TPC TRAINING

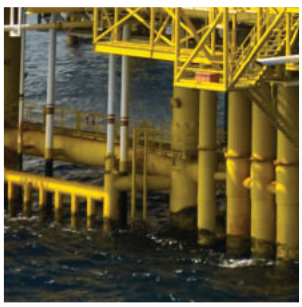




Course Catalog



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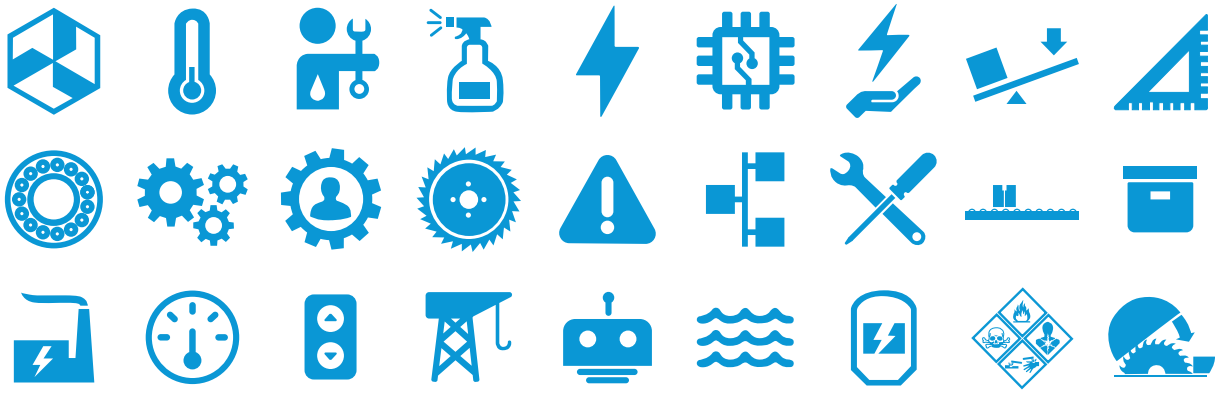
TPC TRAINING

TPC Training is the leader in industrial skills training, offering unparalleled content delivery and customization to build a better, safer, more efficient workforce.

Only TPC Training offers four decades of industrial training experience on behalf of more than 40,000 clients worldwide. We've been meeting the training needs of our clients by combining an extensive and unmatched line of industrial skills and safety training materials with exceptional services.

Every client's training situation is unique, whether you're implementing a pay-for-skills system, planning apprenticeship programs, cross-training to support multi-craft operations, or just filling a gap in your existing training. Even within one company, we understand that similar plants and facilities have different training requirements depending on their systems, equipment, and the make-up of their workforce.

Our experienced Training Consultants are here to help you every step of the way, from the early planning stages of program analysis and design through the implementation, management, and measurement of your training program. Our full range of materials and services are designed to give you exactly what you need for your unique training circumstances and help you identify and build the business case for a larger training investment with reliable return. Start accomplishing your training goals today with the world-class training solutions provided by TPC Training.



THE TOTAL TRAINING SOLUTION

PLAN

Plan your technical skills training

Understanding the current knowledge levels of your workforce is critical in determining what skills your employees need to meet your performance goals. From here, TPC Training is able to design a training plan with the correct training content and specific delivery formats required by your personnel. With tools like our Training Needs Analysis, TPC is able to craft a training plan to fit every need and budget. TPC is the right place to start for companies taking their first step toward a safer and better-trained workforce.

Training Needs Analysis

This objective, survey-based analysis covers more than 500 core knowledge and skill areas for virtually all crafts, and can be completed in just a couple of hours by a few members of your workforce. We'll analyze the results and give you a detailed report that ranks the core knowledge and skills by importance to the job and frequency of occurrence. The result is a comprehensive report that identifies the specific TPC industrial skills and safety courses that cover the highest priority core knowledge and skill requirements.

Job Task Analysis

For a more comprehensive understanding of the tasks required to perform a particular job function, the Job Task Analysis (JTA) identifies the knowledge and skills specific to your facility, systems, equipment, and processes. Our expert Training Consultants interview your employees and supervisors, review your systems, equipment, and processes, and analyze your documentation and procedures. Based on the gathered information, TPC will provide a detailed report identifying the critical knowledge areas and skills required for your specific operations, along with training recommendations on how to meet these requirements. The Job Task Analysis serves as the foundation for the design of any assessments and training to be delivered, as well as provides the legal documentation to support the assessment process. Only TPC offers fully customizable assessments and courseware to meet the training needs of every business and job function.

Knowledge Assessments

Once the required knowledge level for each job is determined, the next step is to evaluate what your employees already know. Selected from thousands of time-tested questions in our database, TPC Knowledge Assessments compare the knowledge of your employees to the operating needs of your systems, equipment, and processes. After the assessments have been administered, detailed reports are compiled to show you exactly where your employees stand. This crucial tool sets the benchmark to determine the success for your training program.

Skills Assessments

Our Training Consultants can help you assess skill levels in every job position and for every critical hands-on skill required for successful job performance. We create easy-to-use Skill Assessment Checklists that supervisors and managers use to objectively evaluate on-the-job skill levels according to your own criteria. TPC Online™ quickly and easily assigns, tracks, and records Skill Assessment Checklist performance. TPC Consultants are also available to develop practical, hands-on training labs using components from your own equipment to create a real-life training and assessment experience.

CHOOSE

Choose your training method

Many factors go into deciding which training methods are required to meet your performance goals. Some internal considerations include time availability, employee learning styles, cost, where your employees are located, and the facility's infrastructure that is available to support training. TPC gives you a full range of training delivery options, so you can select the methods best suited for your situation.

Interactive Training

Many companies train with TPC Online™ because it reduces training time and helps improve knowledge retention of key subjects. With hundreds of interactive courses covering over 1,000 detailed lessons, TPC Online™ has the deepest industrial training library in the industry providing training to over 100,000 active users. Every course and learning plan is fully customizable to the needs of your business and are delivered online and on demand.

Course Manual Training

Our course manuals are typically chosen for their flexibility and affordability. Each manual includes detailed technical content at the level your employees need, dozens of illustrations, charts, diagrams, and photos, as well as comprehensive self-study interactions and progress check points to make sure your employees are comprehending the training material.

Instructor-Led Training

TPC Training's instructor-led training programs offer industry leading open seminar training with more than 2,000 seminars conducted nationwide each year. We have trained more than 100,000 industrial maintenance workers since 2004 and lead the nation in producing more effective plant, building, and facility maintenance technicians with short-term seminars. TPC Training's live instructor format is the most efficient way to learn and retain maintenance skills, and it allows your employees to get personalized help from expert instructors. Our two-day seminars provide intensive training that gets your employees back to the workplace quickly to apply what they've learned on-the-job. TPC Training instructors also host in-house training seminars at your facility in order to deliver a wide range of one to five day seminars that address your plant's most critical training requirements.

Machine-Specific Training

TPC Operate is a customized, interactive schematic that is ideal for troubleshooting and machine-specific training. By documenting every operation and component of a machine in an online, interactive format, TPC Operate puts shareable, updateable institutional knowledge right at the fingertips of your entire workforce. TPC Operate can provide significant and rapid return on your training investment by greatly reducing equipment downtime. TPC Operate also makes a powerful contribution to classroom training by bringing machine operations to life and giving workers an ongoing support tool to reinforce their training.

Custom Training

Let our training consultants create specialized maintenance and operations training programs for your facility. TPC Training's analysis of your plant and equipment-specific training needs allows TPC to develop training courses and assessment materials in the formats that best suit your facilities and workforce. We can train your trainers, create custom course content focusing on your equipment, train new employees at your facility, or deliver refresher training to your seasoned employees. Only TPC offers a total training portfolio, expertly tailored by our experienced training professionals.

MANAGE

Manage and measure your training progress

Determining how you will oversee and evaluate training is essential when creating a successful training program. TPC Training offers several options that efficiently manage and measure your training program's success.

TPC Online™

Built-in administrative tools help you to effectively manage your maintenance training program for your facility or across the entire enterprise. The industry-leading Learning Management System (LMS) makes it easy to administer, track, assess, and report on employee skills training. A computer with Internet access is all you need to manage, administer, and track your training at your convenience, anywhere and at any time.

TPC TestMaster™

TPC TestMaster™ allows administrators to easily create customized pre- and post-training tests by accessing TPC's entire library of test questions. Tailor your online or printed assessments further by creating your own questions, including images, and adding references to TPC courses. TPC TestMaster™ is seamlessly integrated with TPC Online™ to give you complete control managing your training program.

On-the-Job Training and Assessment

The importance, benefits, and simplicity of our structured on-the-job assessment program cannot be stressed enough. We have a wide-range of customizable assessments that are designed to qualify an employee's ability to perform required hands-on tasks. The detailed information on assessment preparation and the comprehensive checklist make it easy for supervisors and managers to implement this process of training.

Proctored Testing

Our open seminars also offer optional online or proctored testing and industry-accepted ATMT® Certification to help you get the most from your training investment. Proctored testing ensures the validity and consistency of the test and gives credibility to the final score and certification process.

Instructor Support Materials

To manage classroom training, we offer a full line of instructor support materials. Our collection includes PowerPoint™ presentations, step-by-step lesson plans, and testing materials. Instructor support materials help instructors introduce difficult topics effectively in the classroom.

TPC's standardized On-the-Job Training and Assessment program can also be specifically customized to fit your facility's training needs, call our Training Consultants to develop a customized program for you.

As an IACET Accredited Provider, TPC Training offers CEUs for both online and printed self-study courses.

TPC Training is an Accredited Provider by the International Association for Continuing Education and Training (IACET). In obtaining this accreditation, TPC Training has demonstrated that it complies with the ANSI/IACET Standard which is recognized internationally as a standard of good practice.

IACET Accredited courses are vital to the success of your training program. The ANSI/IACET Standard for Continuing Education and Training defines a proven model for developing effective and valuable continuing education and training programs.

IACET Accreditation quantifies your training progess through continuing education units (CEU's) which provide a standard unit of measurement that is accepted and recognized by learners, instructors, regulators, and employers worldwide.

About IACET

The International Association for Continuing Education and Training (IACET) is a non-profit association dedicated to quality continuing education and training programs. IACET is the only standard-setting organization approved by the American National Standards Institute (ANSI) for continuing education and training. The ANSI/IACET 1-2007 Standard is the core of thousands of educational programs worldwide. For more information, please visit www.iacet.org or call 703-506-3275.

About CEUs

A Continuing Education Unit (CEU) is defined as 10 contact hours of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction. Each TPC lesson is worth 0.1 CEUs.

ACCREDITED IACET PROVIDER

TPC Training has been accredited by the International Association for Continuing Education and Training (IACET).

FUNDAMENTALS

Operating and maintenance personnel in every field need skills based on a solid understanding of fundamentals. TPC Training's Fundamentals Series covers subjects essential to every field, while explaining the latest technology and its applications: lessons on blueprints, schematics, math, measurements, materials, tools, safety, troubleshooting, OSHA regulations relevant to operating and maintenance personnel, and more.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
101: Reading Blueprints					9
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Reading Blueprints

Course 101: Reading Blueprints

Covers all types of blueprints used in industrial plants. Discusses machine parts and machine drawings. Features drawings of a compound rest and a clutch-brake control. Examines hydraulic, pneumatic, piping, plumbing, electrical, air-conditioning, and refrigeration drawings. Introduces sketching used in industrial plants.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Introduction to Blueprints

Topics

Importance of Blueprints; Purpose of Blueprints; Types of Information on Blueprints; Supplementary Spaces; Detail Drawings; Interpreting a Detail Drawing; Assembly Drawings; Orthographic Projections; Auxiliary Views; Sections; Pictorial Drawings

Objectives

- Identify details, markings, and machine parts from an assembly drawing.
- Identify an object from an orthographic drawing.
- Identify elements located within the title block of a detail drawing.
- Explain why more than one orthographic projection is needed to show an object on a blueprint.

Lesson 2: Machine Parts

Topics

Six Simple Machines; Screw Threads; Drawings of Screw Threads; Screw Thread Specifications; Heads; Rivets; Welds; Pins; Keys; Springs; Gears; Bearings; Belts and Pulleys

Objectives

- Describe what a machine is, and explain what it does.
- Name the two basic methods of joining machine parts.
- Name and identify from an exhibit several types of threaded fasteners.
- Name the two basic methods of permanent joining.
- Identify gears, bearings, and belt drives on drawings.
- Identify types of screw threads from a specification.

Lesson 3: Machine Drawings

Topics

Understanding Machine Tools; Purpose of the Compound Rest; Exploded View; Assembly Drawing; Detail Drawing; Comparison with Photograph; Clutch-Brake Control Mechanism; Exploded View; Assembly Drawing; Headstock Linkage; Clutch-Operating System; Assembly Drawing; Drafting Techniques for Gear Trains; Reading the Assembly Drawing

Objectives

- Name the main parts of a lathe.
- State the definition of an exploded view.
- Identify an assembly drawing.
- Identify a compound rest swivel on an assembly drawing.
- Identify a specific part on an assembly drawing.

Lesson 4: Sheet Metal Drawings

Topics

Sheet Metal; Ventilation Systems; Ductwork; Sheet Metal Drawings; Parallel Development; Miter Development; Radial Development; Extra Metal for Assembly

Objectives

- Describe the difference among coils, strips, and sheet metal.
- Describe how a ventilation system works.
- State the purpose of an arrow on a duct symbol.
- Demonstrate how to lay out a development.
- Define a radial development of a truncated pyramid.

Lesson 5: Building Drawings

Topics

Using Building Drawings; Buildings and Building Sites; Symbols and Conventions; Plat, Site Floor Plans; Working Drawings

Objectives

- Name building materials, given their standard symbols.
- Explain how to find useful information on a flow diagram.
- Explain how to find useful information on an industrial plat.
- List the contents of a set of building drawings.
- Describe the purpose of a structural drawing.

Lesson 6: Hydraulic and Pneumatic Drawings

Topics

Fluid Systems; Pascal's Law; Multiplying Forces; Pistons and Cylinders; Fluid System Components; Hydraulic and Pneumatic Symbol

Objectives

- Name the components represented by common symbols on hydraulic and pneumatic drawings.
- Name the components in a simple hydraulic power system.
- Name the components in a simple pneumatic power system.
- State Pascal's Law.
- Discuss the purposes of the components of hydraulic systems.

Lesson 7: Piping and Plumbing Drawings

Topics

Importance of Piping Systems; Piping and Plumbing Materials; Kinds of Joints; Fittings; Drawings; Joining Metal Pipes

Objectives

- State the definition of piping.
- Explain why joints are sometimes brazed instead of soldered.
- Explain how to assemble a screwed joint.
- Identify different types of pipe joints.
- Identify piping-system components shown in a single-line drawing.
- Define electrochemical corrosion.

Reading Blueprints

Lesson 8: Electrical Drawings

Topics

Importance of Electrical Drawings; Electric Power; Controlling Electricity; Electrical Drawings; Electrical Wiring; Using Electrical Drawings

Objectives

- Identify different electrical symbols on a drawing.
- Identify the power distribution panels in your plant.
- Identify different types of conduit and cable.
- Select the best electrical drawing to use when looking for a faulty circuit between the basement and the first floor.
- Explain how electricity at 480 volts is reduced by a transformer to 120/240 volts.
- Define the terms voltage, current, and power

Lesson 9: Air Conditioning and Refrigeration Drawings

Topics

Principles of Refrigeration; Component Drawings; Principles of Air Conditioning; Air-Conditioning Systems; A/C and R Operating Controls; A/C and R Drawings

Objectives

- Explain how a refrigeration system works.
- Describe the types of ac controls.
- Name three kinds of condensers used in air conditioning systems.
- Explain the difference between unitary and central air-conditioning equipment.
- Explain how to find useful information on a duct drawing.

Lesson 10: Sketching

Topics

Using Sketches; Making Sketches; Kinds of Sketches; Orthographic Sketches; Isometric Sketches; Perspective Sketches

Objectives

- Name the four kinds of sketches.
- Identify an isometric sketch.
- Describe the appearance of a perspective drawing.
- Discuss how to sketch straight lines and curved lines.
- State the definition of a vanishing point.

Reading Schematics and Symbols

Course 102: Reading Schematics and Symbols

Covers schematics and symbols used in commercial and industrial settings. Examines symbols on schematics, electrical symbols and diagrams, piping symbols and diagrams, hydraulic and pneumatic diagrams and symbols. Discusses air conditioning and refrigeration systems, including explanations of electrical/electronic control schematics. Covers welding and joining symbols.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Introduction to Schematics and Symbols

Topics

Symbols in Schematics; Using Schematics; Electrical Schematics; Pneumatic and Hydraulic Schematics; Piping Schematics; Value of Schematics; Looking for Flow; Electric Current; Fluid Flow

Objectives

- State the definition of a schematic.
- List some characteristics of schematics.
- Identify a schematic among other kinds of technical drawings and diagrams.
- Explain how flow is indicated on a schematic.

Lesson 2: Symbols on Schematics

Topics

Common Features of Schematics; Differences in Schematics; Using the Schematic; Understanding Symbols; Identifying Symbols; Identifying Connections; Reading Diagrams

Objectives

- Identify various types of lines on schematics
- Identify the following schematics by their symbols:
  - Electrical
  - Fluid-power
  - Piping
- Give the purpose of legends and other tables of symbols.

Lesson 3: Electrical Symbols

Topics

Wires and Connections; Switches; Power Supply; Electrical Loads; Coils and Transformers; Fuses and Circuit Breakers; Grounding; Contacts; Resistors; Symbols in a Diagram

Objectives

- State the meaning of symbols and lines on an electrical schematic.
- Explain the difference between a fuse and a circuit breaker.
- Explain how to trace an electrical circuit.

Lesson 4: Electrical Diagrams

Topics

Kinds of Electrical Drawings; Schematic Diagrams; Series and Parallel Circuits; Wiring Diagrams; Reading Electrical Diagrams; Reading Industrial Schematics; Practice Exercises

Objectives

- Explain the difference in current flow between a series circuit and a parallel circuit.
- Explain the purpose of a wiring diagram.
- Demonstrate how to read an electrical schematic.
- Identify the objects represented by the symbols on an industrial schematic.

Lesson 5: Piping Symbols

Topics

Piping Systems; Kinds of Diagrams; Projections; Joints; Fittings; Symbols

Objectives

- Explain the function of a valve in a piping system.
- Name the ways of joining pipe.
- Identify the symbols for various kinds of fittings and describe the function of each fitting.

Lesson 6: Piping Diagrams

Topics

Piping Systems; Valves; Identifying Piping Symbols; Reading a Simple Schematic; Reading a Piping Schematic

Objectives

- Give the purpose of a valve in a piping system.
- Explain the difference between a check valve and a cock valve.
- Identify the symbols for various types of valves.
- Demonstrate the ability to determine pipe size from a diagram.

Lesson 7: Hydraulic and Pneumatic Symbols

Topics

Fluid Power; Reservoirs and Receivers; Pumps and Compressors; Actuators; Valves; Piping and Tubing

Objectives

- Describe a fluid-power system.
- List and give the purpose of the main parts of a hydraulic system.
- List and give the purpose of the main parts of a pneumatic system.
- Identify pneumatic and hydraulic symbols on schematics.

Lesson 8: Hydraulic and Pneumatic Diagrams

Topics

Schematic Diagrams; Composite Symbols; Understanding Circuits; Hydraulic Circuit Diagram; Pneumatic Circuit Diagram; A More Complicated Diagram; Local Areas; Putting Local Areas Together

Objectives

- Describe a composite symbol.
- Explain the difference between a closed and an open hydraulic or pneumatic system.
- Identify the actuator in a hydraulic diagram.
- Explain the purpose of local areas on a hydraulic or pneumatic diagram.

Reading Schematics and Symbols

Lesson 9: Air Conditioning and Refrigeration Systems

Topics

A/C and R Systems; Refrigeration Subsystem; Water Subsystems; Air Distribution Subsystem; Control Subsystems; Electric Control Schematics; Electronic Control Schematics; Pneumatic Control Schematics

Objectives

- Describe the subsystems of an air conditioning system.
- Identify the symbols for air conditioning and refrigeration components.
- Explain the operation of an air conditioning and refrigeration control system.

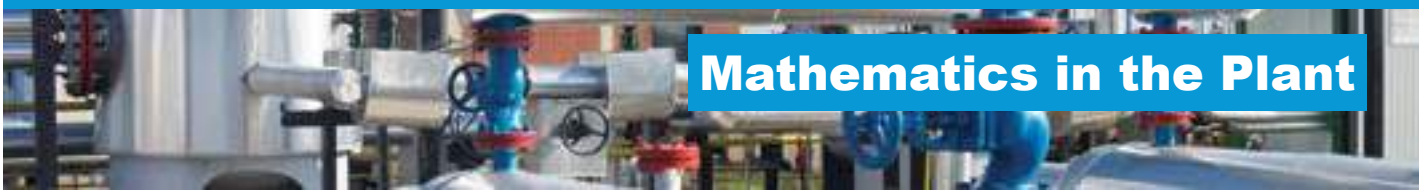
Lesson 10: Welding and Joining Symbols

Topics

Welding; Methods of Welding; Joints; Welds; Symbols for Welds; Assembled Welding Symbol; Placement of Welds; Special Symbols; Reading Welding Symbols

Objectives

- Explain fusion welding.
- Name the main methods of fusion welding.
- Name the five types of joints and three ways of welding each joint.
- Demonstrate how to read and interpret a complete welding symbol.



