and Load Handling

I. Planning the Rigging Job

- Factors For Consideration
- Advance Planning
- Site Planning
- Job Preparation

II. Rigging Components

- Connectors
- Rope
- Commonly Used Knots
- Splices
- Adjusters
- Hoists

III. Inspecting the Selected Rigging Equipment

Root Cause Failure Analysis

Root Cause Failure Analysis

This 2-½ day course shows participants how to collect facts, analyze those facts, pinpoint the problem, recommend solutions to eliminate the problem, and then track the progress of the implemented recommendations. Additionally, participants will understand who is responsible for monitoring, identifying, documenting, and implementing improvements for equipment, processes, or human failures.

I. Root Cause Failure Analysis Overview

- Definition of a Problem
- Categories of Failures
- Root Cause Failure Analysis Process
- Gathering Information
- Interviewing
- Describing the Problem

II. Root Cause Failure Analysis Techniques

- Change Analysis
- Barrier Analysis
- Event and Causal Factor Analysis Charting

III. Test and Verification of Probable Root Cause

- Test Probable Causes
- Verification of the Root Cause
- Steps to Verification
- Root Cause Failure Analysis Documentation

IV. Root Cause Coding

- Basic Cause Categories
- Pareto Analysis Procedure

V. Component Failure Modes and Mechanisms

- Component Life Concept
- Specific Failures

Shaft Alignment

Shaft Alignment

This five-day course designed to remove these problems from your facility by teaching the most current alignment techniques used in industry today. Vibration problems are the cause of 50-70% of all rotating mechanical equipment failures. Most vibration problems can be traced back to the alignment condition of the machine. Considering that alignment is historically the number one cause of component failure, this course is the foundation for all maintenance personnel involved with the installation and repair of rotating mechanical equipment.

I. Alignment Fundamentals

- Types of Misalignment
- Causes of Misalignment
- Effects of Misalignment
- Indications of Misalignment
- Alignment Tools
- Alignment Methods

II. Alignment Preparation

- Pre-Alignment Checklist
- Soft Foot
- Bar Sag

III. Stages of Alignment

- Stages
- Moving the Machine

IV. Precision Alignment

- Rim and Face
- Cross Dial
- Reverse Dial

V. Thermal Growth

- Thermal Growth Calculation
- Alignment Corrections with Thermal Growth
- Determining Final Indicator Readings

VI. Non-Standard Alignments

- Multiple Feet/Bolts
- Multiple Machines
- Jackshaft Alignment

Static and Dynamic Sealing

Static and Dynamic Sealing

This three-day course is designed for a maintenance target group comprised of the following: first time maintenance personnel, journeyman refresher, electrical or electrical test personnel required to perform mechanical maintenance, supervisors and inspection personnel. The course is roughly 50% "hands-on" laboratory sessions and 50% classroom instruction.

I. Compression Packing

- Mechanical Seals Applications
- Packing Materials
- Selecting and Sizing Packing
- Lantern Rings and Throttle Bushings
- Renewal Techniques
- Formed and Molded Packing

II. Gaskets

- Transformer Gaskets
- Preparation of Surfaces and Gaskets
- O-Ring, Foam Rubber, and Cork Gaskets
- Leak Detection
- Common Gaskets and Materials
- Gasket Replenishment

III. Bolted Joints

- Proper Torque
- Joint Types
- Flange Connections
- Flange Faces
- Studbolts

IV. Threaded Fasteners

- Threads and Terminology
- Mechanical Properties
- Fastener Materials
- Tightening Methods/Good Practices

V. Valves

- Valve Types and Use
- Gate, Globe and Ball Valves
- Valve Installation
- Bolting Patterns
- Proper Wrench Use

Sulzer Valve Maintenance

Sulzer Valve Maintenance

This three-day course (two days mechanical and one day electrical) discusses the maintenance, inspection, and repair of Sulzer valves.

I. Basic Principle of Operation

- Valve Construction
- Actuators

II. Valve Maintenance

- Prerequisites
- Clearances/Equipment Conditions Cautions and Warnings
- Required Tools and Equipment
- Tools
- Rigging Equipment
- Consumables
- Procedures
- Disassemble the Actuator from the Valve
- Disassemble the Valve
- Inspect the Valve
- Assemble the Valve
- Assemble the Actuator to the Valve

III. Actuator and Valve Setting

- Prerequisites
- Required Tools and Equipment
- Procedure
- Torque Couplings Checking
- Torque Couplings Setting
- Torque Limit Checking
- Torque Limit Setting

IV. Troubleshooting Sulzer Valves

Thermography

Thermography

This three-day course covers the concepts of how to properly use infrared cameras to collect quality data. Students learn how to calculate accurate, repeatable temperature measurements. This course also covers your camera's critical parameters and setup. Students learn infrared thermographic interpretation through class exercises and in-plant examples. A wide variety of thermography applications are covered in this course. We also focus on improving the students' equipment operational skills, image acquisition, interpretation, and report generation abilities. Using site equipment, we develop exercises to ensure proper equipment use and interpretation.