Mathematics in the Plant

Course 103: Mathematics in the Plant

Begins with mathematical basics—numbers, numerals, subtraction, addition, multiplication, and division. Examines common and decimal fractions, ratios and proportions, powers and roots. Discusses the uses and functions of a calculator. Moves on to geometry, algebra, and formulas for problem solving. Concludes by explaining properties of triangles and trig and inverse trig functions.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Whole Numbers

Topics

Numbers and Numerals; Decimal Systems; Positive and Negative Numbers; Addition; Carrying; Shortcuts in Addition; Multiplication; Subtraction; Borrowing; Division

Objectives

- Describe the difference between a number and a numeral.
- Demonstrate how to add three four-digit numbers, with carrying.
- Demonstrate how to subtract two four-digit numbers, with borrowing.
- Demonstrate how to multiply a four-digit number by a two-digit number.
- Demonstrate how to divide a four-digit number by a two-digit number.

Lesson 2: Common Fractions

Topics

Definition of a Fraction; Value of a Fraction; Improper Fractions; Mixed Numbers; Equivalent Fractions; Reducing Fractions; Common Denominators; Lowest Common Denominator; Adding Fractions; Subtracting Fractions; Subtracting Mixed Numbers; Multiplying Fractions; Canceling; Dividing Fractions

Objectives

- State the definition of a fraction.
- Demonstrate how to reduce a fraction to its lowest terms.
- Demonstrate how to find the lowest common denominator of two fractions.
- Demonstrate how to add three common fractions having different denominators.

Lesson 3: Decimal Fractions

Topics

Decimal Form; Rounding Off; Adding Decimal Fractions; Rounding Off in Addition; Subtracting Decimal Fractions; Rounding Off in Subtraction; Decimal Fractions in the Shop; Multiplying Decimal Fractions; Rounding Off in Multiplication; Adding Extra Zeros; Dividing Decimal Fractions; Rounding Off in Division; Changing Common Fractions to Decimal Form; Changing Mixed Numbers to Decimal Form; Changing Decimal Fractions to Common Fractions

Objectives

- Describe the difference between a decimal fraction and a common fraction.
- Demonstrate how to round off a decimal fraction to a specified number of places.
- Demonstrate how to multiply one decimal fraction by another.
- Demonstrate how to round off the products and quotients of decimal fractions.
- Demonstrate how to change fractions from common form to decimal form, and vice-versa.

Lesson 4: Ratios and Proportions

Topics

Comparing Numbers; Ratios; Expressing Ratios; Writing Ratios; Units in Ratios; Proportion

Objectives

- Demonstrate how to calculate the ratio of two numbers.
- Demonstrate how to use a ratio to express a change.
- Demonstrate how to use a ratio to solve a typical plant problem.

Lesson 5: Powers and Roots

Topics

Repeating Multiplication and Division; Exponential Form; Multiplying in Exponential Form; Dividing in Exponential Form; Zero Power; Fractions with Exponents; Products with Exponents; Powers of Powers; Powers of Sums and Differences; Roots; Fractional Exponents; Decimal Exponents; Negative Fractional Exponents

Objectives

- Demonstrate how to calculate the value of a number given in exponential form.
- Demonstrate how to write products and quotients of numbers given in exponential form.
- Demonstrate how to calculate the value of a number raised to a fractional power.
- Demonstrate how to calculate the value of a number raised to a negative power.

Lesson 6: Calculators

Topics

Using This Lesson; What a Calculator Does; Inside a Calculator; Internal Logic; Basic Functions; Special Functions; Special-Purpose Calculators

Objectives

- Explain the importance of an algorithm in a calculator.
- Describe how a calculator with arithmetic logic performs calculations.
- Describe how a calculator with algebraic logic performs calculations.
- Describe how a calculator with RPN logic differs from other calculators.

Mathematics in the Plant

Lesson 7: Geometry

Topics

Lines and Curves; Circles; Angles; Measuring Angles; Polygons; Triangles; Quadrilaterals; Constructions

Objectives

- Explain the differences among a line, a line segment, and a ray.
- Identify a radius, a chord, and a diameter of a circle.
- Demonstrate how to measure an angle with a protractor.
- Define a circle.
- Identify a right triangle, an equilateral triangle, and an isosceles triangle in a drawing.
- Demonstrate how to duplicate an angle using a straightedge and a compass.

Lesson 8: Algebra

Topics

Need for Algebra; Symbols, Expressions, and Equations; Order of Operations; Parentheses; Numbers and Variables; Equations; Algebraic Laws; Writing Equations; Solving Equations

Objectives

- Demonstrate how to calculate the value of an expression by performing mixed operations in the correct order.
- Demonstrate how to write an algebraic equation, based on a relationship stated in words.
- Demonstrate how to solve an algebraic equation for a specific variable.

Lesson 9: Using Formulas

Topics

A Real Problem; Solving the Problem; Length, Area, and Volume; Solving Other Problems

Objectives

- Identify values as length, area, or volume, based on their units of measurement.
- Demonstrate how to calculate the surface area and volume of a rectangle, a circle, a cylinder, and a sphere, given the dimensions of each and a list of formulas from which to choose.
- Demonstrate how to calculate the length of one side of a right triangle, given the other two sides.

Lesson 10: Trigonometry

Topics

Properties of Triangles; Trig Functions; Trig Tables; Inverse Trig Functions; Using Trig Functions

Objectives

- State the definition of the sine, cosine, and tangent of an angle.
- Demonstrate how to find the value of the sine, cosine, and tangent of a given angle, using either a trig table or a calculator.
- Demonstrate how to find the inverse sine, inverse cosine, and inverse tangent of a given value, using either a trig table or a calculator.
- Demonstrate how to solve a geometric problem, using trigonometry.

Making Measurements

Course 104: Making Measurements

Examines all aspects of basic measurement concepts and procedures, including accuracy and tolerance. Discusses techniques and devices for comparison measurements. Shows common methods for measuring volume, motion, force, temperature, fluid flow, and electricity. Explains how to use scales, rules, combination calipers, and micrometers.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Units of Measurement

Topics

Kinds of Units; Length; Area; Volume; Angles; Time; Speed and Velocity; Mass and Weight; Force; Work and Power; Pressure; Temperature; Electricity

Objectives

- Identify various units of measurement.
- State the definition of the joule, the coulomb, and the horsepower.
- Explain how to calculate pressure.
- Explain the difference between mass and weight.
- Demonstrate how to measure the volume of an object.
- Explain the difference between the Celsius scale and the Fahrenheit scale.

Lesson 2: Metric Measurement

Topics

History; Measuring Terms; Length; Area and Volume; Mass; Time; Frequency; Speed and Velocity; Acceleration; Force and Weight; Work and Energy; Power; Temperature; Electric Current; Light; Amount of Substance; Using SI Units

Objectives

- List the seven base units in the SI (metric) system.
- Name three derived units.
- Define work and power in SI units.
- Explain what power is and how it is measured.
- Name two metric measuring instruments and their U.S. Standard equivalents.

Lesson 3: Linear Measurement

Topics

Units of Linear Measurement; Measurement Error; Tolerances; Measuring Devices; Scales and Rules; Scribers and Dividers; Bevel Gauge; Calipers; Combination Square; Reading a Vernier Scale; Using a Micrometer; Reading a Micrometer

Objectives

- List five units used for making linear measurements.
- Demonstrate how to use a micrometer.
- Explain what each head of a combination square is used for.
- State the definition of parallax error.
- Define the different types of tolerance.

Lesson 4: Comparison and Surface Measurement

Topics

Comparison Measurement; Gauge Blocks; Measuring Screw Threads; Measuring Radius; Measuring Surface Texture; Hardness Testing; Testing Surface Coatings; Detecting Defects

Objectives

- Explain the difference between a continuous dial and a balanced dial on a dial indicator.
- the definition of pitch on a screw.
- Name two hardness tests.
- Explain why nondestructive testing is preferable to destructive testing on surface coatings.

Lesson 5: Measuring Bulk Materials

Topics

Bulk Solids; Storing and Handling Bulk Solids; Conveyors; Measuring Area; Measuring Volume; Weight, Mass, and Density; Weighing Bulk Materials; Measuring Lumber

Objectives

- Explain why weight-density and the angle of repose are important to workers who handle and store loose bulk material.
- Name the two types of conveyors and list three specific examples of each type.
- Name the three basic measurements of bulk materials.
- Demonstrate how to find the radius of a circle, given its area, and how to find the area of a circle, given its circumference.
- Demonstrate how to convert a typical order of lumber into board feet.

Lesson 6: Measuring Motion

Topics

Relative Motion; Displacement; Velocity; Acceleration; Average and Instantaneous Values; Motion on a Curved Path; Graphs of Motion

Objectives

- Name the three measurements of motion.
- State the definition of speed.
- Explain the difference between average and instantaneous velocity.
- Demonstrate how to interpret a graph of motion.
- Explain of the velocity of an object is shown on a graph of motion.

Making Measurements

Lesson 7: Measuring Forces

Topics

How Forces Act; Combining Forces; Force and Motion; Torque; Force-Measuring Instruments; Torque-Measuring Instruments; Analyzing Forces

Objectives

- Name both the metric and the U.S. Standard units of measurement for force, mass, and acceleration.
- State the definition of force.
- Demonstrate how to calculate torque.
- State an advantage of using a balance instead of a scale.
- Demonstrate how to draw a force diagram.

Lesson 8: Measuring Temperature

Topics

Temperature and Heat; Thermometers; Temperature-Sensing Materials; Digital and Analog Thermometers; Bourdon-Tube Thermometers; Bimetallic Thermometers; Electric Thermometers; Pyrometers; Response Time and Accuracy

Objectives

- Explain the difference between heat and temperature.
- Name four different scales for measuring temperature.
- Explain the use of heat-sensitive pellets, crayons, and paints.
- Explain how Bourdon tubes work.
- Explain how a pyrometer works.

Lesson 9: Measuring Fluids

Topics

States of Matter; Measuring Liquid Level; Viscosity; Flow Rate; Measuring Volume of Flow; Humidity; Density; Measuring Specific Gravity; Pressure; Measuring Pressure; Measuring Flow Rate by Pressure

Objectives

- State the definition of a fluid.
- Describe how liquids differ from gases.
- List the instruments used to measure the level of water.
- Name two instruments that measure the flow of fluids, and explain how they work.

Lesson 10: Measuring Electricity

Topics

Structure of Matter; Electricity; Electric Circuits; Electrical Units; Measuring Current; Measuring Potential Difference; Measuring Resistance; Measuring Power; AC and DC Measurements

Objectives

- List the parts of an atom.
- Define potential difference.
- Identify a wattmeter.
- Describe the difference between alternating current and direct current.
- Describe the difference between an ohmmeter and an ammeter.

Metals in the Plant

Course 105: Metals in the Plant

Introduces metals, metallurgy, and metalworking. Discusses the properties of metals, including mechanical properties. Examines several industrial manufacturing processes. Covers iron and standard steels. Explains the different kinds of heat treatment and their usage. Discusses some techniques of working with copper, aluminum, magnesium, titanium, lead, nickel, tin, and zinc.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Introduction to Metals

Topics

Metals and Metallurgy; Properties of Metals; Internal Structure of Metals; Important Metals; Casting Metals; Metalworking; Joining Metals

Objectives

- Name five metals or alloys commonly used in industry.
- Name five mechanical properties of metals.
- Describe the uses of three metal alloys.
- Describe the metalworking processes of casting, forming, and machining.

Lesson 2: Properties of Metals

Topics

Mechanical Properties; Hardness; Ductility; Malleability; Toughness; Strength; Tensile Strength; Compression; Shear; Elasticity; Strain; Metal Fatigue; Thermal Expansion; Density; Specific Gravity

Objectives

- State the definitions of four mechanical properties of metals.
- Describe the three kinds of stress.
- List the ways in which a metal can fail.
- State the definition of elasticity.
- Demonstrate how to calculate the density of metal.

Lesson 3: Manufacturing Processes

Topics

Casting; Sand Casting; Permanent-Mold Casting; Centrifugal Casting; Die Casting; Forging; Extrusion; Powder Metal Forming; Sheet Metal Forming; Wire Drawing

Objectives

- Name four kinds of molds used in casting.
- List the steps in making a sand mold.
- Describe the differences between hot-chamber and cold-chamber die casting.
- Describe extrusion.
- List the steps involved in making a part by powder metallurgy.

Lesson 4: Iron and Steel

Topics

Iron Ore; Pig Iron; Smelting; Cast Iron; Gray Cast Iron; White Cast Iron; Malleable Cast Iron; Ductile Cast Iron; High-Alloy Cast Iron; Steel

Objectives

- Name the commercial grades of cast iron.
- List the important mechanical properties of commercial grades of cast iron.
- Describe the forms in which carbon appears in commercial grades of cast iron.
- Describe the process of smelting.

Lesson 5: Standard Steels

Topics

Carbon in Steels; Steel Rolling; Steel Classification; Spark Testing; Forms of Steel Stock; Hot-Rolled Plate and Sheet; Cold-Rolled Sheet; Steel Strip; Steel Plate; Steel Bars; Structural Steel; Alloy Steels; Stainless Steels

Objectives

- State the definition of steel.
- Name the method by which a steel was made, based on its AISI code.
- Demonstrate how to conduct a spark test.
- Identify steel sheets having as-rolled edges and cut edges.
- Describe two differences between alloy steels and steels containing only iron and carbon.

Lesson 6: Heat Treatment

Topics

Uses of Heat Treatment; Welding; Repairing Tools; Repairing Machines; Castings; Forgings; Carbon Content of Steels; Science of Heat Treatment

Objectives

- Describe the two basic processes, and state the four major purposes, of heat treatment.
- Explain why distortion and cracking occur during welding.
- Explain how to anneal, harden, and temper a star drill.
- State the definitions of low-carbon, medium-carbon, and high-carbon steels.

Lesson 7: Copper

Topics

Producing Copper; Copper Alloys; Machining Copper and Copper Alloys; Electrical Conductivity; Corrosion; Annealing Copper; Brasses; Muntz Metal; Admiralty Brass; Bronzes; Nickel Silvers; Aluminum Bronze; Beryllium-Copper Alloys; Cupro-Nickel Alloys; Copper Alloys for Casting

Objectives

- List the steps in producing copper from ore.
- List the contents of brass, Muntz metal, admiralty brass, bronze, nickel silver, aluminum bronze, and cupro-nickel.
- Describe dezincification in brass.
- Name the three groups of brasses, based on their zinc content, and the three categories of hardness.
- List the contents of red brass, and describe its uses.

Metals in the Plant

Lesson 8: Aluminum

Topics

Properties of Aluminum; Producing Aluminum; Aluminum Alloys; Wrought Aluminum Grades; Cast Aluminum Grades; Alloying Elements; Forming Processes; Anodizing; Welding Aluminum; Brazing Aluminum; Soldering Aluminum; Safety Precautions

Objectives

- List advantages and disadvantages of the oxide coating on aluminum.
- State the definition of wrought-grade and casting-grade aluminums.
- Describe the advantages of aluminum-silicon alloys.
- Describe how aluminum is anodized.
- Name the classifications of aluminum solders.

Lesson 9: Magnesium and Titanium

Topics

Producing Magnesium; Extracting Magnesium; Melting and Refining Magnesium; Alloying Magnesium; Magnesium Alloy Designation; Casting and Wrought Alloys; Extruding; Rolling and Forging; Machining; Joining Magnesium; Properties of Titanium; Uses of Titanium; Processing Titanium; Commercially Pure Titanium

Objectives

- Name the alloys of magnesium and titanium.
- List the useful properties of magnesium and titanium.
- Describe how to join magnesium alloys.
- Describe the precautions that must be taken when working with magnesium and titanium.
- Describe the uses of magnesium and titanium in industry.

Lesson 10: Lead, Nickel, Tin, and Zinc

Topics

Using Lead; Producing Lead; Properties of Lead; Forms of Lead; Fabricating Lead; Joining Lead; Using Nickel; Producing Nickel; Nickel Alloys; Using Tin; Producing Tin; Properties of Tin; Tinplate; Tin Alloys; Tin Solders; Babbitt; Bronze; Using Zinc; Producing Zinc; Machining Zinc

Objectives

- Describe the properties and characteristics of lead.
- List the properties that are improved by adding nickel to stainless steel.
- Describe how tinplate is manufactured.
- Describe how zinc is refined and processed.

Nonmetals in the Plant

Course 106: Nonmetals in the Plant

Describes properties, characteristics, and classifications of each material. Covers synthetic and natural materials. Examines various paints and coatings, their proper use, preparation, and application. Surveys industrial chemicals. Chemical safety precautions are covered, along with the proper use of protective equipment.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Introduction to Nonmetals

Topics

Classifying Materials; Properties of Solids; Properties of Liquids; Behavior of Liquids at Rest; Properties of Gases; Behavior of Gases; Fluids in Motion; Mixed States of Matter

Objectives

- State the definition of a solid, a liquid, and a gas.
- Demonstrate how to change a liquid to a solid.
- Demonstrate buoyancy.
- Identify an object less dense than water, and an object more dense than water.
- List six possible combinations of matter.

Lesson 2: Plastics

Topics

Characteristics of Plastics; Processing Plastics; Molding; Casting and Foaming; Extruding; Reinforcing; Machining; Assembly; Welding; Patching

Objectives

- State the definition of a thermoplastic and a thermoset.
- Describe injection molding, foam molding, and extrusion.
- Select the best bonding agent for joining polyethylene parts.
- Describe the steps in patching a damaged area with glass-plastic material.

Lesson 3: Rubber

Topics

Nature of Rubber; Processing Rubber; Kinds of Rubber; Properties of Rubber; Vulcanizing Rubber; Uses of Rubber; Foam Rubber; Hose and Tubing; Tank Linings; Other Uses of Rubber; Reclaiming Rubber

Objectives

- Name four properties of rubber.
- Explain the vulcanizing process.
- Select the best hose for handling oils or gasoline.
- Describe how to use a pinhole locator.
- List the kinds of sheet rubber that should be kept on hand in the storeroom of an industrial maintenance department.

Lesson 4: Wood

Topics

Lumber; Properties of Wood; Wood Grades; Wood Defects; Measuring Lumber; Plywood; Plywood Grades; Choosing Wood; Wood Frame Construction; Wood Joints; Wood Preservation; Industrial Uses; Fasteners

Objectives

- State the definition of hardwood and softwood.
- Name the grades of softwoods and hardwoods.
- Describe a radial cut, a crosscut, and a tangential cut.
- Demonstrate how to calculate the number of board feet in a piece of 2 x 8 lumber 10 ft long.

Lesson 5: Construction Materials

Topics

Concrete; Mixing Concrete; Concrete Defects; Removing Stains; Masonry Units; Brick; Mortar; Patching and Repairing Masonry; Wallboard; Repairing Wallboard; Plaster; Glass

Objectives

- List the ingredients in concrete.
- State the definition of spalling, crazing, and dusting.
- Explain how to remove an oil stain from concrete.
- Demonstrate how to mix a small batch of mortar.
- List the steps in repairing a hole in wallboard.

Lesson 6: Insulating Materials

Topics

Heat Flow; Thermal Insulation; Loose-Fill Insulation; Blanket Insulation; Low-Density Insulation; Special Thermal Insulation; Acoustic Insulation; Vapor Barriers; Electrical Insulation; Fire Prevention

Objectives

- Name the ways by which heat can be transferred.
- State the formula for determining the thermal conductivity coefficient (k value) of a thermal insulator.
- Demonstrate how to install blanket insulation.
- Select the best materials for use an electrical insulation where resistance to flame and high temperature is important.
- List the safety rules that should be followed when working with insulating materials.

Lesson 7: Paints and Coatings

Topics

Protective Materials; Substrates; Paint; Primer; Choosing a Coating; Surface Preparation; Methods of Application; Using Colors; Special Coatings

Objectives

- List the factors to consider in selecting a protective coating.
- Name the qualities and characteristics of pigments and vehicles.
- List the safety precautions to follow when using paints containing solvent thinners.
- State the definition of primer.
- Demonstrate how to prepare a metal substrate for coating.

Nonmetals in the Plant

Lesson 8: Industrial Chemicals

Topics

Chemical Safety; Soaps and Detergents; Solvents; Acids; Packaged Chemicals; Aerosols; Oils; Refrigerants; Water-Treatment Chemicals; Welding and Plating Chemicals; Fuels; Fire-Fighting Chemicals; Protective Equipment

Objectives

- List the safety precautions to follow when working with liquid and solid chemicals.
- Name the general classifications of cleaning agents.
- Select the best acid for cleaning stainless steel and aluminum.
- State the reasons why aerosol spray cans are potentially dangerous.
- List considerations in selecting an oil for a particular use.

Lesson 9: Adhesives

Topics

Adhesive Terms; Kinds of Adhesives; Animal Glues; Casein Glues; Vegetable Glues; Synthetic-Resin Glues; Plastic Welding; Acrylic-Based Adhesives; Special Adhesives; Strength of Adhesives; Tapes; Special Tapes

Objectives

- State the definitions of adhesiveness, curing, drying, joint, pot, life, and tack.
- List the characteristics of thermosetting and themoplastic adhesives.
- Demonstrate the plastic-welding process.
- Select the best tapes for insulating and protecting electrical connections and wires.

Lesson 10: Carbon

Topics

Forms of Carbon; Properties of Carbon; Carbon Electrodes and Resistors; Carbon in Furnaces; Carbon Brushes; Kinds of Carbon Brushes; Industrial Diamonds; Fabricated Carbon Products; Chemical Uses of Carbon

Objectives

- List four uses of carbon and fabricated carbon products in industry.
- List three properties of carbon that make it useful in electrical and mechanical applications.
- Describe the carbon-arc welding process.
- List the most common causes of brush noise.
- Demonstrate the correct method of cutting individual rings from a continuous length of braided packing.

Hand Tools

Course 107: Hand Tools

Begins with measuring tools, including a discussion of units of measurement. Examines the various kinds of wrenches and screwdrivers, their uses and handling techniques. Explains other hand tools by specialty: pipefitting tools, plumbing tools, electrician's tools, sheet metalworking tools, machinists' metal-working tools. Ends with hoisting and pulling tools.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Measuring Tools

Topics

Linear and Angular Measurement; Units of Linear Measurement; Rules and Measuring Tapes; Using Rules and Tapes; Calipers; Slide Calipers; Vernier Calipers; Micrometer Caliper; Using the Micrometer; Squares

Objectives

- Explain how to hold a rigid rule correctly when measuring an object and show from which point the measurement begins.
- Describe how to set lock joint transfer-type calipers.
- Identify vernier calipers.
- Explain how to take a measurement with a micrometer caliper.
- Name the parts of a combination square.

Lesson 2: Wrenches and Screwdrivers

Topics

Using Wrenches; Open-End Wrenches; Box-End Wrenches; Combination Wrenches; Socket Wrenches; Socket Handles; Socket-Screw Wrenches; Adjustable Wrenches; Torque Wrenches; Using Wrenches Safely; Using Screwdrivers; Standard Screwdrivers; Cross-Slot Screwdrivers; Spiral Ratchet Screwdrivers; Offset Screwdrivers; Driving a Screw; Removing a Screw; Restoring a Screwdriver Blade; Using Screwdrivers Safely

Objectives

- Identify types of materials used for making wrenches.
- Identify open-end, box-end, socket, socket-head, adjustable, torque, and striking-face wrenches.
- Describe two sizes that are important in identifying a socket wrench.
- Identify standard, Phillips, offset, and spiral-ratchet screwdrivers.
- List the steps to follow when driving a screw.

Lesson 3: Pipefitting Tools

Topics

Pipe Wrenches; Using a Pipe Wrench; Pipe Vises; Cutting Pipe; Reaming Pipe; Threading Pipe; Tapping Pipe; Cutting Tubing and Plastic Pipe; Flaring Metal Tubing; Caring for Pipe Tools

Objectives

- Identify a straight pipe wrench, a Stillson wrench, a chain pipe wrench, a strap wrench, and a compound-leverage wrench.
- Explain how to use a pipe wrench.
- Explain why a machinists' vise should not be used for holding pipe.
- Explain how to thread pipe.
- Explain how to clean a pipe tool.
- Explain how to cut and flare tubing.

Lesson 4: Plumbing Tools

Topics

Plumbing Codes; Plumbing System; Joining Copper Pipe; Tube Bending; Cutting Cast-Iron Pipe; Joining Cast-Iron Pipe; Assembling Plastic Pipe; Force-Cup Plungers; Augers; Line-Clearing Tools; Sewer Tapes; Special Wrenches; Measuring Pipe

Objectives

- Explain how to use a mechanical tube bender.
- List the steps in joining hubless pipe.
- Explain why the drain pipe should be completely covered by the force cup.
- Name the criteria used in selecting line clearing tools.
- List the steps in measuring pipe when using the center-to-center measuring systems.

Lesson 5: Electrician's Tools

Topics

The Electrician; EMT Bender; Correcting Knocked Over Stubs; Bending Rigid Conduit; Assembling Rigid Conduit; Knockout Punches; Fish Tapes; Pliers; Wire and Cable Strippers; Electrician's Screwdrivers; Test and Safety Equipment

Objectives

- Explain how to use an EMT bender and a neon circuit tester.
- List the parts of a knockout punch.
- Name the uses of the all-purpose tool.

Lesson 6: Woodworking Tools

Topics

Handsaws; Crosscut Saws; Ripsaws; Special-Purpose Saws; Planes; Scrapers; Drills and Bits; Chisels; Levels; Plumb Bobs; Hammers and Nail Sets

Objectives

- Describe the difference between a ripsaw and a crosscut saw.
- Explain the difference between a compass saw and a keyhole saw.
- Describe the different types of planes.
- Identify a Forstner bit.
- Explain the working of a plumb line.

Hand Tools

Lesson 7: Masonry, Plastering, and Glazing Tools

Topics

Concrete and Mortar; Preparing Mortar; Working with Bricks and Mortar; Tuckpointing; Working with Concrete; Edging, Jointing, and Finishing; Repairing Plaster; Repairing Wallboard; Cutting Glass; Installing Glass; Safety on the Job

Objectives

- Explain how to mix a small batch of mortar.
- List the uses of a trowel.
- Define tuckpointing.
- Explain why flat concrete surfaces must be screeded.
- Explain how to repair one of the following problems: (a) small plaster cracks, (b) shrinkage cracks, or (c) loose or bulging plaster.
- Explain how to replace a broken pane of glass in a window.

Lesson 8: Sheet Metalworking Tools

Topics

Sheet Metal; Sheet Metal Gauges; Layout Tools; Dividers; Punches; Rivets and Riveting Tools; Metal-Cutting Chisels; Using a Chisel; Hammers; Metal-Cutting Snips; Dressing; Notchers; Bench Stakes; Forming Tools; Hand Seamer; Soldering; Sheet Metal Safety

Objectives

- Identify different types of snips and punches.
- Identify the bench stakes discussed in this Lesson.
- List six safety practices to follow when working with sheet metal.
- Describe different types of sheet metal.

Lesson 9: Metalworking Tools

Topics

Vises; Hacksaws; Using Hacksaws; Files; File Cuts; File Specifications; Selecting a File; Using Files; Taps; Tap Sizes; Using Taps; Dies; Thread Classes; Using Dies; Reamers; Using Reamers

Objectives

- Select the proper hacksaw blades for cutting various materials.
- Explain the difference between single-cut and double-cut files.
- List the types of taps usually found in a tap set.
- Explain how to cut an external thread on a bolt, screw, or stud.
- Explain how to remove a reamer from a hole.

Lesson 10: Hoisting and Pulling Tools

Topics

Hoisting with Rope; Knots; Wire Rope; Slings; Sling Angles; Sling Hitches; Center of Gravity; Sling Spreader Beams; Block and Tackle; Chain Fall; Chain Load Pullers; Machine Part Pullers; Jaw Pullers; Slide-Hammer Pullers; Choosing the Proper Puller

Objectives

- Explain how to prevent synthetic and fiber rope from unraveling.
- Explain how individual wires and strands of wire are formed into wire rope.
- Identify the most appropriate sling for use near corrosive chemicals.
- Identify a slide-hammer puller.
- Describe different kinds of slings and loads.

Portable Power Tools

Course 108: Portable Power Tools

Explains the uses, selection, safety, and care of industrial power tools: electric drills, electric hammers, pneumatic drills and hammers, screwdrivers, nutrunners, wrenches, linear-motion and circular saws, routers and planes, electric sanders, grinders, and shears. Covers tool sharpening techniques for selected tools.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Electric Drills

Topics

Parts of Electric Drills; Light-Duty Drills; Heavy-Duty Drills; Accessories; Drill Sizes; Drill Bits; Preparing to Drill; Using the Electric Drill; Electric Drill Maintenance; Drill Safety

Objectives

- Name four parts that are common to both the light-duty drill and the heavy-duty drill.
- Name the parts of a drill bit.
- Explain how to drill a blind hole.
- Explain how to inspect a drill bit, both visually and through testing.
- List the safety rules to follow when using electric power tools.

Lesson 2: Electric Hammers

Topics

Types of Hammers; Operating Electric Hammers; Bits and Chisels; Core Bits; Self-Drilling Anchors; Mechanical Safety; Electrical Safety; Environmental Safety

Objectives

- Explain the difference in hammering action between a percussion hammer and a rotary hammer.
- Select the proper chisel to use for each of the following jobs: brick cleaning; general demolition work; edging, chipping, and channeling; and removing floor tile.
- List the precautions that should be taken to ensure electrical safety when using an electric hammer.
- Name two safety items to use when operating an electric hammer in damp or wet areas.

Lesson 3: Pneumatic Drills and Hammers

Topics

Air Power; Types of Pneumatic Drills; Sizes of Pneumatic Drills; Bits for Pneumatic Drills; Preparing to Drill; Operating Pneumatic Drills; Types of Pneumatic Hammers; Chipping and Scaling; Drilling; Riveting; Tampers; Needle Scalers; Diggers; Lubrication and Maintenance

Objectives

- Explain how drill size is determined.
- Describe the chiseling action of a bull point chisel when it is used to clean masonry seams.
- Describe how to use a rivet buster.
- Explain drill speed requirements.
- Identify various types of drill bits used in pneumatic hammers.

Lesson 4: Screwdrivers, Nutrunners, and Wrenches

Topics

Screwdrivers and Nutrunners; Clutch Mechanisms; Power Wrenches; Bits and Sockets; Operating Power Screwdrivers and Wrenches; Lubricators and Moisture Separators; Tool Safety

Objectives

- Identify the operating advantages of pneumatic tools.
- Define stalling torque.
- Describe the clutch action of direct drive, positive drive, and adjustable torque drive.
- Explain how to install a bit in an electric screwdriver.
- Describe how to install multiple fasteners correctly in a circular pattern.
- List safety rules to follow when using power screwdrivers and wrenches.
- Describe the difference between pneumatic and electric nutrunners.

Lesson 5: Linear-Motion Saws

Topics

Straight-blade Power Saws; Saber Saws and Blades; Plunge and Straight Cutting; Cutting Metals; Reciprocating Saws and Blades; Band Saws

Objectives

- List other names for both the saber saw and the reciprocating saw.
- Describe the cutting action of a saber saw.
- Explain how to draw a saw blade with regular set teeth and one with wavy set teeth.
- Explain how to plunge cut a rectangular opening.
- List the types of band saw blades described in this Lesson and a few characteristics of each.

Lesson 6: Circular Saws

Topics

Circular Saws; Using the Circular Saw; Circular Saw Blades; Special Saw Blades; Crosscutting; Ripping; Angular Cutting; Plunge Cutting; Notching and Grooving; Cutoff Wheels; Arbors and Arbor Adapters; Circular Saw Accessories; Safety Rules

Objectives

- Name the major parts of a circular saw.
- Describe the cutting action of a circular saw.
- List the factors that determine feed speed.
- State the definition of an arbor.
- Identify different types of blades.

Portable Power Tools

Lesson 7: Routers and Planes

Topics

Router Characteristics; Collet Chucks; Bits; Using a Router; Direction of Feed; Grooves and Dadoes; Rabbet Cuts; Decorative Trim; Circular Cuts; Using Templates; Hinge-Butt Mortising; Jointing; Plane Characteristics; Using a Plane; Safety

Objectives

- Discuss how to use a router.
- Name the major parts of a router.
- Explain how to use a router and bit.
- Identify a rabbeting joint, a straight joint, and a mortising joint.
- Explain how to adjust and use a power plane.

Lesson 8: Electric Sanders

Topics

Belt Sanders; Installing a Sanding Belt; Using the Belt Sander; Belt Sander Lubrication; Motor Maintenance; Pad Sanders; Loading the Sander; Using the Pad Sander; Pad Sander Maintenance; Disk Sanders; Using the Disk Sander; Disk Assembly; Disk Sander Maintenance Safety

Objectives

- Explain how to install a sanding belt.
- Identify different types of sanding belts.
- Explain how to flush the gear chamber of a belt sander.
- Discuss the assembly of a sanding disk.
- List the safety rules to follow when using a disk sander.

Lesson 9: Grinders and Shears

Topics

Selecting a Grinder; Grinding Wheels; Mounting Grinding Wheels; Using the Grinder; Grinder Maintenance: Safety; Selecting Shears; Using Shears and Nibblers

Objectives

- State the meaning of each symbol in the six-symbol standard marking system for grinding wheels.
- Explain the correct procedure for mounting a grinding wheel.
- List safety rules to follow when using a grinder.
- Discuss how to maintain grinders.

Lesson 10: Tool Sharpening

Topics

Reasons for Sharpening; Whetstones; Using a Bench Grinder; Sharpening Chisels; Sharpening Drill Bits; Sharpening Screwdrivers; Sharpening Pointed Tools; Sharpening Reamers; Sharpening Taps and Dies; Other Sharpening Tools

Objectives

- State the reasons for sharpening tools.
- Explain the use of whetstones.
- Identify a bench stone.
- Explain how to sharpen taps, dies, screwdrivers, and chisels.

Industrial Safety and Health

Course 109.1: Industrial Safety and Health

Explains government involvement in ensuring a safe workplace. Discusses safety in various situations. Discusses personal protective equipment and fire safety. Includes expanded coverage of many health hazards. Covers ergonomics, environmental responsibility and importance of maintaining a safe work environment.

TPC Training is accredited by IACET to offer **1.2 CEU** for this program.

Lesson 1: Introduction to Safety and Health

Topics

Responsibility for Safety; Unsafe Acts and Conditions; Health Hazards; Accidents; Handling Emergencies; Safety Off the Job

Objectives

- Define the terms accident and hazard.
- Name and define the four main types of hazards.
- List and define various types of accidents.
- Compare meanings of unsafe act and unsafe condition.
- Name the three ways in which a toxic substance can enter your body.
- List ways in which a company must plan for emergencies.
- Tell the main reason for prompt accident investigation.

Lesson 2: Government Safety and Health Regulations

Topics

The Rights of Employees and Employers; OSHA Standards and Inspections; Taking Immediate Action; Records and Reports; OSHA's Hazard Communication Standard; MSDSs; NIOSH; EPA; OSHA

Objectives

- State the purpose of the OSHA Act.
- List the specific rights of employees under the Act.
- Explain what to do in a dangerous work situation.
- List things that you can do to help keep your workplace in compliance with OSHA standards.
- Explain the function of each of the following agencies: NIOSH, EPA.
- List the four main objectives of OSHA's Hazard Communication Standard.
- Tell what information can be found on an MSDS.

Lesson 3: Personal Protective Equipment

Topics

Work Clothes; Special Body Protection; Gloves; Head, Eye, Face, Hearing, and Foot Protection; Safety Harnesses and Lifelines; Respiratory Protection

Objectives

- List employer and employee responsibilities related to PPE.
- Tell why work clothing can be dangerous if it fits poorly.
- Explain the importance of proper glove selection when handling chemicals.
- Describe the proper fit of a hard hat.
- Compare and contrast everyday eyeglasses, industrial safety glasses, and safety goggles.
- Identify noise levels that require hearing protection.
- Name the two basic kinds of respirators.

Lesson 4: Chemical Safety

Topics

Physical Hazards; Health Hazards; Exposure Routes; Control of Chemical Hazards; Spill Response; First Aid

Objectives

- Define chemical hazard, physical hazard, and health hazard.
- Name three kinds of physical hazards.
- Name and describe at least four kinds of health hazards.
- Identify common symptoms of chemical exposure.
- List three health hazard exposure routes.
- Name three ways of controlling chemical hazards and exposures.
- Explain first aid procedures to follow when you are exposed to a hazardous chemical.

Lesson 5: Tool Safety

Topics

Screwdrivers; Wrenches; Pliers; Hammers and Mallets; Chisels and Punches; Knives; Electric Tools; Pneumatic Tools; Gasoline-Powered Tools

Objectives

- Name at least three causes of hand tool accidents.
- List one safety rule to follow when using each of the following: screwdriver, wrench, pliers, hammer, chisel, knife.
- Describe proper and improper dress for working with rotating power tools.
- Explain the importance of grounding electric tools.
- Name two hazards involved in pneumatic tool use and explain how to guard against them.
- Explain proper handling and storage of gasoline.

Lesson 6: Material Handling

Topics

Avoiding Injuries; Rules for Lifting; Teamwork; Hand Tools and Accessories; Power-Operated Handtrucks; Powered Industrial Trucks; Dock Safety; Conveyors; Hoists and Cranes; Receiving and Storing Materials; Corrosive and Flammable Liquids

Objectives

- List simple safety procedures and precautions related to material handling.
- Describe how to lift, carry, and put down a load.
- Explain safety principles for working with or around industrial trucks.
- Discuss safety rules for working with or around conveyors, slings, and hoists.
- Describe how and where to store materials.

Industrial Safety and Health

Lesson 7: Working Safely with Machinery

Topics

Point-of-Operation Guards; Fixed Guards; Special Guards; Power Transmission Guards; Other Safety Devices; OSHA Lockout/Tagout Procedures

Objectives

- Identify a machine's point of operation and other pinch points, and explain why they are dangerous.
- Identify different kinds of mechanical safeguards, and explain why they are necessary.
- Define zero energy state.
- Describe the lockout/tagout procedures established by the OSHA energy control standard.

Lesson 8: Working Safely with Electricity

Topics

The Electric Circuit; Injuries from Electricity; First Aid for Shock Victims; National Electrical Code; Static Electricity

Objectives

- Define the following terms: electric current, circuit, potential difference, ampere, watt, ohm, and volt.
- State Ohm's Law.
- Explain the function of each wire in a simple electric circuit and tell the color(s) used to identify each.
- List the three factors that affect the severity of an electric shock.
- Describe the effects of electric current on the human body.
- Tell the three most important points about first aid for shock victims.
- Explain how static electricity is generated, why its accumulation can be dangerous, and how it can be avoided.

Lesson 9: Electrical Equipment Safety

Topics

Grounding; Ground Faults; Fuses and Circuit Breakers; Portable Power Tools; Hazardous Electrical Locations; Basic Rules of Electrical Safety

Objectives

- Explain the importance of proper grounding.
- Define the term "ground fault" and explain how ground faults occur.
- Explain the purpose and operation of the following devices: GFCI, fuse, circuit breaker.
- Identify typical hazardous electrical locations.
- Explain the purpose of explosion-proof and intrinsically safe electrical equipment.
- List at least two electrical safety rules in each of the following areas: clothing, equipment, water, lockout/tagout.

Lesson 10: Fire Safety

Topics

Causes of Fires; Classes of Fires; Fire and Explosion Hazards; Preventing Fires and Explosions; Fire-Fighting Substances; Fire Hoses; Portable Fire Extinguishers; Protecting Yourself

Objectives

- Name and give the definition of the four classes of fires.
- Define the terms flash point and spontaneous combustion.
- Name the fire-fighting agents, and explain how they work and when to use them.
- Explain the use of at least two different types of portable fire extinguishers.
- List three ways of preventing fires.
- Explain fire hose and fire extinguisher maintenance.

Lesson 11: Protecting Your Health

Topics

Ergonomics; Noise; Radiation; Asbestos, Dusts, and Lung Disease; Fetal Protection; The Environment

Objectives

- Define ergonomics and tell how poor ergonomic conditions affect the body.
- List three actions that you can take to protect your hearing.
- Tell the cause of each of the following lung diseases: asbestosis, lung cancer, brown lung, black lung, silicosis.
- Contrast ionizing and nonionizing radiation.
- Compare and contrast personal and background sampling.
- Explain the importance of protecting women from exposure to certain chemicals.
- State the purpose of the EPA.

Lesson 12: A Safe Work Environment

Topics

Industrial Housekeeping; Walking and Working Surfaces; Safety in Traffic; Working at Elevations; Ladders; Scaffolds; Industrial Lighting; Safety in Extreme Heat; Working in Confined Spaces; Welding and Cutting Safety

Objectives

- Explain the importance of industrial housekeeping.
- List safety measures related to walkways, stairs, and floor openings.
- Tell how to protect yourself and others when working in traffic paths.
- Describe at least three hazards involved with each of the following and tell how to safeguard against them: working at elevations and working in confined spaces.
- Calculate the proper placement of a straight ladder based on its working length.
- Name two kinds of scaffolds and give at least one safety rule associated with each.
- List symptoms of heatstroke, heat cramps, and heat exhaustion.
- Name two major safeguards necessary when welding.
- Explain how to handle and store cylinders safely.

Troubleshooting Skills

Course 110: Troubleshooting Skills

Explores the subject of troubleshooting and the importance of proper maintenance procedures. Covers working with others, aids in communication, and trade responsibilities. Outlines troubleshooting techniques and aids, using schematics and symbols. Focuses on specific maintenance tasks, breakdown maintenance, and planned maintenance.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Introduction to Troubleshooting

Topics

Troubleshooting; Troubleshooting Skills; Troubleshooting Duties; Troubleshooting Aids; Mechanical Troubleshooting; Electrical Troubleshooting; Importance of Maintenance; Maintenance Organization; Maintenance Personnel; Scheduling; Challenge of Maintenance

Objectives

- Tell why efficient troubleshooting is important in a production plant.
- Name the four common troubleshooting aids.
- List the steps in troubleshooting a machine.
- List the steps in troubleshooting a system.
- Describe a typical maintenance organization.

Lesson 2: Working with Other People

Topics

Communicating with People; People Skills; Human Behavior; Communication Cycles; Aids to Communicating; Being Tactful; Preventing Misunderstandings; Working with Older Persons; Trade Responsibilities; Differences of Opinion; You and Your Supervisor; Upgrading Your Skills

Objectives

- Tell why good communication between plant personnel is needed.
- List the ways a person usually sees himself/herself.
- Explain the communication cycle.
- Explain the correct method of delivering a written message from your supervisor to another person.

Lesson 3: Troubleshooting Techniques

Topics

Job Responsibilities; Recognizing Normal Operations; Learning About Normal Operations; Simple Testing and Observation; Reducing Downtime; Routine Repairs; Emergency Repairs

Objectives

- List the steps to recognizing normal machine operations.
- List the questions you should ask yourself when a machine fails.
- List the signs of a machine in need of service.