I. Thermography

- Basic Concepts
- The Camera
- Photo Interpretation
- Usage Principles

II. Typical Applications (Hands-On)

- Electrical Inspections in Buildings, Plants, Facilities
- Power Generation Generator Inspections
- Power Plant Boiler Flue Gas Leak Detection
- Substation Electrical Inspections, Transformers, and Capacitor Evaluation
- Electrical Motor Inspections, Mechanical Bearing Inspections
- HVAC Equipment Evaluation
- Cold Storage Cooling Losses
- Heat Exchanger Quality and Efficiency Evaluation
- Furnace Refractory (Insulation) Inspections
- Furnace Internal Flame Evaluation and Tube Inspections
- Printed Circuit Board Evaluation and Troubleshooting
- Pipeline Inspection, Leak Detection, Stress Corrosion Cracking Area

III. Advantages of Using Thermography

- Quick Problem Detection Without Interrupting Service
- Prevention of Premature Failure
- Extension of Equipment Life
- Identification of Potentially Dangerous or Hazardous Equipment

Troubleshooting Methods

Troubleshooting Methods

This two-day course teaches the fundamentals of troubleshooting to technicians. It covers the areas which are common to most problems encountered in industry, and how to approach these problems with a systematic approach to troubleshooting. This course is split between classroom and hands-on troubleshooting.

I. Troubleshooting Documentation

II. Seven-Step Troubleshooting Philosophy

- Step 1 - Symptom Recognition
- Step 2 - System Elaboration
- Step 3 - Listing of Probable Faulty Functions
- Step 4 - Localizing Faulty Function
- Step 5 - Localizing Fault to a Component
- Step 6 - Failure Analysis
- Step 7 - Retest Requirements

III. Troubleshooting With Flowcharts

- Typical Troubleshooting Process
- The Flowchart Model

IV. Five Action Steps for Systematic Troubleshooting

- Step 1: Verify That a Problem Actually Exists
- Step 2: Isolate the Cause of the Problem
- Step 3: Correct the Cause of the Problem
- Step 4: Verify That the Problem Has Been Corrected
- Step 5: Follow Up to Prevent Future Problems

V. Deriving Logical Troubleshooting Flowcharts and Strategies

- Deriving Your Own Troubleshooting Strategy
- Steps for Troubleshooting Intermittent Failures
- Identifying All Possible Causes of Trouble

VI. Cause and Effect Diagrams

- Constructing a Cause and Effect Diagram

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Valve Maintenance

Valve Maintenance

This five-day course discusses valve fundamentals and construction, maintenance and testing, relief and safety valves, valve actuators and operators, and Limitorque valves.

I. Valve Fundamentals

- Functions and Terminology
- Markings
- Designations

II. Valve Construction

- Valves
- Globe Valves
- Gate Valve
- Knife Valves
- Ball Valves
- Plug Valves
- Diaphragm Valves
- Pinch Valves
- Butterfly Valves
- Needle Valves
- Control Valves
- Regulators and Reducers
- Check Valves
- Bonnets
- Seats and Seat Leakage
- Stem Seals

III. Valve Maintenance and Testing

- Valve Inspection
- Packing
- Packing Adjustment
- Packing Installation
- Lapping
- Blueing
- Optical Flats
- Specific Valve Type Maintenance
- Non-Destructive and Performance Testing

IV. Relief and Safety Valves

- Principles of Operation
- Terminology
- Relief Valves
- Safety Valves
- Troubleshooting
- Safety Valve Maintenance
- Safety Valve Testing
- Vacuum Breakers and Rupture Discs

V. Actuators and Operators

- Manual Operators
- Electric Operators
- Solenoid Operators
- Solenoid Operator Maintenance
- Pneumatic Operators
- Diaphragm Operator Maintenance
- Fire System Valves
- Hydraulic Operators
- Hydraulic Operator Maintenance

VI. Limitorque Valves

- Basic Principle of Operation
- MOV Failures
- Motor Operations
- Hand Operations
- Description of Major Subassemblies
- Nameplate Information
- Lubrication

- Removal
- SMB-000 Overhaul
- SMB-0 Overhaul
- Installation Procedure

Vibration Analysis

Vibration Analysis

This three-day course begins with an introduction to condition monitoring, the types of data, and sequence of operations. Next, the fundamentals of vibration are introduced, followed by monitoring equipment, programs, considerations for balancing machines, and vibration sensors is provided.

I. Introduction to Condition Monitoring

- Types of Monitoring
- Types of Data Available
- Sequence of Operations

II. Fundamentals of Vibration

- Common Measurement Systems
- Harmonic Motion Equations
- Power Equations
- Relationships
- Beat Frequencies
- Real World Machinery Harmonics
- Decibels

III. Monitoring Equipment

- Transducers
- Mounting Transducers
- Analyzers

IV. Condition Monitoring Programs

- Mechanical Monitoring Objectives

V. Considerations for Balancing Machinery

- Setting Up a Monitoring Route
- Taking Readings
- Interpreting
- Sensor Selection Guide

VI. Common Vibration Sensors

- Displacement Sensors
- Choosing an Industrial Sensor
- Primary Sensor Considerations
- Typical Questions

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Welding

Welding

This five-day course provides the participants with hands-on instruction on the tools, procedures, and processes used in the welding and cutting of metals. This course is designed for the training of participants with a limited knowledge of welding and focuses on the hands-on skills and techniques used in modern welding.

I. Alignment Fundamentals

- Types of Misalignment
- Causes of Misalignment
- Effects of Misalignment
- Indications of Misalignment
- Alignment Tools
- Alignment Methods

II. Alignment Preparation

- Pre-Alignment Checklist
- Soft Foot
- Bar Sag

III. Stages of Alignment

- Stages
- Moving the Machine

IV. Precision Alignment

- Rim and Face
- Cross Dial
- Reverse Dial

V. Thermal Growth

- Thermal Growth Calculation
- Alignment Corrections with Thermal Growth
- Determining Final Indicator Readings

VI. Non-Standard Alignments

- Multiple Feet/Bolts
- Multiple Machines
- Jackshaft Alignment

VII. Metal Technology

- Metal Production
- Metal Properties and Identification
- Heat Treatment of Metals