Lesson 4: Aids to Troubleshooting

Topics

Equipment Repairs; Drawings and Blueprints; Sketches; Manufacturer's Literature; Service Representatives; Planned-Maintenance Records; Machine Records and Work Orders; Electrical Test Equipment; Mechanical Instruments; Temperature-Measuring Instruments

Objectives

- Describe a blueprint.
- List the information that should be recorded in a machine equipment record.
- Identify calibration standards.
- Identify a multimeter (VOM).
- Identify different troubleshooting test equipment.

Lesson 5: Preparing for Troubleshooting

Topics

Troubleshooting Responsibilities; Tools for Troubleshooting; Parts and Supplies; Safety Rules; Example of Troubleshooting; Charts and Diagrams for Troubleshooting; Correcting Malfunctions; Power-Transmission Equipment; Drive and Conveyor Belts; Drive and Conveyor Chains

Objectives

- List the information you must know about mechanical or electrical systems before you can troubleshoot them successfully.
- Name the commonly used items that should be carried in every troubleshooter's tool box.
- List the steps to follow in reading a pneumatic or hydraulic schematic.
- List the responsibilities of a troubleshooter.

Lesson 6: Using Schematics and Diagrams

Topics

Using Schematic Diagrams; Piping Schematics; Compressor and Engine Piping Schematics; Hydraulic and Pneumatic Schematics; Pneumatic Circuits; Pneumatic-Hydraulic Schematics; Electrical Schematics; Motor-Starting Circuits; Plant Lighting Diagrams; Plant Lighting Controls; Electrical Troubleshooting Charts

Objectives

- Discuss how to use schematics when troubleshooting.
- Identify differences in schematics.
- Explain how to use a troubleshooting chart.

Troubleshooting Skills

Lesson 7: Solving Mechanical Problems

Topics

Bearing Problems; Pump Problems; Piping Systems; Flexible Hose; Compressed-Air Equipment; Hydraulic Systems; Heating, Ventilating, and Air Conditioning; Refrigeration Equipment; Pollution-Control Equipment; Building Maintenance

Objectives

- Identify bearing wear problems.
- Identify pump failure problems and solutions.
- Identify types of hosing.
- Identify different plant equipment and their problems.

Lesson 8: Solving Electrical Problems

Topics

Power Generation and Distribution; Feeders, Subfeeders, and Branch Circuits; Fuses and Circuit Breakers; Current Capacity of a Wire; Understanding Basic Principles; Diagnosing Trouble; Testing for Continuity; Electrical Safety; Communication and Diagrams; Using Building Lighting Diagrams; Troubleshooting with Electrical Diagrams; Electrical Instruments

Objectives

- State the definition of switchgear.
- Identify current voltage characteristics of wire.
- List the safety rules to follow when working with electrical equipment.
- Identify a pictorial diagram, a block diagram, and a schematic diagram.
- Explain how to troubleshoot an electric problem.

Lesson 9: Breakdown Maintenance

Topics

Definition of Breakdown Maintenance; How Breakdown Maintenance Works; Good Breakdown Maintenance; Work-Order Procedures; Preparing for Emergencies; Skills for Emergency Work; Maintenance Parts and Supplies; Breakdowns in Automatic Machinery; Using Downtime; Resurfacing Machine Parts

Objectives

- Explain what to do if you are the first member of the emergency crew.
- Explain the spare parts requisition form.
- Discuss the four main parts of practical machine maintenance.

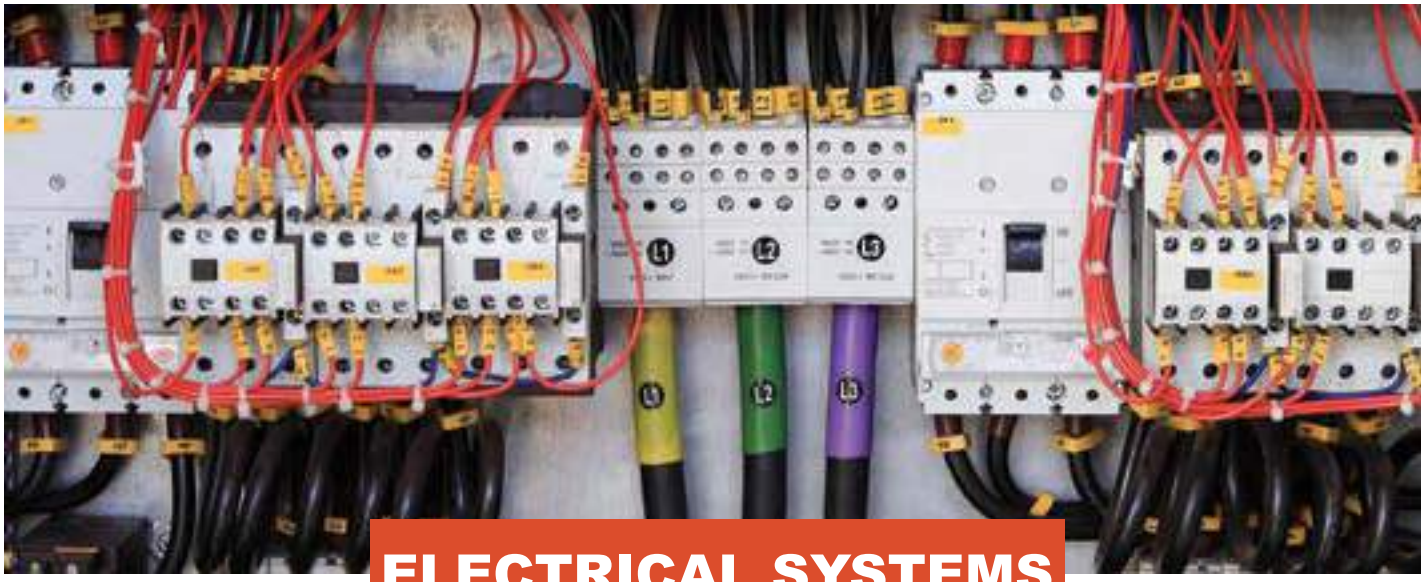
Lesson 10: Planned Maintenance

Topics

Definition of Planned Maintenance; Importance of Planned Maintenance; Frequency of Planned Maintenance; Benefits of Planned Maintenance; Unscheduled Maintenance; Parts Requiring Planned Maintenance; Keeping Maintenance Records; Inspection Records; Lubrication; Using Lubrication Charts

Objectives

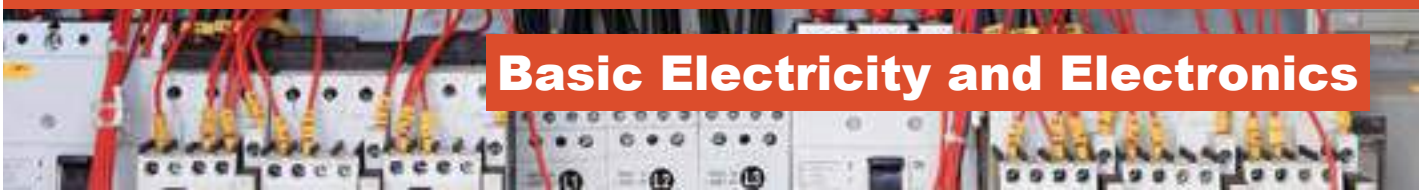
- State the definition of planned maintenance.
- List the information that should be included on record sheets or file cards as part of the machine inventory.
- List the benefits to be accrued from an effective lubrication program.
- Describe the proper sag in a drive chain.
- Explain how to service a battery properly.



ELECTRICAL SYSTEMS

Technicians must have a thorough knowledge of how electrical equipment operates in order to effectively perform maintenance and repairs. TPC's Electrical Systems Series covers an introduction to electricity and electronics to step-by-step troubleshooting.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
201: Basic Electricity and Electronics	✓	✓	✓	✓	30
202: Batteries and DC Circuits	✓	✓	✓	✓	32
203: Transformers and AC Circuits	✓	✓	✓	✓	34
204.1: Electrical Measuring Instruments	✓	✓	✓	✓	36
205.1: Electrical Safety and Protection	✓	✓	✓	✓	38
206: DC Equipment and Controls	✓	✓	✓	✓	40
207: Single-Phase Motors	✓	✓	✓	✓	42
208: Three-Phase Systems	✓	✓	✓	✓	44
209: AC Control Equipment	✓	✓	✓	✓	46
210: Electrical Troubleshooting	✓	✓	✓	✓	48
211: Electrical Safety in the Workplace - Understanding NFPA 70E®	✓	✓	✓	✓	50
212: Variable Frequency Drives	✓				52



Basic Electricity and Electronics

Course 201: Basic Electricity and Electronics

Covers basic, nonmathematical approach to understanding principles of electricity. Introduces electron theory, static electricity, electrons in motion, and magnetism. Covers basic methods of measuring current, voltage, and resistance. Explains circuit components—conductors, insulators, resistors, capacitors—and simple Ohm's Law calculations for DC and AC circuits.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Introduction to Electricity

Topics

History of Electricity; Language of Electricity; Structure of Matter; Structure of Atoms; Electron Shells; Transferring Charges; Electrical Forces; Electrical Terms

Objectives

- Describe the structure of an atom.
- Tell the difference between a compound and an element.
- Explain how electrical forces cause objects to attract or repel other objects.
- Describe electron flow.
- State the definition of a cell.

Lesson 2: Static Electricity

Topics

Nature of Static Electricity; Generating Static Electricity; Effects of Static Electricity; Eliminating Static Electricity; Static Eliminators; Effects of Humidity; Static Charges on a Liquid Surface; Static Charges on Rubber-Tired Vehicles; Static Charges on Dusts and Fibers; Static Charges in Process Machinery; Using Static Electricity; Measuring Static Electricity

Objectives

- List the conditions that must exist in order for static electricity to cause ignition.
- List the common causes of static electricity in an industrial plant.
- State the definition of bonding.
- Explain how liquid affects a static charge.
- State the definition of grounding.
- Explain the relationship between humidity and static electricity.

Lesson 3: Current Electricity

Topics

Electric Current and Energy; Electricity from Chemical Action; Primary Cells; Secondary Cells; Batteries; Electricity from Electromagnetism; Electricity from Contact; Electricity from Heat; Electricity from Light; Electricity from Deformation

Objectives

- List the main methods of producing potential difference.
- State the main difference between a primary cell and a secondary cell.
- Explain how to connect cells in parallel and in series.
- Describe how a photoelectric device works.
- Identify potential hazards when recharging batteries.

Lesson 4: Magnetism

Topics

Discovery of Magnetism; Definition of a Magnet; Magnetic Forces; Molecular Theory of Magnetism; Magnetic Fields; Magnetism and Electricity; Left-Hand Rules; Using the Left-Hand Rules; Electromagnets; Industrial Uses of Magnets

Objectives

- State the most basic law of magnetic force.
- Describe how magnetic force operates.
- Describe the left-hand rule for magnetic field direction.
- Describe an electromagnet.
- Explain how to use lifting magnets, magnetic pulleys, and magnetic clocks.

Lesson 5: Current, Resistance, and Potential Difference

Topics

Electric Current; Resistance; Potential Difference; Ohm's Law; Resistance and Voltage Drop; Measuring Current; Measuring Potential Difference; Measuring Resistance

Objectives

- State the characteristics of an electrical conductor and an electrical insulator.
- State the definition of electric current.
- Explain the relationship of potential difference to the flow of electric current.
- State the definition of Ohm's Law.
- Identify the purpose and parts of an ammeter.

Lesson 6: Electrical Components

Topics

Resistance; Resistors; Fixed Resistors; Resistor Color Code; Resistor Power Rating; Tapped Resistors; Variable Resistors; Capacitors; Capacitance; Types of Capacitors; Connecting Capacitors; Induction; Mutual Induction; Inductance; Inductors; Solenoids and Relays

Objectives

- Identify symbols for resistors, capacitors, and relays in an electric circuit diagram.
- Explain the operating principles of resistors, capacitors, and inductors.
- State the meaning of each band in the resistor color-code system.
- List the factors to consider when choosing a resistor.
- Explain how to connect capacitors in parallel and in series.

Basic Electricity and Electronics

Lesson 7: Conductors

Topics

Conductors and Insulators; Conductors; Conductor Sizes; Conductor Classification; Insulation Properties; Insulating Tapes; Protecting Conductors; Flexible Conduit; Conduit Fill; Splicing Conductors

Objectives

- Explain the difference between a conductor and an insulator.
- Identify a bare conductor, a covered conductor, an insulated conductor, a stranded conductor, a cable, and a cord.
- State the definitions of insulation resistance and dielectric strength.
- Select the best tapes for insulating splices, restoring the outer protecting covering on a splice, and connecting motor leads.
- Explain how to make a pigtail splice and a fixture splice.
- State the purposes of cable protection.

Lesson 8: DC Circuits

Topics

DC Characteristics; Ohm's Law; Applying Ohm's Law; Circuit Power; Series Circuits; Parallel Circuits; Series-Parallel Circuits; Open and Short Circuits

Objectives

- State the difference between ac and dc.
- Solve for R, E, I, and P in a simple electrical problem.
- Solve for potential difference, current, and resistance in a series and parallel circuit.

Lesson 9: AC Circuits

Topics

Advantages of Alternating Current; Generating Alternating Current; Effective and Average Values; Electrical Degrees; Resistance in AC Circuits; Inductance in AC Circuits; Capacitance in AC Circuits; Current in AC Circuits; Power in AC Circuits

Objectives

- Explain the importance of the transformer in ac electricity.
- Explain what a complete cycle of ac consists of and how it is produced.
- State the definition of ac inductance.
- List the ways inductive reactance differs from resistance.
- Explain the difference between the terms in-phase and out-of-phase in an ac circuit.

Lesson 10: Electronics

Topics

Development of Electronics; Electron Motion in a Vacuum Tube; Kinds of Cathodes; Vacuum-Tube Diode; Vacuum-Tube Triode; How a Triode Amplifies; A Vacuum-Tube Circuit; Semiconductors; Semiconductor Junctions; Kinds of Semiconductor Diodes; Transistors: Kinds of Transistors; Microprocessors

Objectives

- Name the parts of a vacuum tube, and describe the function of each part.
- Explain the difference between p-type semiconductor materials and n-type semiconductor material.
- List the parts of a transistor.
- State the definition of an integrated circuit.

Batteries and DC Circuits

Course 202: Batteries and DC Circuits

Covers how electrochemical action is used. Covers batteries, electrolytic action, electroplating, characteristics of storage batteries, application and maintenance of lead-acid, nickel-alkaline, and nickel-cadmium batteries, putting batteries in service, charging batteries, maintaining records, fundamentals of DC circuits, and using Ohm's Law to solve problems in DC series, parallel, and series-parallel circuits.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Electrochemical Action

Topics

History of Batteries; Battery Characteristics; Electrochemical Action; Cell Chemistry; Electrolysis; Electroplating; Extracting and Refining Metals; Electrolytic Corrosion; Electrolytes; Choosing a Battery; Battery Power

Objectives

- State the difference between a primary cell and a secondary cell.
- Discuss electrochemical action.
- Explain how battery polarization works.
- State the definition of an electrolyte.
- List the factors to consider in selecting a battery.

Lesson 2: Battery Characteristics

Topics

Cells in Batteries; Construction of Dry Cells; Characteristics of Dry Cells; Care and Maintenance of Dry Cells; Kinds of Primary Cells; Secondary Cells; Stationary Batteries; Construction of Storage Cells; Rating Storage Batteries

Objectives

- List advantages of dry cells.
- State the characteristics of dry cells.
- Explain how to create a six-volt battery from 1.5 volt dry cells.
- Name the basic kinds of storage cells in use today.
- Explain how to calculate the rating required in a battery for a specific application.

Lesson 3: Kinds of Batteries

Topics

Lead-Acid Batteries; Lead-Acid Battery Construction; Forming the Plates; Discharging; Recharging; Lead-Calcium Batteries; Cell Voltage; Specific Gravity; Capacity of Storage Batteries; Nickel-Iron Alkaline Cell; Construction of Nickel-Iron Cells; Voltage in Nickel-Iron Cells; Electrolyte in Nickel-Iron Cells; Nickel-Cadmium Cell; Chemical Action in a Nicad Cell; Construction of the Nicad Cell; Nicad Cell Characteristics

Objectives

- Name the items necessary to form a cell.
- Explain how plates in a cell are commonly assembled.
- List the advantages of nickel-cadmium battery.
- Discuss the construction of storage cells.

Lesson 4: Maintaining Lead-Acid Batteries

Topics

Inspecting New Batteries; Lead-Acid Battery Construction; Forming the Plates; Discharging; Recharging; Lead-Calcium Batteries; Cell Voltage; Specific Gravity; Capacity of Storage Batteries; Nickel-Iron Alkaline Cell; Construction of Nickel-Iron Cells; Voltage in Nickel-Iron Cells; Electrolyte in Nickel-Iron Cells; Nickel-Cadmium Cell; Chemical Action in a Nicad Cell; Construction of the Nicad Cell; Nicad Cell Characteristics

Objectives

- List the steps in placing a new dry-charged battery in service.
- Name the three basic methods of charging batteries.
- Explain how to measure a cell's specific gravity.
- List causes of low specific gravity in a cell.
- Tell how to clean a wet, dirty battery cover.

Lesson 5: Charging Lead-Acid Batteries

Topics

Principles of Battery Charging; Initial Charge; Normal Charge; Equalizing Charge; Trickle Charge; Emergency Charge; Boost Charge; Freshening Charge; Battery Test Discharge; Cell Failure; Mixing Electrolyte; Battery Charging Test; Battery Charging Source; Safety During Battery Charing; Battery Records

Objectives

- Explain how to conduct an initial charge.
- Discuss the different types of battery charges.
- List the common causes of cell failure.
- Explain how to mix electrolyte correctly.
- Explain how to treat both skin and eyes that have been splashed with acid.

Lesson 6: Solving Problems in DC Circuits

Topics

Sources of DC Electricity; Ohm's Law; Work; Torque; Power; Efficiency; Branch Points and Loops

Objectives

- Define Ohm's Law and use it to solve a problem.
- State the definition of a branch point.
- Solve a problem using the power formula.
- State the definition of Kirchhoff's rules.
- Define work, power, torque, and efficiency.

Batteries and DC Circuits

Lesson 7: DC Series Circuits

Topics

Characteristics of a Series Circuit; Ohm's Law for Series Circuits; Current Control; Voltage Drop; Problems in Voltage Drop; Using Equations; Practice Problems; Using Kirchhoff's Rules; Power Equations

Objectives

- Describe a series circuit.
- Solve for E, I, and R in series circuits.
- State the basic rule you must follow when making changes in an equation.

Lesson 8: Parallel Circuits

Topics

Definition of a Parallel Circuit; Recognizing Parallel Circuits; Resistance in Parallel Circuits; Calculating Resistance; Voltage Drop in Parallel Circuits; Current in Parallel Circuits; Conductance; Calculating Power; Practice Problems

Objectives

- State the definition of a parallel circuit.
- Explain how to calculate the current in each branch of a parallel circuit.
- Explain how to calculate resistance in a parallel circuit.
- Calculate power in a parallel circuit.
- Find the reciprocal of any value.

Lesson 9: Series-Parallel Circuits

Topics

Complex Circuits; Examples of Series-Parallel Circuits; Kirchhoff's Rule; Series-Parallel Resistances; Two Resistors in Parallel; Redrawing Circuits; Tracing Circuits; Steps in Calculating Resistance; Calculating Circuit Values

Objectives

- State the definition of a series-parallel circuit.
- Identify series, parallel, and series-parallel circuits.
- Explain how to calculate resistances in a series-parallel circuit.
- Demonstrate how to trace and simplify a circuit.

Lesson 10: DC Circuits in Use

Topics

DC Motors and Generators; Internal Resistance of a Generator; Field Windings in DC Motors; Controlling a DC Shunt Motor; Voltage Dividers; Lighting Circuits; Three-Way Switch Circuits; Four-Way Switch Circuits

Objectives

- Explain how the three types of dc motors differ.
- Demonstrate how to increase and decrease the speed of a dc motor by adding resistors.
- Identify a three-way switch.
- Calculate current and resistance using voltage divider circuits.

Transformers and AC Circuits

Course 203: Transformers and AC Circuits

Covers differences between DC and AC circuits. Explains AC sine wave, using vectors to solve AC problems, calculating impedance in circuits having inductance, capacitance, and resistance, AC power relationships in single-phase and three-phase circuits, and principles of transformer maintenance.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Principles of Alternating Current

Topics

AC and DC Electricity; Waveforms; AC Waveform; Frequency; Peak-to-Peak Values; Average Values; Effective Values; Energy Storage; Faraday's Law; Basic Circuit Concepts

Objectives

- State of definition of a waveform.
- Demonstrate how to calculate the frequency of an alternator's output.
- Explain how to calculate an effective value.
- Name the kinds of values that must be used when applying the dc rules and laws to ac circuits.

Lesson 2: Mathematics in AC Circuits

Topics

AC Potential Difference; Angles and Degrees; Right Triangles; Vectors Applied to AC Circuits; Graphic Solutions; Mathematical Solutions; Calculating Instantaneous Values

Objectives

- Describe a triangle.
- State the definition of a vector.
- Identify the vector representing resistance in a vector diagram.
- Demonstrate how to calculate the total impedance in an ac circuit.

Lesson 3: Inductance and Inductive Reactance

Topics

Inductance; Factors Affecting Inductance; Counter Electromotive Force (CEMF); Inductive Reactance; Inductive Time Delay; Phase Angles; Calculating Impedance; Mutual Induction; Inductors in Series; Inductors in Parallel

Objectives

- Name the property of a coil that makes it resist changes in current.
- List the factors that determine inductance in a coil.
- State the definition of counter electromotive force.
- Demonstrate how to convert a frequency in Hz to a frequency in radians per second.

Lesson 4: Capacitance and Capacitive Reactance

Topics

How a Capacitor Works; Units of Capacitance; Factors Controlling Capacitance; Kinds of Capacitors; Discharging Capacitors; Series Capacitors; Parallel Capacitors; Time Constants; Capacitive Reactance; Phase Angle

Objectives

- Name the parts of a capacitor.
- List the factors that affect the amount of charge stored in a capacitor at a given potential difference.
- Demonstrate how to install a multisection electrolytic capacitor.
- State the definition of capacitive reactance.

Lesson 5: Impedance

Topics

Impedance in Series circuits; Phase Angles; Resonance in Series Circuits; Impedance in Parallel Circuits

Objectives

- State the definition of impedance.
- Explain how to calculate the impedance in a series ac circuit.
- Demonstrate how to find the value of a phase angle for a circuit.
- Explain how to calculate the impedance in a parallel circuit.

Lesson 6: Power and Energy in AC Circuits

Topics

Work and Energy; Power; Power in Resistive Circuits; Power in Inductive Circuits; Power in Capacitive Circuits; Importance of the Power Factor; Power Factor Correction; Power Capacitors; Capacitor Installation

Objectives

- State the definition of power.
- Demonstrate how to calculate power in an inductive circuit.
- State the reason why capacitors are added to circuits to increase the power factor.
- Explain how to install capacitors correctly.

Lesson 7: Three-Phase Circuits

Topics

Three-Phase Alternators; Y-Connected Alternators; Delta-Connected Alternators; Power in Three-Phase Circuits; Load Connections; Measuring Power in Three-Phase Circuits

Objectives

- List the main advantages of the three-phase ac system.
- State the definition of phase sequence.
- Demonstrate how to calculate the RMS power in a single-phase circuit.
- Explain how to measure the total power consumed by the load in a three-phase circuit.

Lesson 8: Principles of Transformers

Topics

Magnetic Field; No-Load Operation; Construction of Transformers; Variable Transformers; Transformer Losses and Efficiency; Autotransformers; Instrument Transformers

Objectives

- Explain the difference between the primary winding and the secondary winding in a transformer.
- Explain how the windings are positioned in a core-type transformer.
- List the kinds of losses that occur in transformers.
- State the definition of a current transformer.
- List the functions of an instrument transformer.

Transformers and AC Circuits

Lesson 9: Transformer Applications

Topics

Transformer Designation; Transformer Insulation; Transformer Cooling; Transformer Polarity; Single-Phase Transformer Connections; Three-Phase Transformer Connections; Three-Phase Transformers; Installing Transformers

Objectives

- Name general kinds of transformers.
- List the temperature limits for each class of transformer insulation.
- Explain how oil-immersed transformers are cooled.
- Name the common methods of connecting three single-phase transformers for three-phase operation.
- Explain how to select the correct location for a transformer.

Lesson 10: Maintaining Transformers

Topics

Preventive Maintenance Program; Inspection; Making Transformer Inspections; Transformer Liquids; Dielectric Test; Breakdown Test; General Testing; Transformer Failure; Electrical Test; Disassembly and Inspection

Objectives

- Explain what to look for during an inspection of sealed transformers.
- List problems that are indicated by an increase in transformer operating temperature.
- Demonstrate how to perform a breakdown test.
- Explain how to locate the exact point of a leak in a welded joint below the liquid level.
- List the steps in inspecting a transformer when a winding fails.

Electrical Measuring Instruments

Course 204.1: Electrical Measuring Instruments

Covers the principles on which electrical test instruments operate. Basic instruments covered include voltmeter, ammeter, wattmeter, ohmmeter, and megohmmeter. Covers AC metering, split-core ammeter, use of current and potential transformers. Includes detailed coverage of modern multimeters. Explains functions and uses of oscilloscopes.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Principles of Meter Operation

Topics

Meter Principles; General Digital Meter Design; Integrating ADCs; Digital Displays; Sensitivity, Accuracy, and Resolution; Introduction to Analog Meters; The D'Arsonval Movement; Electrodynamometer Movements; Moving-Vane Meters; Magnetic Shielding; Parallax Error; Analog Instrument Sensitivity; Analog Accuracy

Objectives

- Define the terms digital meter and analog meter.
- Describe the purpose of the analog-to-digital converter in a digital meter.
- Identify and label graphs of integrator output from a dual-slope integrating meter.
- Explain how time is related to voltage measurement in an integrating digital meter.
- Differentiate among the terms accuracy, sensitivity, and resolution.
- Explain how a D'Arsonval meter movement works.
- Describe the parallax effect, and explain how to avoid it when using an analog meter.
- State the sensitivity formula for an analog meter.

Lesson 2: Ammeters, Voltmeters, and Wattmeters

Topics

Measurement Considerations; Current Measurement; Measuring Direct Current; Multirange Ammeters; Hooking Up an Ammeter; Measuring Alternating Current; Clamp-On Ammeters; Voltmeters; Using a Voltmeter; Wattmeters

Objectives

- Describe the differences and similarities between an analog ammeter and a voltmeter.
- Explain how ammeters and voltmeters are protected internally from overcurrent.
- Explain how a make-then-break switch works.
- Identify which meters should be connected in series in a circuit and which should be connected in parallel.
- Describe how an analog wattmeter works.
- Explain how it is possible to overload a wattmeter, even with the meter's pointer at less than full-scale deflection.

Lesson 3: Resistance Measurement

Topics

Measuring Resistance with an Ohmmeter; Ohmmeter Currents Are Small; Checking and Calibrating an Ohmmeter; How Does a Multirange Ohmmeter Work?; Shunt Ohmmeters; Advantages and Disadvantages of Shunt Ohmmeters; Megohmmeters; How to Use a Megohmmeter

Objectives

- Explain characteristic differences between a series ohmmeter and a shunt ohmmeter.
- Explain why ohmmeter scales read from right to left, instead of left to right, and why they are nonlinear.
- Describe the internal circuits and basic operation of an opposed-coil megohmmeter.
- State the primary safety precaution to take when using an ohmmeter.
- Describe two methods used by ohmmeter manufacturers to extend the range of their instruments.
- Explain how to test for opens, shorts, and grounds, using a megohmmeter.
- Describe how to make zero-adjustments on ohmmeters and megohmmeters.
- Explain why variable resistors are needed in battery-powered ohmmeters.

Lesson 4: Multimeters

Topics

The Multimeter; Guidelines for Using a Multimeter; An All-Purpose Graphical DMM; More Advanced Meter Functions; Multimeter Accessories; Multimeter Safety

Objectives

- Demonstrate how to measure ac and dc current and voltage with a multimeter.
- Describe the function of a current probe.
- Explain how to isolate the source of a glitch with a graphical multimeter.
- Demonstrate how to read the screen display of a graphical multimeter in the Trend mode.
- Explain why you set a meter to its highest range before taking your first measurement.
- Define autoranging and auto-polarity.
- List three safety precautions to take when using multimeters.

Electrical Measuring Instruments

Lesson 5: Oscilloscopes

Topics

Who Needs an Oscilloscope?; Kinds of Oscilloscopes; How an Analog Oscilloscope Works; Triggering; Digital Oscilloscopes; Dual-Trace Oscilloscopes; Real-Time vs Sampling Oscilloscopes; Selecting the Right Oscilloscope; Oscilloscope Controls; Probes; Basic Measurement Procedures; Using the Oscilloscope in Troubleshooting

Objectives

- Describe how an analog oscilloscope works.
- Describe advantages of a digital oscilloscope over an analog oscilloscope.
- Demonstrate how to measure voltage with an oscilloscope.
- Show two methods of determining phase angles with an oscilloscope.

Electrical Safety and Protection

Course 205.1: Electrical Safety and Protection

Examines electrical hazards and stresses the importance of electrical safety. Covers the equipment and procedures necessary to work safely with electricity, including PPE, lockout/tagout, and first aid. Explains the importance of grounding. Describes many kinds of fuses, circuit breakers, and motor protection devices and their uses.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Electrical Hazards

Topics

The Importance of Electrical Safety; The Electric Circuit; Electric Shock; Electric Arc; Basic Rules of Electrical Safety; Hazardous Electrical Locations; Additional Hazards

Objectives

- List the three main factors that determine the effect of electric current on the human body.
- Explain what to do if a person is a victim of electric shock.
- Name four precautions you can take to guard against electric shock.
- Define the term qualified person.
- Summarize the basic rules of electrical safety.

Lesson 2: Electrical Safety Equipment

Topics

Work Clothes; Personal Protective Equipment; Special Body Protection; Foot Protection; Gloves; Head Protection; Eye Protection; Face Protection; Safety Harnesses and Lifelines; Respiratory Protection; Lockout Devices; Barricade Tape; Electrical Tools; Voltage Testers

Objectives

- Describe appropriate clothing and PPE to wear when working with electricity.
- Explain first aid procedures for eyes.
- Describe the devices used to lock out power.
- Tell how to keep plant personnel out of an area where electrical work is being performed.
- Explain the purpose of a voltage tester.

Lesson 3: Electrical Safety Procedures

Topics

Energy Control; Lockout/Tagout Procedures; Using Power Tools Safely; Power Tool Safety Rules; Recognizing Electric Shock Victims; First Aid for Shock Victims

Objectives

- Explain the concepts of energy control and zero energy state.
- Summarize the OSHA lockout procedure.
- Explain how portable power tools are grounded.
- List some common symptoms of electric shock.
- Summarize the steps involved in administering CPR.

Lesson 4: The National Electrical Code®

Topics

Overview of the *NEC*; Chapter 1: General *NEC*; Chapter 2: Wiring and Protection; Chapter 3: Wiring Methods and Materials; Chapter 4: Equipment for General Use; Chapter 5: Special Occupancies; Chapter 6: Special Equipment; Chapter 7: Special Conditions; Chapter 8: Communications Systems; Chapter 9: Tables; Informative Annexes

Objectives

- Understand the purpose and scope of the National Electrical Code.
- Define key terms related to the National Electrical Code.
- Determine requirements for electrical installations.
- Locate and reference common National Electrical Code articles.
- Identify common calculation tables.

Lesson 5: Grounding, Ground Faults, and Short Circuits

Topics

Equipment Grounding; Circuit Grounding; Protection Against Ground Faults; Transformer Grounding; Effects of Impedance; Grounding Through Enclosures; Visual Indication of Ground for Ungrounded Circuits; Grounded Conductor Alarms; Detecting Faults Automatically; Static Electricity

Objectives

- State the reason why circuits should be grounded.
- Explain how to test a circuit for proper grounding.
- Explain how a ground-fault circuit interrupter works.
- Contrast current electricity and static electricity and explain why each can be hazardous.
- Identify the correct extinguisher to use on flammable liquid fires and on energized electrical equipment fires.

Lesson 6: Fuses and Circuit Breakers

Topics

The Purpose of a Fuse; Lead-Wire Fuses; Cartridge Fuses; Dual-Element Cartridge Fuses; Current-Limiting Fuses; Power Fuses; Cartridge Fuse Classes, Sizes, and Ratings; Installing Cartridge Fuses; Plug Fuses; Glass-Tube Fuses; Kinds of Circuit Breakers; Magnetic Circuit Breakers; Thermal-Magnetic Circuit Breakers; Ambient-Compensated Circuit Breakers; Molded-Case Circuit Breakers; Low-Voltage Power Circuit Breakers; Circuit Breaker Tripping; Circuit Breaker Reset and Fuse Replacement

Objectives

- Explain how a dual-element cartridge fuse works.
- List the NEC rules on installing fuses.
- Explain how a circuit breaker works.
- Describe molded-case circuit breakers.
- Explain the steps involved in fuse replacement and/or circuit breaker reset.

Electrical Safety and Protection

Lesson 7: Motor Protection

Topics

The Importance of Motor Protection; Motor-Feeder Protection; Feeder Size; Branch Circuits; Motor Branch-Circuit Overcurrent Protection; Motor-Running Overcurrent Protection; Inherent Thermal Protection; Temperature-Sensing Devices; Current-Sensing Devices; Melting-Alloy Relays; Bimetallic Relays; Selecting Motor Protection; Ambient-Compensated Overload Relays; Single Phasing; Protecting Overload Relays

Objectives

- List the steps in determining the correct rating of the motor feeder protection.
- Explain how to select a thermal overload relay.
- Explain how thermostatic, resistance, and thermocouple detectors work.
- Contrast temperature-sensing devices and current-sensing devices.
- Explain how various relays provide motor protection.
- Define single phasing.

DC Equipment and Controls

Course 206: DC Equipment and Controls

Covers DC power applications in industry, types of DC generators, operating characteristics of DC motors, DC armature principles, and armature maintenance and repair. Includes types of DC relays, DC controllers, overspeed and overload protection, drum and reversing controllers, dynamic braking, DC power supplies, diodes, semiconductors, SCR principles, and DC maintenance practices.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: DC Power in Industry

Topics

Advantages of Direct Current; DC Generators; Rectifiers; DC Motors; SCR Speed Control; Storage Batteries; Charging Storage Batteries; Electroplating; Electropolishing; Electroforming; Electrolytic Refining; Electrolytic Furnaces; Arc Welding

Objectives

- List the advantages of dc over ac.
- List the brush problems caused by eddy currents.
- Name three types of batteries commonly used in the plant.
- Explain how the electroplating process works.
- Explain the difference between straight polarity and reversed polarity in arc welding.

Lesson 2: DC Electromagnets

Topics

Magnets and Magnetic Materials; Magnetic Forces; Magnetic Fields; Effect of Distance on Magnetic Field Strength; Magnetic Shielding; Solenoids; U-Shaped Magnets; Reducing the Effects of Residual Magnetism; Uses for Solenoids; Choosing the Right Solenoid; Causes of Solenoid Problems; Relays; Polarized Relays; Protecting Relay Contacts

Objectives

- State the definition of residual magnetism.
- Explain the effects of distance on magnetic field strength.
- Discuss the characteristics and uses of solenoids.
- Discuss the characteristics of relays.

Lesson 3: DC Generators

Topics

Magnets and Magnetic Materials; Magnetic Forces; Magnetic Fields; Effect of Distance on Magnetic Field Strength; Magnetic Shielding; Solenoids; U-Shaped Magnets; Reducing the Effects of Residual Magnetism; Uses for Solenoids; Choosing the Right Solenoid; Causes of Solenoid Problems; Relays; Polarized Relays;

Objectives

- Explain the function of each of the main parts of the dc generator.
- Explain how to increase the number of pulses during each rotation of an armature.
- Demonstrate how to combine the shunt field and series field to produce a compound generator.
- State the reasons why electrical losses, magnetic losses, and mechanical losses occur in the dc generator.

Lesson 4: DC Motors

Topics

Principles of DC Motors; Counter-Electromotive Force (CEMF); Armature Reaction; Self-Induction and Commutation; Interpoles; Torque in DC Motors; Factors Determining Torque; Work and Power; Speed Regulation; Kinds of DC Motors; Shunt Motors; Torque Variation in a Shunt Motor; Effects of an Open-Shunt Field; Series Motor; Compound Motors; Cumulative Compound Motors; Differential Compound Motors

Objectives

- Explain what happens during self-induction and commutation.
- Define CEMF.
- State the difference between speed regulation and speed control.
- Name the kinds of dc motors.
- Explain the different operating characteristics of series, shunt, and compound motors.

Lesson 5: DC Armatures

Topics

Kinds of DC Armatures; DC Armature Windings; Simplex-Lap Windings; Simplex-Wave Windings; Armature Losses; Copper Loss; Eddy-Current Loss; Hysteresis Loss; Commutation; Armature Maintenance; Locating Armature Problems

Objectives

- Name the basic parts of an armature assembly.
- Describe the main differences between a lap winding and a wave winding.
- List the characteristics of a single-reentrant simplex-lap winding.
- State the definition of copper loss, eddy-current loss, and hysteresis loss.
- Demonstrate how to perform preventive maintenance on an armature.

Lesson 6: DC Relays

Topics

Relay Operating Characteristics; Overload Relays; DC Motor Acceleration; Shunt Relays; Series Lockout Relays; Double-Coil Series Lockout Relays; Two-Coil Lockout Relays; Inductive Time-Delay Relays; Magnetic Blowout Coils; Dynamic Braking; Electrically Operated Brakes

Objectives

- Name three factors that determine the performance and reliability of a relay.
- Name the six types of commonly used relays.
- Explain the operation of each type of relay.
- Explain dynamic braking.
- Describe how a disc brake is attached to a motor.

DC Equipment and Controls

Lesson 7: DC Controllers

Topics

Factors Affecting Motor Speed; Classification by Performance; Low-Voltage Protection; Overvoltage Protection; Low-Voltage Release; Overload Protection; Temperature Compensation; Controller Overload Reset; Manual Starters; Magnetic Controllers; Drum Controller

Objectives

- List the kinds of functions performed by motor-control devices.
- Name the types of motor controllers and discuss their operating characteristics.
- Explain how each of the three kinds of thermal overload relays works.
- Name the kinds of resets for overload relays.

Lesson 8: DC Power Supplies

Topics

Electron Emission; Electron Tubes; Vacuum-Tube Diode; Vacuum-Tube Diode Rectifiers; Semiconductors; Why Semiconductors Fail; Comparing Generators to Rectifiers; Automotive AC-DC Power Supply; Checking Diodes; Identifying Replacement Semiconductors

Objectives

- Discuss the operating principles of vacuum tubes and rectifiers
- Name the four types of filters commonly used in rectifier circuits.
- Identify a mercury-vapor diode.
- List common causes of semiconductor failure.
- State the criteria for selecting replacement semiconductors.

Lesson 9: Silicon Controlled Rectifiers

Topics

Principles of SCRs; Pulse Timing in DC Circuits; Trigger Pulses; SCR Control of Motors; DC Applications of SCRs; AC-DC Conversion; AC Applications of SCRs

Objectives

- State the definition of a silicon controlled rectifier.
- Explain how an SCR works.
- Explain how to increase the effective current and the power delivered to a motor by an SCR motor control.
- List four dc applications of SCRs.

Lesson 10: Maintenance of DC Equipment

Topics

Inspection; Maintaining Field Coils; Locating Problems in Field Coils; Short-Circuited Field Coils; Open Field Coils; Replacing Field Coils; DC Motor Controllers; Maintaining Relays; Relay Contacts; Maintaining DC Armatures; Commutation; Maintaining the Commutator; Brush Selection and Care; Setting Brushes

Objectives

- Explain how to test field coils to determine the condition of the insulation.
- List the signs of a short-circuited field coil in a machine.
- Explain how to replace a field coil in a machine.
- Discuss how to maintain relay control.
- Name the criteria for satisfactory commutation.

Single-Phase Motors

Course 207: Single-Phase Motors

Covers the types and operating principles of common single-phase motors. Explains NEMA motor standards. Explains how to identify motor leads on split-phase, capacitor-start, capacitor-run, permanent split capacitor, and repulsion motors. Covers universal motors, shaded-pole motors, synchro motors, and servo systems. Gives general maintenance procedures on all single-phase motors.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Introduction to Single-Phase Motors

Topics

Parts of a Single-Phase Motor; Definitions; NEMA Motor Standards; Motor Enclosures; Nameplate Data; Induction Motors; Single-Phase Stator Field; Single-Phase Rotor Field; Split-Phase Starting; Number of Poles; Electrical Degrees; Synchronous Speed; Starting Switches; Standard and Special Split-Phase Motors

Objectives

- List the parts of a rotor.
- List the data given on a typical motor nameplate.
- Explain how an induction motor works.
- Demonstrate how to calculate the number of electrical degrees in one complete rotation of a motor.
- Explain how a centrifugal switch works.

Lesson 2: Split-Phase Motors

Topics

Starting Single-Phase Motors; Stator Windings; Split-Phase Motor Connections; Identifying Motor Leads; Winding Connections; Skein Winding; Consequent-Pole Windings; Two-Speed Motors; Two-Speed, Three-Winding Motors; Four-Winding Motors; Dual-Voltage Motors; Troubleshooting Split-Phase Motors; Open Circuit in a Winding; Shorted Turns in a Winding; When a Motor Fails to Start; When a Motor Runs Slow

Objectives

- State the reason why a second stator winding is important in the single-phase induction motor.
- Explain how to identify motor leads when there are no tags or colors to identify them.
- Describe a skein winding.
- List the ways to change the speed of a motor by changing the number of poles.
- Discuss some common motor problems.

Lesson 3: Capacitor Motors

Topics

Kinds of Capacitor Motors; The Capacitor; Capacitor-Start Motor Operation; Rotating Magnetic Fields; Single-Voltage Reversible Motors; Single-Voltage Three-Lead Motors; Instantly Reversible Motors; Dual-Voltage Motors; Capacitor-Start Capacitor-Run Motors; Permanent-Split Motors; Reversible Capacitor-Run Motors; Two-Speed Capacitor-Run Motors; Troubleshooting Capacitor Motors; Symptoms and Causes of Motor Trouble; Replacing Capacitors

Objectives

- State the definition of a capacitor.
- Explain how to make a split-phase motor operate as a capacitor-start motor.
- Explain how the running windings are connected to make a dual-voltage motor run on either 120 or 240 volts.
- Select the best capacitor to use as a substitute for a defective capacitor when an identical unit is not available.
- List problems that cause the circuit breaker to trip when you turn on a capacitor motor.

Lesson 4: Repulsion Motors

Topics

Characteristics of Repulsion Motors; Repulsion-Start, Induction-Run Motors; The Repulsion Principle; Hard and Soft Neutral Planes; Purpose of the Brushes; Short-Circuiter; Commutator; Brush-Lifting Mechanism; Brush-Riding Motor; Brush Holders; Hard Neutral Setting; Brush Replacement; Repulsion Motor; Compensated Repulsion Motor; Repulsion-Induction Motor; Stator and Armature Windings; Equalizer Connections; Troubleshooting and Maintenance

Objectives

- Discuss the operating principles of a repulsion-start induction-run motor.
- Explain how to seat new brushes on the commutator.
- Discuss the functions of the major motor components.
- List the reasons a repulsion motor might fail to start.

Lesson 5: Universal Motors

Topics

Operating a DC Shunt Motor on AC Power; DC Series Motors Operated on AC Power; Hysteresis and Eddy-Current Losses; Advantages of Universal Motors; Performance Characteristics; Speed Control; Motor Life; Universal Motor Assemblies; Ventilation; Brush Mountings; Brush Selection; Electrical Connections; Troubleshooting and Repair

Objectives

- Explain eddy current loss in the universal motor.
- List the advantages of a universal motor.
- Explain how the speed of the universal motor is controlled.
- List the criteria for selecting carbon brushes for universal motors.
- State reasons why a universal motor might have poor torque.

Single-Phase Motors

Lesson 6: Special Motors

Topics

Shaded-Pole Motors; Principles of Operation; Reversing Shaded-Pole Motors; Synchronous Motors; Hysteresis Motor Construction; Theory of Hysteresis Motors; Unexcited Synchronous Motors; Inductor Motors; Reluctance Motors; Permanent-Magnet Motors

Objectives

- State the definition of a salient pole.
- Explain the operating principles of a shaded-pole motor.
- Discuss the operating principles of a hysteresis motor.
- Explain the difference between an unexcited synchronous motor and an excited synchronous motor.

Lesson 7: Synchros

Topics

A Synchro System; Rotor Construction; Stator Construction; Terminal-to-Terminal Stator Voltages; Synchro Assembly; Synchro Transmitter Operation; Receivers; A Simple Synchro System; Synchro Transmission Systems; Reversing a Receiver's Rotation; Differential Receivers and Transmitters; TX-TDX-TR Synchro Systems; Control Synchro Systems; The Control Transformer; CX-CT System

Objectives

- State the definition of the term synchro.
- Describe motor construction in a synchro.
- Demonstrate how to calculate terminal-to-terminal stator voltage.
- State the reason why the control transformer is important in a synchro control system.
- Explain how to connect a differential synchro system.

Lesson 8: Servos

Topics

Servomechanisms; Operation of a Basic Servomechanism; Amplidynes; Amplidyne Operation; Overtravel Control; DC Servomotors; AC Servomotors; Servocontrol Bridges; Servo Actuators

Objectives

- State the definition of a servomechanism.
- List the four characteristics needed to keep a regulated quantity matched to a reference valve in a servomechanism.
- Explain how an amplidyne control system works.
- Discuss how to control overtravel in a servomechanism.

Lesson 9: Motor Installation

Topics

Protecting Single-Phase Motors; Conductor Size; Preventing Shorts and Grounds; Single-Phase Motor Controllers; Overcurrent Protection; Disconnecting Devices; Guards and Grounding; Fuses; Selecting Fuses; Manual Single-Phase Starters; Integral-Horsepower Starters; Single-Phase Magnetic Starters; Selecting the Proper Motor; Service Factor; Classification of Insulation; Selecting Split-Phase Motors; Selecting Capacitor-Start Motors; Selecting Permanent Split-Capacitor Motors; Selecting Shaded-Pole Motors

Objectives

- Explain how to determine conductor size for motors.
- State the definition of a controller.
- List the conditions under which the frames of stationary motors must be grounded.
- Demonstrate how to determine the size of a dual-element when two or more motors are connected to one feeder.
- List the electrical and mechanical factors to consider in selecting a motor for a specific application.

Lesson 10: Motor Maintenance

Topics

General Maintenance Procedures; Testing Capacitors; Armature Defects; Testing Stator Windings; Locating Problems in Motors; Noisy Operation; Bearing Problems; High Temperatures; Incorrect Speed; Excessive Sparking at the Brushes; Test Equipment

Objectives

- Demonstrate how to test bearings for wear.
- Explain how to test capacitors.
- State the reason why proper belt tension in important.
- List the common causes of excessive brush sparking.

Three-Phase Systems

Course 208: Three-Phase Systems

Covers three-phase motor principles for induction, synchronous, and multi-speed dual-voltage motors. Gives recommended maintenance practices for large AC motors. Covers principles of three-phase motor starters, part winding, reversing, jogging, alternator principles and operation. Describes three-phase power distribution.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Principles of Three-Phase Motors

Topics

Induction Motors; Squirrel-Cage Rotors; Rotating Field; Pole-Phase Relationships; Development of Torque; Rotor Speed and Slip; Rotor Frequency; Rotor Resistance and Reactance; Rotor Current and Potential Difference; Power Factor of Induction Motors; Induction-Motor Torque; Variations in Torque

Objectives

- Describe a squirrel-cage rotor.
- List the factors that determine the strength of the magnetic field in an induction motor.
- Discuss pole-phase relationships.
- Demonstrate how to reverse the rotation direction of the magnetic field.
- Discuss the relationship between rotor speed and frequency.

Lesson 2: Induction Motors

Topics

Characteristics of Squirrel-Cage Motors; Stator Construction; Rotor Construction; Air Gap; Operating Features; Torque; Care of Stator Windings; Wound-Rotor Induction Motors; Brushes and Slip Rings; Wound-Rotor Characteristics; Wound-Rotor Maintenance; Applications of Wound-Rotor Motors; Maintaining Induction Motors

Objectives

- List the main parts of the stator.
- List operating characteristics of a wound-rotor motor.
- Demonstrate how to check rotor windings for short circuits.
- State the definition of a standard motor.

Lesson 3: Synchronous Motors

Topics

Characteristics of Synchronous Motors; Operating Principles; Synchronous Motor Fields; Starting Characteristics; Pull-In Torque; Effects of Slipping a Pole; Synchronous-Motor Applications; Power Factor of a Synchronous Motor; Improving the Power Factor; Brushless Synchronous Motors; Motor Efficiency and Care

Objectives

- List factors that contribute to the torque of an industrial synchronous motor during starting.
- Explain the effects of an amortisseur winding in a synchronous motor.
- State the definition of pull-in torque.
- State the reason why using synchronous motors can increase a low power factor in a plant.
- List the characteristics of brushless synchronous motors.

Lesson 4: Multispeed Motors

Topics

Multispeed Induction Motors; Consequent-Pole Motors; Consequent-Pole Motor Connections; Constant-Horsepower Motor Connections; Constant-Torque Motor Connections; Variable-Torque Motor Connections; Dual-Voltage Motor Connections; Y-Connected Dual-Voltage Motors; Delta-Connected Dual-Voltage Motors

Objectives

- Discuss the operating characteristics of multispeed induction motors.
- Select the best motor for driving equipment that requires the same torque at both high and low speeds.
- State the definition of a variable-torque motor.
- Explain the difference between a constant-horsepower motor and a constant-torque motor.

Lesson 5: Maintaining Three-Phase Motors

Topics

Maintenance Requirements; Cleaning Motors; Care of Stator Windings; Rotor Winding Care; Air Gap; Overload and Single-Phase Operation Problems; Motor Shaft Currents; Induction-Motor Bearings; Bearing Temperatures; Lubricating Motor Bearings; Maintenance Schedule

Objectives

- List the steps in measuring the resistance of the insulation on motor windings.
- Explain how to raise the temperature of a motor winding.
- List the steps in lubricating motor bearings.
- List the conditions that must exist before you can lubricate bearings.

Lesson 6: Motor Starters

Topics

The Need for Motor Starters; Electrical Limitations; Mechanical Limitations; Full-Voltage Starting; Typical Across-the-Line Starting; Methods of Reducing Starting Currents; Primary-Resistance Starter; Secondary-Resistance Starter; Reactor Starter; Part-Winding Starter; Y-Delta Starter; Synchronous-Motor Starters; Maintaining Motor Starters

Objectives

- Explain how a motor starter works.
- Explain the difference between open transition and closed transition.
- Name the common kinds of reduced-voltage starters.
- List the steps in inspecting motor starters.

Three-Phase Systems

Lesson 7: Three-Phase Motor Controllers

Topics

Motor Starters; Circuit Protection; Multiple Start-Stop Control; Across-the-Line Reversing Starters; Plugging Control; Jogging; Controlling Surge and Backspin; Manual Compensator Starter; Magnetic Compensator Starters; Primary-Resistance Starters; Reactor Starters; Wound-Rotor Motor Starters

Objectives

- Explain how to select the best motor starter for a particular application.
- Explain the difference between low-voltage release and low-voltage protection.
- Describe the plugging process.
- Explain how to prevent backspin.

Lesson 8: Alternators

Topics

Alternator Characteristics; Three-Phase Alternators; Air Gap; Slip Rings; Exciters; Rating of Alternators; Alternator Windings; Effect of Current in the Armature; Voltage Regulation; Load Characteristics and Effects

Objectives

- Describe a three-phase alternator.
- Discuss the operating characteristics of alternators.
- List the characteristics that must be considered when you work on alternator windings.
- Name the causes of change in potential difference between terminals as the load changes.
- Demonstrate how to calculate three-phase power in an alternator.

Lesson 9: Auxiliary Generator Systems

Topics

Emergency Generator Requirements; Voltage-Control Equipment; Control Equipment; Manual Transfer Systems; Automatic Transfer Systems; Time-Delay Transfer; Safety Switches; Engine Protection; 400 Hz Generating Systems; General Characteristics; Controlling Potential Difference; Prime Movers and Output Control; 400 Hz Distribution; Maintenance Procedures

Objectives

- Explain how an automatic auxiliary generator works.
- List the methods of overcoming voltage-drop problems when starting loads.
- List the parts of a hydraulic starting system.
- State the definition of a prime mover.
- List the four guidelines to follow when troubleshooting or performing routine maintenance on generators.

Lesson 10: Power Distribution Systems

Topics

Distribution Voltages; Systems of 600 V or Less; Heat Losses; System Grounding; Benefits of System Grounding; Overcurrent Relay Protection; Overcurrent Relays with Voltage Control; Ground Relays; Phase-Sequence or Reverse-Phase Relays; Circuit-Opening Devices; Kinds of Protection; Selective Tripping; Cascade Tripping; Network Protection; Typical Small-Plant System; Distribution-System Testing

Objectives

- State the reasons why 240-volt systems are not as widely used as are 480-volt systems.
- Explain the difference between system grounding and equipment grounding.
- List the benefits of system grounding.
- Explain how an overcurrent relay works.
- Name common circuit-opening devices.

AC Control Equipment

Course 209: AC Control Equipment

Covers the broad range of industrial motor starting and control equipment, including NEMA sizes and ratings. Includes pushbutton control stations, limit switches, mercury switches, mechanical and magnetic plugging, foot switches, and pressure, temperature, and float switches. Covers control panel wiring and special applications.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Motor Starters

Topics

Selecting Motor Controls; Motor Controllers; Controller Enclosures; Starters; Manual Motor-Starting Switches; Magnetic Controls; Armature Assemblies; Magnetic Circuits; Shading Coil; Magnet Coils; Effects of Voltage Variation; NEMA Sizes for Magnetic Starters; AC Hum; Magnetic Starter Control Circuits; Auxiliary Contacts; Reversing Starters; Combination Starters

Objectives

- Describe the difference between a manual starter and a magnetic starter.
- Explain the function of a shading coil in a magnetic starter.
- Explain the effects of low voltage on a controller.
- State the reason why holding-circuit interlocks are required on magnetic starters and contactors.
- Demonstrate how to reverse the shaft rotation of a three-phase motor.

Lesson 2: Switches and Controls

Topics

Industrial Pushbuttons; Standard-Duty Pushbuttons; Selector Switches; Wall Boxes; Single-Contact Ratings; Heavy-Duty Pushbuttons; Contact Ratings; Pushbutton-Station Descriptions; Oiltight Pushbuttons; Pushbutton Operators; Selector-Switch Operators; Key-Operated Selector Switches; Illuminated Pushbuttons; Contact Blocks; Indicating Lights; Circuit Diagrams; Joy-Stick Operators; Assembled Pushbutton Stations; Legend Plates

Objectives

- Discuss the characteristics of industrial switches and controls.
- Identify the five most commonly used NEMA pushbutton stations.
- Demonstrate how to mount an oil-tight control station both vertically and horizontally.
- Explain the difference between standard and press-to-test indicating lights.
- Explain how a three-wire control circuit works.

Lesson 3: Limit Switches

Topics

Precision Snapswitches; Precision-Snapswitch Elements; Precision-Snapswitch Applications; Precision-Snapswitch Selection; Snapswitch Contact Arrangements; Snapswitch Operating Characteristics; Limit-Switch Contact Arrangement; Actuators for Limit Switches; Limit-Switch Enclosures; Mounting Limit Switches; Cam Design; Mercury Tilt Switches; Replacement of Mercury Switches; Failure of Mercury Switches

Objectives

- List the main parts of a precision snap-action limit switch.
- Describe the contact arrangement of a snapswitch.
- Describe the kinds of actuators used in limit switches.
- List the rules for the proper design and application of limit switch cams.
- Explain how a mercury switch works.

Lesson 4: Special Control Switches

Topics

Reversing Drum Switches; Foot Switches; Transfer Switches; Plugging Switches; Mechanical and Magnetic Plugging Switches; Selecting a Plugging Switch; Mechanical Pressure Switches; Bellows Pressure Switches; Diaphragm Pressure Switches; Piston Pressure Switches; Characteristics of Pressure Switches; Mechanical Temperature Switches; Float Switches

Objectives

- Explain how a drum switch works.
- Select the best switch for stopping a motor quickly.
- List the criteria for selecting a plugging switch.
- Identify different types of pressure switches.
- State the definition of pressure differential.

Lesson 5: Timers and Counters

Topics

Importance of Electromechanical Controls; Interval or Reset Timers; Reset-Timer Operation; Pushbutton-Start Interval Timers; Time-Delay Relays; Pneumatic Time-Delay Relays; Repeat-Cycle Timers; Pulse Timers; Percentage Timers; Impulse Counters; Electromechanical Counters; DC and AC Operation Counters; Time Totalizers; Revolution Counters; Programming Control

Objectives

- Explain how a reset timer works.
- Describe the different types of timers.
- Compare and contrast an electric counter and a time totalizer.
- Select the best control device for use where a machine cannot be controlled by time.
- Demonstrate how to set up a chart for a programed control circuit.

AC Control Equipment

Lesson 6: Control Relays

Topics

Types of Relays; Operation of Relay Contacts; Relay Mountings and Enclosures; Relay Terminals; Relay Definitions; Time-Delay Relays; Voltage-Sensing Relays; Frequency-Sensing Relays; Phase-Sequence-Sensing Relays; Reed Relays; Kinds of Reed Relays; Operation of Reed Relays; NEMA Classes for Industrial Relays; Industrial Relay Construction; Causes of Relay Failures

Objectives

- State the definition of a relay.
- Explain the function of relay contacts.
- Select the best relay for use where large movement of the contacts or high contact force is required.
- List the advantages of a reed relay.
- Tell why industrial relays usually have double-break contacts.

Lesson 7: Equipment for Hazardous Locations

Topics

Enclosures for Hazardous Locations; Sources of Ignition; Combustion Principles; Evaluation of Hazardous Areas; Enclosures for Class I, Divisions 1 and 2; Switchgear and Industrial Controls; Lighting Fixtures; Motors and Generators; Plugs and Receptacles; Portable Equipment; Conduit for Class I Locations; Seals for Conduit Systems; Mineral-Insulated Cable; Armored Cable

Objectives

- List the requirements an enclosure must meet in order to be called explosion proof.
- List the characteristics of switchgear and industrial controls in hazardous conditions.
- List three situations in hazardous locations that require the use of seals.
- List the three basic conditions that can cause fire or explosion.
- Demonstrate how to terminate armored cable that enters an explosion proof housing.

Lesson 8: Special Motor Controls

Topics

Synchronous-Motor Control; Automatic Synchronous-Motor Control; Synchronous-Motor Control Units; Automatic Sequence-Accelerating Relays; Automatic Sequence-Decelerating Relays; Manual Autotransformer Starters; Automatic Autotransformer Starters; Part-Winding Starters; Primary-Resistance Starters; Multipoint-Resistance Starters; Y-Delta Starters

Objectives

- Name the two relays required for automatic starting of a synchronous motor.
- Explain how an automatic sequence-accelerating relay works.
- Select the best starter for use where the highest possible starting torque per ampere of line current is required.
- List the characteristics of different types of resistance starters.
- Describe a Y-delta starter.

Lesson 9: Motor Control Centers

Topics

Definition; Features and Advantages of MCCs; MCC Bus; NEMA Standards for MCCs; Construction Features of MCCs; NEMA Enclosures; NEMA Wiring; Circuit Protection; MCC Installation; Preoperation Checks

Objectives

- Define the term motor control center.
- Name the main advantages and disadvantages of back-to-back MCC construction.
- Explain how to install an MCC.
- Define a note, a caution, and a warning as each relates to MCC equipment.
- List the checks to conduct prior to releasing an MCC for plant operation.

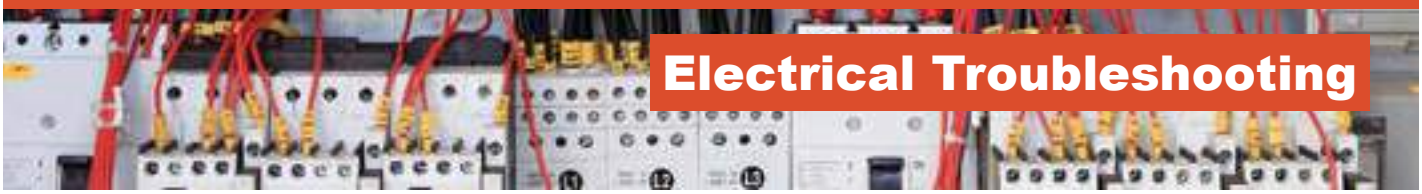
Lesson 10: Control Panel Wiring

Topics

Control-Panel Enclosures; Terminal Blocks; Wire Identification; Terminal Connections; Wire Connectors; Spring-Type Connectors; Pressure Connectors; Tap Connectors; Connector Markings; Wire Dressing

Objectives

- State the function of terminal blocks.
- Demonstrate how to make a terminal connection.
- Tell when to use different types of connectors.
- Describe the proper lacing of wires in a control panel.
- Explain when and how to use a wiring duct.



Electrical Troubleshooting

Course 210: Electrical Troubleshooting

Covers use of schematic diagrams, determining sequence of operation, and use of building diagrams and single-line diagrams. Includes troubleshooting procedures for control circuits and combination starters. Explains troubleshooting practices on DC and AC motors, identifying unmarked leads on three-phase delta and Y-connected motors, and troubleshooting lighting systems.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Troubleshooting with Electrical Schematics

Topics

Standard Symbols and Diagram Identification; Elementary Diagrams; Reading the Schematic Diagram; Power Circuit; Control Circuit; Motor-Starting Circuit; Identifying Conductors; Numbering Components; Locating Relay Contacts; Control-Panel Layouts; Sequence of Operation; Related Schematic Information

Objectives

- Identify a control relay on an electrical schematic.
- State the NEC requirements for fuses in ungrounded conductors.
- Explain component numbering on electrical schematics.
- Explain how conductors in a motor-control circuit are identified.

Lesson 2: Troubleshooting with Building Drawings

Topics

Architectural Drawings; Materials for Construction; Installation Drawings and Diagrams; Riser Diagrams; Substation Drawings; One-Line Diagrams; Electrical Symbols on Blueprints; Building Lighting Diagrams; Power Installation Drawings; Circuit Tracing

Objectives

- Name the kinds of drawings used by electrical specialists.
- Identify electrical symbols commonly used for building diagrams.
- Describe a one-line diagram.
- Discuss the different types of drawing characteristics.

Lesson 3: Troubleshooting Control Circuits

Topics

Control-Circuit Functions; Trouble Conditions; Conditions of Protection; Pushbutton Control Circuits; Sequence-Control Circuits; Troubleshooting Control Circuits; Overload-Protection Circuits; Troubleshooting a Motor Circuit

Objectives

- Explain how severe three-phase voltage unbalance affects a three-phase motor.
- List the advantages of inherent protection.
- Explain how undervoltage release works.
- Describe how to troubleshoot a motor circuit.

Lesson 4: Troubleshooting Combination Starters

Topics

Troubleshooting Control Circuits; Instruments for Troubleshooting; Troubleshooting a Starter; Step-by-Step Troubleshooting Procedures; Troubleshooting Problems; Steps in Locating Problems; Troubleshooting Control Relays; Using Relay-Troubleshooting Charts; Latching-Relay Contact Checks; Timing-Relay Checks; Replacing Relay Coils

Objectives

- List the reasons why a magnet coil burns or short-circuits.
- List the steps in troubleshooting a defective motor.
- Explain how a mechanical latching relay works.
- Explain how an electronic timing relay operates.

Lesson 5: Troubleshooting Control Devices

Topics

Reversing Controllers; Using a Checking-Sequence Chart; Autotransformer Starters; Multispeed Motor-Starter Controls

Objectives

- Demonstrate how to reverse the rotation of a three-phase induction motor.
- Explain the function of limit switches in reversing-motor applications.
- Describe how to use a checking-sequence chart.
- Select the best starter for use where it is undesirable to put a heavy load on the power supply.
- Explain how to change the speed of a squirrel-cage motor.

Lesson 6: Troubleshooting Special Controls

Topics

Selenium Rectifiers; Unbalance in Three-Phase Rectifiers; Selenium-Rectifier Life; Testing Rectifier Diodes; Testing Three-Phase Rectifiers; Electric-Pneumatic Control Circuits; Speed, Size and Safety Comparisons; Comparing Relays and Valves; Control-System Logic; Producing Memory with Feedback; Static Control and Logic; Logic Functions; Time-Delay Element

Objectives

- Explain the effects of age on a selenium rectifier.
- Name the protective devices used in electrical systems and pneumatic systems.
- State the definition of a bistable device.
- List the functions of a static control device.

Lesson 7: Troubleshooting DC Motors

Topics

Problems in DC Motors; Commutator Discoloration; Brush Sparking; Open Armature Winding; Electrical Vibration; Mechanical Vibration; Stationary Parts of the Motor; Brush Problems; Bearings; DC Motor Controls; Drum Controllers; Problems Caused by Fire and Flood

Objectives

- List causes of electrical and mechanical vibration in a dc motor.
- Explain how oil saturation affects brushes in a dc motor.
- Explain how maximum bearing operating temperature is determined.
- List problems in the motor control that can cause sudden or unexpected changes in motor speed.
- Explain how to salvage a water-soaked motor.

Electrical Troubleshooting

Lesson 8: Troubleshooting AC Motors

Topics

Failures in Three-Phase Motors; Grounded Stator Windings; Shorted Pole-Phase Groups; Reversed Pole-Phase Groups; Short-Circuited Phases; Reversed Phases; Open Circuits; Incorrect Voltage Connections; Identifying Y Connections; Identifying Delta Connections; Troubleshooting Split-Phase Motors; Grounded Windings; Open Circuits in Split-Phase Motors; Short-Circuited Windings; Noisy Operation

Objectives

- Identify various kinds of three-phase motor failures.
- Demonstrate how to conduct a balanced-current test on a three-phase, Y-connected winding.
- List the symptoms of a reversed phase in a three-phase winding.
- Explain how to identify external leads that have become defaced.
- Demonstrate how to test for an open circuit in a split-phase motor.

Lesson 9: Troubleshooting Lighting Systems

Topics

Planned Lighting Maintenance; Troubleshooting Basics; Troubleshooting Fluorescent Lighting Systems; Troubleshooting Dimmable Fluorescent Lighting Systems; Troubleshooting HID Lighting Systems; Troubleshooting Dimmable HID Lighting Systems; Troubleshooting Incandescent Lamps; Troubleshooting Occupancy Sensors and Other Switching Controls

Objectives

- Describe the elements of a planned maintenance program.
- Explain the function of lamps, ballasts, and lighting controls.
- Describe the basic troubleshooting process.
- Detail how to troubleshoot common lamp ballast system problems.
- Describe lighting system commissioning.
- Detail how to troubleshoot common occupancy sensor and dimming system problems.

Lesson 10: Saving Time in Troubleshooting

Topics

Preliminary checks; Analyzing the complaint; Checking refrigerant pressures; Sequence of Operation; Developing the Graph and Log; Tracing Circuit Problems; Troubleshooting Before Installation; Troubleshooting After Installation; Standardizing Prints; Equipment Changes and Modifications; Motor-Location File

Objectives

- Name and describe the elements of a sequence of operation.
- List the features that must appear on an elementary wiring diagram to make it comply with JIC standards.
- List the steps in troubleshooting a new machine.
- List the information to be included in a motor location file.
- Select the best method for identifying a motor.

Electrical Safety in the Workplace Understanding NFPA 70E®

Course 211: Electrical Safety in the Workplace - Understanding NFPA 70E®

Introduces the trainee to the purpose of NFPA 70E and explains the history of its creation. After discussing the relationship between OSHA and NFPA 70E, the course moves through the standard, article by article, highlighting the important points in each. Concludes with a lesson on the annexes and supplemental material found in the NFPA 70E Handbook.

TPC Training is accredited by IACET to offer **0.8 CEU** for this program.

Lesson 1: Article 90: Introduction and Purpose

Topics

Introduction to *NFPA 70E*; Enforcement of *NFPA 70E*; National Electrical Code; Electrical Hazards; Purpose of *NFPA 70E*; Scope of *NFPA 70E*; Arrangement of *NFPA 70E*; Organization of *NFPA 70E*; Rules; Interpretation and Application

Objectives

- Explain how and why *NFPA 70E* was created.
- State the purpose of *NFPA 70E*.
- Understand how OSHA can use *NFPA 70E* in enforcement actions.
- Explain which areas are covered by *NFPA 70E* and which are not covered.
- Explain how *NFPA 70E* is arranged and organized.
- State the differences among mandatory rules, permissive rules, and explanatory material.

Lesson 2: Articles 100 and 105: Terms and Definitions

Topics

Overview of Article 100; Electrical Safety and Hazards; Electrical Equipment; Accessibility and Boundaries; Grounding and Ground Faults; *National Electrical Code (NEC)*; Overview of Article 105

Objectives

- Understand the importance of terms described in Article 100.
- Define terms related to electrical safety and hazards.
- Define terms related to electrical grounding and ground fault equipment.
- Define and understand accessibility terms.
- Recognize terms that are common to *NFPA 70E* and the *NEC*.
- State the purpose and scope of *NFPA 70E* Chapter 1 and the responsibilities of employer and employee.

Lesson 3: Article 110: General Requirements for Work Practices

Topics

Overview of Article 110; Establishing an Electrical Safety Program; Training Procedures and Requirements; Host and Contract Employers; Working with Electrical Equipment

Objectives

- Give an overview of the contents of Article 110.
- Describe the relationship between host employers and contract employers.
- Identify the training requirements, types of training, and documentation procedures covered in the article.
- Explain how to develop an electrical safety program.
- Identify the risks of working with electrical hazards.
- Explain how to use test equipment and instruments safely.

Lesson 4: Article 120: Establishing an Electrically Safe Work Condition

Topics

Overview of Article 120; Achieving an Electrically Safe Work Condition; Principles of Lockout/Tagout; Types of Hazard Control Procedures; Lockout/Tagout Equipment; Lockout/Tagout Application Procedures; Temporary Grounding Equipment

Objectives

- Understand the process of achieving an electrically safe work condition.
- Explain lockout/tagout principles and procedures.
- Describe the different forms of control procedures.
- Define the requirements for lockout/tagout devices.
- Identify the procedures for removing and releasing lockout/tagout devices.
- Understand the requirements for temporary grounding equipment.

Lesson 5: Article 130: Work Involving Electrical Hazards

Topics

Overview of Article 130; Electrical Work Permits; Working with Electrical Hazards; Approach Boundaries; Arc Flash Risk Assessment and Boundary; Personal Activity Precautions; Personal Protective Equipment (PPE); Other Protective Equipment; Overhead and Underground Lines

Objectives

- Recognize electrical hazards and know when it is justifiable to work near such hazards.
- Understand the purpose and use of energized electrical work permits.
- Determine shock hazards associated with approach boundaries.
- Determine required arc flash protection.
- Determine the type of personal protective equipment required for a task.
- Develop an understanding of insulated tools and other protective equipment.
- Identify alerting techniques.
- Learn safety procedures to follow while working with overhead lines.

Electrical Safety in the Workplace Understanding NFPA 70E®

Lesson 6: Articles 200-250: Safety-Related Maintenance Requirements

Topics

Overview of Chapter 2; Article 200: Introduction; Article 205: General Maintenance; Article 210: Enclosures; Article 215: Wiring Systems; Article 220: Controllers; Article 225: Overcurrent Devices; Article 230: Rotating Equipment; Article 235: Hazardous Locations; Article 240: Batteries; Article 245: Portable Equipment; Article 250: Protective Equipment

Objectives

- Determine the general maintenance requirements for electrical equipment.
- Identify safety-related maintenance practices.
- Describe the electrical maintenance requirements for facilities.
- Determine to what degree fuses and circuit breakers should be maintained.
- Understand the maintenance of equipment in hazardous locations.
- Explain the requirements for maintaining and testing personal protective equipment.

Lesson 7: Articles 300-350: Safety Requirements for Special Equipment

Topics

Overview of Chapter 3; Article 300: Introduction; Article 310: Electrolytic Cells; Article 320: Batteries and Battery Rooms; Article 330: Lasers; Article 340: Power Electronic Equipment; Article 350: Research and Development Laboratories

Objectives

- Understand the hazards of working with special electrical equipment.
- Determine the safety requirements for special equipment
- Identify safe work practices for electrolytic cells.
- Identify safe work practices for installing and maintaining batteries.
- Identify safe work practices for lasers.
- Identify safe work practices for power electronic equipment.
- Identify safe work practices for laboratories.

Lesson 8: Annexes and Supplemental Materials

Topics

Annexes A and B: References; Annexes C and D: Distances and Boundaries; Annexes E and F: Safety Program and Hazard Evaluation; Annex G: Lockout/Tagout; Annex H: Protective Clothing and PPE; Annexes I and J: Job Planning and Energized Work Permits; Annexes K and L: Hazards and Cell Line Safeguards; Annex M: Layering of Protective Clothing; Annexes N and O: Overhead Lines and Design Requirements; Annex P: *NFPA 70E* and Other Standards; Supplemental Information

Objectives

- Reference publications related to *NFPA 70E*.
- Obtain additional information related to *NFPA 70E*.
- Identify examples of approach and arc flash boundaries.
- Develop a safety program and risk assessment forms.
- Discuss lockout/tagout procedures.
- Be aware of the National Electrical Code references related to *NFPA 70E*.

Variable Frequency Drives

Course 212: Variable Frequency Drives

This Variable Frequency Drives course introduces students variable frequency drives and their applications in industrial plants and commercial buildings. Students learn how to improve VFD control and efficiency, troubleshoot and fix VFDs, reduce equipment downtime, and eliminate chronic VFD problems. Students who take this online course will learn to lower the cost of VFD operation.

TPC Training is accredited by IACET to offer **1.0 CEUs** for this program.

Lesson 1: Basics for Understanding & Working with VFDs

Topics

Variable Frequency Drives; Becoming a Better Qualified Person when Working on VFDs; What is a Variable Frequency Drive; Basics for Understanding and Working with VFDs; Understanding Loads; Types of Torque; Other Load Considerations; Typical VFD Applications

Objectives

- Describe how a VFD operates.
- Identify the components of a VFD.
- Recognize the various torque demands on a VFD.
- Name typical VFD applications.

Lesson 2: Motors for VFDs

Topics

Basics of Motors; Induction Motor Rotation Basics; Three-Phase Motor Operation; Motor Speed and Number of Poles; Volts/Hz Ratio; Motor Nameplate Information; Recommended Maximum Insulation Temperature; The Inverter Duty Rated Motor

Objectives

- Explain the theory of AC motor operation.
- Understand the importance of Volts/Hz ratio.
- Describe the information on a motor nameplate.
- Recognize the importance of an inverter duty rated motor.

Lesson 3: VFD Data Input

Topics

Programming a VFD

Objectives

- Identify the components on a VFD keypad.
- Enter Motor Nameplate Data into a VFD.
- View the VFD parameters on the keypad display.

Lesson 4: Measurement and Safety for VFDs

Topics

Safety and VFDs; Test Equipment for VFDs; Making Safe Measurements

Objectives

- Identify OSHA safety standards.
- Use meters safely.
- Establish an electrical safe work condition.
- Choose the correct meter for troubleshooting VFDs.

Lesson 5: Hands-On Drive Exercises

Topics

Drive External Accessories; Drive Exercises

Objectives

- Review a schematic diagram for external VFD accessories.
- Connect indicator lights to an internal drive relay.
- Connect inputs for various desired control functions.
- Check the fault code register to determine the history of faults.

Lesson 6: Electronics for VFDs

Topics

3-Phase Rectification: The VFD “Front End”; Values Along the Sine Wave; The Diode Symbol; Checking Solid State Components in the Field; Full-Wave Bridge Rectifier; Ripple Voltage and Filtering; Types of Drives

Objectives

- Understand how an AC sine wave is generated.
- Explain the process of rectification.
- Identify semiconductor components.
- Describe pulse width modulation.
- Recognize basic drive types.

Lesson 7: Sizing and Selecting VFDs

Topics

Steps for Selecting a VFD; Sizing and Selecting VFDs; Key VFD Specs; Special Considerations

Objectives

- Create an equipment profile.
- Prepare a detailed analysis of performance requirements.
- Research either machine or process equipment history.
- Identify environmental conditions.
- Analyze the power distribution system.

Lesson 8: Installation and Startup of VFDs

Topics

Steps to Selecting a VFD; VFD Installation Requirements; Startup

Objectives

- Develop a checklist of items.
- Comply with manufacturer’s instructions and specifications.
- Identify with National Electrical Code® requirements.
- Verify proper overcurrent protection to drive.

Variable Frequency Drives

Lesson 9: Troubleshooting VFD Systems and Motors

Topics

Troubleshooting 3 Phase Motors; Insulation Considerations for VFD Motors; Solutions Used to Prevent Motor Failures; Motor Bearing Issues for VFDs; Bearings; Resolving Bearing Problems; Troubleshooting VFDs; VFD Faults;

Objectives

- Troubleshoot three-phase motors.
- Identify motor failures.
- Discuss the six conditions needed to troubleshoot VFDs.
- Discuss a by-pass option.

Lesson 10: Preventative Maintenance

Topics

Preventive Maintenance: NETA Recommendations

Objectives

- Conduct a visual and mechanical inspection of the VFD.
- Perform electrical testing.
- Test the equipment grounding path.

MECHANICAL SYSTEMS

The Mechanical Systems Series covers the principles of operating and maintaining most types of common equipment. The series begins with a thorough grounding in the elements of mechanics, including working with hand tools, power tools, and fasteners. In logical learning sequence, the series continues through lubricants, drive components, bearings, pumps, and piping systems. It concludes with hydraulics and pneumatics, including troubleshooting.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
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302: Lubricants and Lubrication					57
303.1: Power Transmission Equipment					59
304: Bearings					61
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307: Basic Hydraulics					67
308: Hydraulic Troubleshooting					69
309: Basic Pneumatics					71
310: Pneumatic Troubleshooting					73

Basic Mechanics

Course 301: Basic Mechanics

Covers force, motion, work, energy, and fluid mechanics as applied in industrial maintenance. Explains principles of operation for simple machines. Explains the basic elements of industrial machines, as well as common measurement tools used to monitor and adjust equipment. Covers hand tools, power tools and fasteners, ending with a discussion of ways to reduce friction and wear.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Forces and Motion

Topics

Definition of Force; Sources of Forces; Measuring Forces; Forces Applied to Stationary Objects; Normal Forces; Describing Motion; Acceleration; Types of Motion; Newton's Law of Motion

Objectives

- Name five ways forces originate.
- Explain how forces are measured.
- Define velocity, acceleration, and elastic distortion.
- Define rotary motion and reciprocating motion.
- State and explain Newton's Laws of Motion

Lesson 2: Work, Energy, and Power

Topics

Defining Work; Measuring Work; Torque; Energy; The Law of Conservation of Energy; Forms of Energy; Kinetic and Potential Energy; Power; Horsepower; Calories and Btu

Objectives

- Define work, and explain how to calculate it.
- Define the terms torque and prime mover.
- Define energy, and tell how it is measured.
- Differentiate between kinetic and potential energy, and give an example of each one.
- Define power and horsepower, and tell how each is measured.

Lesson 3: Fluid Mechanics

Topics

Definition of a Fluid; Fluids Distribute Forces; Definition of Pressure; Measuring Pressure; Sources of Fluid Pressure; Gauge Versus Absolute Pressure; Liquid Seeks Its Own Level; Velocity Head Versus Static Pressure Head; The Bernoulli Effect; Venturi Applications; Friction Head; The Siphon

Objectives

- Define a fluid.
- Define pressure, and identify common units of pressure measurement.
- State Pascal's Law, and give an example of its application.
- Explain the difference between gauge pressure and absolute pressure.
- Explain the Bernoulli Effect, and give three examples of how it is utilized in industry.
- Explain how a siphon works.

Lesson 4: Simple Machines

Topics

Simple Machines in Your Life; The Lever; Classes of Lever; The Wheel and Axle; Gear Trains; The Inclined Plane; The Wedge; Cam-and-Follower Devices; The Screw; Jackscrews; Pulleys and Pulley Systems; Mechanical Efficiency

Objectives

- Identify and name six types of simple machines.
- Calculate the ideal mechanical advantage of each of six simple machines.
- Describe the action and purpose of cam-and-follower mechanisms.
- Determine the ideal mechanical advantage of several simple gear trains.
- Explain mechanical efficiency and show how to calculate it.

Lesson 5: Machine Elements

Topics

The Machine; Machine Motions; Mechanisms; Lever Linkages; Four-Bar Linkages; Cam-and-Follower Mechanisms; Devices For Producing Linear Motion; Ratchet-and-Pawl Mechanisms; Fluid-Powered Mechanisms; Applying Your Knowledge of Mechanisms

Objectives

- List the four classifications of mechanisms.
- Name the six basic motion conversions, and give an example of each.
- Explain the functions of bell cranks, Pitman arms, and toggle bars.
- Name three types of four-bar linkages, and explain how they function.
- Describe the ratchet-and-pawl mechanism.

Lesson 6: Measurement Tools and Instruments

Topics

Definition of Measurement; Measurement Terminology; Function of Measurement Tools and Instruments; Classification of Measurement Instruments; Typical Portable Instrument Design; Measurements in Maintenance; Routine Maintenance and Repair; Process Monitoring and Quality Assurance; Predictive Maintenance

Objectives

- Define measurement, parameter, accuracy, precision, sensitivity, and range.
- Explain why measurements are important to maintenance operations.
- Describe the general features of a portable measurement instrument.
- List the basic measurement instruments most often used in mechanical maintenance, and describe the operating principles of each.

Basic Mechanics

Lesson 7: The Safe Use of Hand Tools

Topics

Screwdrivers; Wrenches; Hammers and Mallets; Chisels and Punches; Saws; Files and Rasps; Snips, Nippers, and Cutters; Pliers; Organizing Your Tools

Objectives

- Name the major hand tools used in maintenance.
- State criteria for selecting the proper tools for specific jobs.
- Identify safe/unsafe practices in the use of hand tools and explain why they are safe/unsafe.
- Explain how to prolong the useful life of selected hand tools.
- Explain the advantages of having a well-organized tool box.

Lesson 8: The Safe Use of Portable Power Tools

Topics

Hazards of Power Tool Use; Rules to Observe Before Using Power Tools; Protection Against Electric Shock; Electric Drills; Electric Sanders; Portable Grinders; Portable Circular Saws; Saber Saws; Metal Shears; Electric Impact Wrenches; Rotary Hammers; Pneumatic Power Tool Safety; Pneumatic Impact Wrenches; Pneumatic Hammers; General Guidelines for Power Tools

Objectives

- State three precautions to take before using any power tool.
- Describe the safe use of each of the following power tools: electric drills, sanders, grinders, and saws; electric impact tools; pneumatic impact wrenches and hammers.
- State three general guidelines for the safe operation of any portable power tool.
- Describe the potential electrical hazards associated with electric power tools.

Lesson 9: Fasteners

Topics

Kinds of Threaded Fasteners; Screw Threads; Screw Thread Specifications; Threaded Fastener Specifications; Types of Nuts; Washers; Safety Wiring; Keys and Pins; Rivets

Objectives

- Identify seven major types of threaded fasteners.
- Read and interpret common screw thread and threaded fastener specifications.
- Describe the three actions in a manual riveting operation, and explain why each action must be done properly.
- Demonstrate the proper technique for safety wiring a group of threaded fasteners.
- Identify three kinds of washers.

Lesson 10: Friction and Wear

Topics

The Nature of Friction and Its Importance; Causes of Friction; Static and Kinetic Friction; Measuring Friction; Coefficients of Friction; Wear—The Major Consequence of Friction; Static Electricity

Objectives

- Define friction, identify the forces that cause it, and describe its effects.
- Differentiate between static friction and kinetic friction.
- Define coefficient of friction.
- Calculate the expected friction force between two surfaces, given the normal force and the coefficient of friction.
- Describe four types of wear.

Lubricants and Lubrication

Course 302: Lubricants and Lubrication

Covers a complete lubrication training program, including functions and characteristics of lubricants, factors in selection of lubricants, and effects of additives. Oils, greases, and other compounds used for lubrication are described, as well as their applications. Lubrication methods and recommended storage and handling procedures are included.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Principles of Lubrication

Topics

Lubrication; Lubricant Classification; Characteristics of Friction; Why Lubricate Machinery?; Reducing Wear; Dampening Shock; Cooling Action of Lubricants; Corrosion Prevention; Sealing Action of Lubricants; Preventive Maintenance

Objectives

- Define lubrication and describe the four forms of lubricants.
- Discuss the characteristics of static, kinetic, fluid, and rolling friction.
- Explain how a lubricant reduces wear and dampens shock.
- Discuss the cooling action of lubricants and explain how they prevent corrosion.
- Explain the importance of a lubricant's sealing action, and explain how it works.

Lesson 2: Lubricant Characteristics

Topics

Types of Lubricants; Sources of Petroleum; Refining Petroleum; Finish Processing of Lubricants; Chemistry of Petroleum; Properties of Lubricating Oils; Viscosity; Viscosity Index; Flash Point and Fire Point; Pour Point; Oxidation Resistance; Emulsification; Greases; Lubricant Selection

Objectives

- Describe how lubricating oils are obtained and processed and briefly discuss the chemistry of petroleum.
- Explain how viscosity is rated and measured in lubricating oils.
- Explain how flash point, fire point, pour point, oxidation resistance, and emulsification affect a lubricant.
- Describe the five major properties of greases.
- Name four factors that affect lubricant selection.

Lesson 3: Additives, Lubricating Action, and Bearing Lubrication

Topics

The Nature of Additives; Multipurpose Lubricants; Bearing Lubrication; Problems in Bearing Lubrication

Objectives

- Describe the nature and purpose of pour-point depressants, oxidation inhibitors, viscosity-index improvers, and antifoam agents.
- Explain how rust and corrosion inhibitors, extreme-pressure additives, and detergent-dispersants work.
- Discuss the use of emulsifying and demulsifying agents, oiliness and antiwear agents, tackiness agents, and other additives.
- Describe the differences between mixed-film, boundary, and full-film lubrication.
- Discuss elements which determine proper bearing lubricant selection.
- Identify common bearing lubrication problems and ways to avoid them.

Lesson 4: Oils and Their Applications

Topics

General-Purpose and Special-Purpose Oils; Oil Bases; Equipment; Types of Lubricating Oils; Circulating Oils; Gear Oils; Machine Oils; Spindle Oils; Refrigeration Oils; Steam Cylinder Oils; Internal Combustion Engine Oils; Lubricating Wire Ropes

Objectives

- Describe the four types of oil bases.
- Name three types of circulating oils and describe their properties.
- Compare the characteristics and uses of gear oils, machine oils, and spindle oils.
- Discuss the special properties of refrigeration oils, steam cylinder oils, and internal combustion engine oils.

Lesson 5: General-Purpose Greases

Topics

Why Grease?; Grease Defined; How Greases Are Made; Characteristics of Greases; Classification of Greases; Calcium-Soap Greases; Sodium-Soap Greases; Barium-Soap Greases; Lithium-Soap Greases; Aluminum-Soap Greases; Other Soap-Based Greases; Nonsoap-Based Greases; Guidelines for Grease Selection; Bearing Relubrication Techniques; General Do's and Don'ts

Objectives

- Define grease and compare the advantages of using greases and using oils.
- Describe methods for making grease and compare the uses and properties of at least five soap-based greases.
- State the advantages and disadvantages of using nonsoap-based greases.
- Discuss grease selection and application for plain and antifriction bearings.

Lesson 6: Special-Purpose Greases and Dry-Film Lubricants

Topics

Multipurpose Greases; Additives; Extreme-Pressure Greases; Water-Repellent Greases; High- and Low-Temperature Greases; Lamellar Greases; Silicone Greases; Dry-Film Lubricants; Dry-Film Lubricant Application

Objectives

- List three purposes for grease additives and explain how extreme-pressure greases accomplish their purpose.
- Compare uses and characteristics of water-repellent and high- and low-temperature greases.
- Describe lamellar greases, giving an example, and list some special uses for silicone greases.
- Compare three types of dry-film lubricants and describe how and where to use them

Lubricants and Lubrication

Lesson 7: Lubrication Systems and Methods

Topics

Selecting a Lubrication System; Lubricating Methods; Manual Lubrication; Gravity Lubrication; Natural Lubrication; Pressure Lubrication

Objectives

- Name four main considerations for selecting a lubrication system and explain the importance of each.
- Explain how manual and drip lubrication methods work.
- Describe the operating principles of natural and pressure lubrication methods.

Lesson 8: Automatic Lubrication Methods

Topics

Automatic Lubrication; Oil Lubrication; Sight-Glass Flow Indicators; Spray Nozzles and Valves; Metered Systems; Header Systems; Single-Line Metering; Two-Line Metering; Progressive Metering

Objectives

- Describe a typical positive feed oil lubrication system.
- Compare three types of sight glass flow indicators.
- Describe types and operation of various spray nozzles and valves used in automatic lubrication systems.
- Compare the operation of header and progressive metering systems.

Lesson 9: Lubricant Storage and Handling

Topics

Importance of Proper Storage; Inside Storage; Outside Storage; Drum and Tank Dispensing; Direct Dispensing; Inventory and Rotating Stock; Purification and Reclamation; Gravity Separation; Centrifuges; Strainers; Absorbent Filters

Objectives

- Explain the importance of proper lubricant storage and describe good inside and outside storage practices.
- Describe various methods of dispensing lubricants.
- Discuss proper inventory and stock rotation procedures and define lubricant purification and reclamation.
- Explain how gravity separation, centrifuges, strainers, and filters work.

Lesson 10: Lubrication Management

Topics

Good Lubrication Practices; Manual Systems of Lubrication Control; Establishing Oiler Routes; Color-Coding the Lubrication Points; Computer-Managed Lubrication Programs; Installing the System; Useful Computer Reports; Expanded Programs; Making the System Work

Objectives

- Explain the importance of good lubrication management practices and describe seven different kinds of information that should be included on an equipment lubrication survey form.
- Explain how to set up an oiler route and how to color-code the lubrication points.
- Discuss the considerations involved in establishing and installing a computerized lubrication program.
- Describe the purposes of several types of basic computer lubrication forms and list advantages of expanded programs.

Power Transmission Equipment

Course 303.1: Power Transmission Equipment

Covers belt drives, chain drives, gears and gear drives, adjustable-speed drives, shaft alignment, shaft coupling devices, and clutches and brakes.

TPC Training is accredited by IACET to offer **0.8 CEU** for this program.

Lesson 1: Belt Drives

Topics

Uses of Belt Drives; V-Belts; Special V-Belts; Timing Belts; Flat Belts; V-Belt Sheaves; Timing-Belt Pulleys; Flat-Belt Pulleys; Variable-Speed Sheaves; Manually Adjustable Sheaves; Spring-Loaded Sheaves; V-Belt Installation

Objectives

- List the factors that affect the power transmitted by a belt drive.
- Name the main components of a belt drive.
- List the standard V-belt designations.
- Explain the reason for using group belts.
- Describe installation and replacement procedures for V-belts.

Lesson 2: Chain Drives

Topics

Chain Drives Compared to Belt Drives; Chain Drive Terminology; Roller Chains; Double-Pitch Chains; Leaf Chains; Silent Chains; Engineering-Class Chains; Cast Drive Chains; Sprockets; Chain Drive Installation

Objectives

- Explain the differences between chain drives and belt drives in transmitting power.
- Explain how a roller chain drive works.
- Describe the construction of offset roller chain.
- Explain the differences between sprocket types A, B, and C.
- List the steps in installing a chain drive.

Lesson 3: Gears

Topics

Gear Drives; Gear Definitions; Tooth Contour and Diametral Pitch; Spur Gears; Helical Gears; Single- and Double-Cut Gears; Herringbone Gears; Bevel Gears; Worm Gears; Maintenance

Objectives

- Define the following terms used to describe gear drives: pitch circle, pitch diameter, working depth, tooth face, tooth flank.
- Calculate the diametral pitch of a gear.
- List advantages and disadvantages of helical gears.
- Explain the differences between herringbone gears and double-cut helical gears.
- Define the following terms used in discussing worm gears: worm lead, worm lead angle, normal worm pitch, worm axial pitch.

Lesson 4: Gear Drives

Topics

Types of Gear Drives; Shaft-Mounted Gear Drives; Worm-Gear Drives; Miter-Gear Boxes; Gear Drive Installation; Gear Drive Maintenance; Gear Drive Definitions; Concentric-Shaft Gear Drives; Parallel-Shaft Gear Drives; Right-Angle-Shaft Gear Drives; Vertical-Shaft Gear Drives

Objectives

- Explain how additional speed reduction can be obtained with shaft-mounted gear drives.
- Describe a worm-gear drive and a miter-gear box.
- Give a general explanation of gear drive installation and maintenance.
- Define mechanical power, thermal power, and overload capacity.
- Explain what determines the service factor of a gear drive.
- Describe a concentric-shaft gear drive and a right-angle-shaft gear drive.
- Explain how parallel-shaft gear drives are lubricated.

Lesson 5: Adjustable-Speed Drives

Topics

Adjustable-Speed Drives; Belt-Type Adjustable-Speed Drives; Disk-Type Adjustable-Speed Drives; Roller-Type Adjustable-Speed Drives; Hydraulic Adjustable-Speed Drives; Electric Adjustable-Speed Drives

Objectives

- Identify the main criteria for selecting adjustable-speed drives for industrial plants.
- Explain the operation of a variable-speed belt drive.
- Describe how to control variable-speed drives.
- Describe the belts and chains used for variable-speed drives.
- Explain the operation of a roller-type variable-speed drive.

Lesson 6: Shaft Alignment

Topics

Need for Shaft Alignment; Geometry of Shaft Alignment; Preparing for Alignment; Reverse-Indicator Method; Aligning Multiple Machines; Face-Rim Alignment; Long-Span Alignment; Laser Alignment

Objectives

- Determine the corrections needed to align two machines, using the reverse-indicator method.
- Determine the corrections needed to align two machines, using the face-rim indicator method.
- Determine the corrections needed to align three machines on a common centerline.
- Determine the corrections needed to align two machines separated by a long floating shaft.
- State at least three advantages of using laser alignment equipment over using dial indicators.

Power Transmission Equipment

Lesson 7: Shaft Coupling Devices

Topics

Couplings in Industry; Coupling Characteristics; Solid Couplings; Jaw Couplings; Molded Rubber Couplings; Chain Couplings; Gear Couplings; Metal Disk Couplings; Metal Grid Couplings; Special Couplings; Shear-Pin Couplings; Torque-Limiting Couplings; Brake-Wheel Couplings; Floating-Shaft Couplings; Limited-End-Float Couplings; Spacer Couplings; Electrically Insulated Couplings; Torsionally Soft Couplings; Sheave-Mounted Couplings; Continuously Lubricated Couplings

Objectives

- List three functions usually performed by a coupling.
- Describe two types of jaw couplings.
- Name an application for molded rubber couplings.
- State an advantage of chain couplings.
- Explain the operation of a shear pin coupling.
- Describe a torque limiting coupling.
- Name an application that involves a floating shaft.
- Describe a limited end float coupling.
- List advantages and disadvantages of spacer couplings.

Lesson 8: Clutches and Brakes

Topics

Clutches as Couplings; Clutch Operating Methods; Jaw Clutches; Friction Clutches; Torque-Limiting Clutches; Tooth-Type Clutches; Centrifugal-Type Friction Clutches; Overrunning Clutches; Electric Clutches; Fluid Clutches; Dry-Charged Fluid Clutches; Brakes; Friction Shoe Brakes; Friction Disk Brakes; Electric Brakes

Objectives

- Explain the purposes of a clutch.
- Describe the operation of a friction clutch.
- Explain the need for overrunning clutches.
- Name at least one application for an electric clutch.
- Explain how a fluid clutch works.

Bearings

Course 304: Bearings

Covers principles and applications of various types of bearings, including plain journal, ball, and roller bearings. Explains installation, inspection and repair of bearings. Deals with specialized bearings, including powdered-metal, nonmetallic, and hydrostatic bearings. Covers bearing seals, lubrication, and maintenance practices.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Bearings and Shafts

Topics

Bearing Classification; Bearing Selection; Principles of Bearing Operation; Shafts and Shafting; Shaft Materials; Shaft Stresses; Vibration and Critical Speed; Fits and Clearances

Objectives

- Name the two main categories of bearings and cite their advantages.
- Identify bearings by the kind of support they provide.
- Describe the three kinds of stresses acting on shafts.
- Explain natural frequency of vibration and critical speed.
- Name and describe three classes of fits.

Lesson 2: Plain Journal Bearings I

Topics

Plain Journal Bearings; Advantages of Plain Journal Bearings; Lubrication; Lubricating Grooves; Seals; Types of Plain Journal Bearings; Split Bearings; Bearing Design and Selection

Objectives

- Explain the function of lubricating grooves.
- State two reasons for using seals on plain bearings.
- Name the principal types of plain journal bearings.
- Describe the structure of two kinds of precision inserts.
- Define crush and spread.

Lesson 3: Plain Journal Bearings II

Topics

Characteristics of Bearing Materials; Score Resistance; Load Capacity; Fatigue Strength; Conformability; Embeddability; Corrosion Resistance; Temperature Resistance; Bearing Materials; Inspection; Bearing Repair; Relining; Disassembly and Reconditioning; Bearing Installation

Objectives

- Name and explain the characteristics that are most important in materials for bearings.
- State advantages and disadvantages of the standard types of bearing materials.
- Describe standard practices for inspecting bearings.
- Explain bearing repair procedures.

Lesson 4: Antifriction Bearings I

Topics

Antifriction Bearings; Operating Principles; Bearing Materials; Cage Materials; Lubrication of Antifriction Bearings; Seals and Shields; Bearing Classifications; Tolerances; Bearing Installation

Objectives

- Identify the functions of the various parts of a typical rolling-element bearing.
- Explain the three elements of the AFBMA code.
- Define the categories of tolerances for ball bearings.
- Describe the factors that influence running accuracy of bearings.

Lesson 5: Antifriction Bearings II

Topics

Bearing Design; Environment; Mounting Types; Radial and Axial Clearance; Fixed and Floating Bearings; Bearing Fits; Squareness and Alignment; Mounting Methods; Mounting for Precision Applications; Bearing Applications

Objectives

- Name the factors that must be considered in the design of antifriction bearings.
- Describe the process of checking adequate running clearances for bearings.
- Explain the reasons for using fixed and floating bearings together.
- Describe the common methods of mounting bearings.

Lesson 6: Ball and Roller Bearings

Topics

Ball and Roller Bearings; Ball Bearings; Basic Ball Bearings; Single-Row, Angular-Contact Bearings; Double-Row, Angular-Contract Bearings; Other Ball Bearings; Two-Piece, Inner-Ring Bearings; Fractured-Ring Bearings; Bearing Series; Roller Bearings; Cylindrical Roller Bearings; Spherical Roller Bearings; Tapered Roller Bearings; Needle Roller Bearings

Objectives

- Name the three basic ball bearing designs and describe their characteristics.
- Explain the purposes served by the basic roller bearing shapes and their variations in typical applications.

Lesson 7: Specialized Bearings

Topics

Thrust Bearings; Self-Aligning Bearings; Linear-Motion Bearings; Mounted Bearings; Instrument Bearings; Unground Ball Bearings; Powdered-Metal Bearings; Nonmetallic Bearings; Other Materials; Hydrostatic Bearings

Objectives

- Identify ten specialized bearings.
- Describe a specific function or application of each of these bearing types.

Lesson 8: Bearing Seals

Topics

Why Seals Are Used; Seal Functions; Labyrinth Seals; Oil Seals; Oil Seal Terminology; Oil Seal Classification; Special Seals; Seal Selection; Other Seal Materials; Seal Applications; Other Special Seals; O-Rings and Mechanical Seals

Objectives

- Identify the functions of bearing seals.
- Describe the construction and operation of labyrinth and oil seals.
- Explain the two classification systems for oil seals.
- Name typical applications for the different kinds of seals.

Bearings

Lesson 9: Lubrication

Topics

Lubrication Practices; Bearing Lubrication and Lubricants; Oil Lubrication; Grease Lubrication; Special-Purpose Greases; Packing Bearings; Lubrication Equipment; Manual Lubricating Devices; Natural Oil Lubrication Systems; Pressurized Oil Lubrication; Automatic Oil Lubricating Devices; Automatic Grease Lubrication Systems; Rules for Lubrication

Objectives

- State typical applications for oil lubrication of bearings.
- Detail the cleaning procedures for different oil lubrication systems.
- Discuss the three qualities that are the bases for selecting a grease lubricant.
- Give five easy rules for lubricating bearings.

Lesson 10: Bearing Maintenance

Topics

Bearing Maintenance; Installing Plain Journal Bearings; Installing Antifriction Bearings; Mounting a Bearing; Bearing Removal; Bearing Loading Patterns; Bearing Failure Terminology; Bearing Cleaning

Objectives

- Identify a principal cause of early bearing failure.
- Describe installation procedures for antifriction and plain journal bearings.
- Name the different types of bearing failure and their causes.
- Tell how bearings should be cleaned and lubricated after inspection.

Pumps

Course 305: Pumps

Covers typical applications of various types of pumps. Describes factors affecting pump selection. Explains operating principles of centrifugal, propeller, and turbine, rotary, reciprocating, and metering pumps. Includes special-purpose pumps, diaphragm pumps, and others designed to handle corrosive and abrasive substances. Covers pump maintenance, packing gland, seal, and bearing replacement.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Pump Development and Application

Topics

The Development of Pumps; Pumping Systems; Water Pumping Systems; Chemical Pumping Systems; Waste Pumping Systems; High-Viscosity Material Pumping Systems; Solids Pumping Systems

Objectives

- Describe dead-end and recirculating hot water distribution systems.
- List several special considerations involved in chemical pumping systems.
- Define the term viscosity and give examples of high-viscosity materials.
- Tell the effects of heat on the pumping of high-viscosity materials.
- List some special problems involved in the pumping of solids.

Lesson 2: Basic Pump Hydraulics

Topics

Pumping Terminology; Calculating Total Head; Horsepower Calculations; Total Energy vs. Available NPSH; Available NPSH vs. Required NPSH; Pump Performance Curves; Head Capacity Curves; Efficiency Curves; Horsepower Curves; Curve Families; Pump Selection

Objectives

- Describe suction head and suction lift pumping conditions.
- Tell what three elements make up total dynamic head.
- Define static suction head.
- Contrast liquid, brake, and electrical horsepower.
- Tell what useful information can be gained from pump curves.

Lesson 3: End-Suction Centrifugal Pumps

Topics

Introduction to Centrifugal Pumps; Pump Operation; Pump Part Definitions; Pump Casing Materials; End-Suction Casing Configurations; Split-Case Centrifugal Pumps; Double-Volute Pumps; Impeller Types; Wearing Rings; Shafts, Bearings, and Sleeves

Objectives

- Describe the function of the following: pump casing, shaft, impeller, wearing rings, and stuffing box.
- Contrast frame-mounted and close-coupled end-suction pumps.
- Give characteristics of fluids pumped with open, semi-open, and closed impellers.
- Name an advantage and a disadvantage each for stainless steel and brass shaft sleeves.

Lesson 4: Propeller and Turbine Pumps

Topics

Turbine Pump Introduction; Lineshaft Turbines' Submersible Turbines; Flow Patterns; Axial-Flow Propeller Pumps; Mixed-Flow Propeller Pumps; Special Propeller Pumps; Turbine Pump Construction; Vertical Turbine Pump Applications; Regenerative Turbine Pumps

Objectives

- Explain the construction of a line-shaft turbine pump.
- Name the two types of flow possible in a propeller pump.
- Tell the function of diffuser vanes in an axial-flow propeller pump.
- Define electrochemical corrosion and state its cause.
- Describe fluids that can be pumped by a regenerative turbine pump.

Lesson 5: Rotary Pumps

Topics

Introduction to Rotary Pumps; External-Gear Pumps; Internal-Gear Pumps; Lobe Pumps; Screw Pumps; Vane Pumps; Rotary Piston Pumps; Flexible-Member Pumps; Rotary Pump Installations

Objectives

- Describe the fluids that can be pumped by a rotary pump.
- Explain the operation of external- and internal-gear pumps.
- Describe the parts and construction of a lobe pump.
- Compare and contrast timed and untimed screw pumps.
- Tell why sealed bearings might be used in a vane pump.

Lesson 6: Reciprocating Pumps

Topics

Reciprocating Pump Applications, Parts and Classifications; Steam-Driven Pump Operation; The Fluid End; The Steam End; Power Pump Operations; Horizontal and Vertical Plunger Pumps; Flexible-Member Pumps; Rotary Pump Installations

Objectives

- Name the parts that make up the power end of a reciprocating pump and describe their operation.
- Define the terms single-acting pump and double-acting pump.
- Compare simplex and duplex pumps.
- Explain how the pumped fluid lubricates a reciprocating pump.
- Calculate the discharge pressure of an air-driven pump when given the piston ration and motor air supply.

Pumps

Lesson 7: Metering Pumps

Topics

Introduction to Metering Pumps; Metering Pump Classifications; Plunger and Piston Metering Pumps; Diaphragm Pumps; Air-Operated Metering Pumps; Rotary Metering Pumps

Objectives

- Tell what kinds of pumps are used for metering applications.
- Describe metering pump lubrication techniques.
- Name the parts of a diagram metering pump and state the function of each.
- Explain the operation of a diaphragm metering pump.

Lesson 8: Special-Purpose Pumps

Topics

Handling Difficult Materials; Chemical Pumps; Special Chemical Pumps; Magnetic-Drive Pumps; Canned-Motor Pumps; Centrifugal Slurry Pumps; Pulp-Handling Pumps; Trash and Sewage Pumps; Diaphragm Pumps; Reciprocating Slurry Pumps; Vortex Pumps

Objectives

- Describe the operation of a flexible-tube pump.
- Give an application for a progressing-cavity pump.
- Name one disadvantage of a seal-less magnetic-drive pump.
- Explain how to prepare a new centrifugal pump for operation.
- Tell which parts of a reciprocating slurry pump require the most maintenance.

Lesson 9: Packings and Seals

Topics

Pump Sealing Requirements; Stuffing Boxes; Types of Stuffing Boxes; Packing Materials; Installing Packing; Mechanical Seals; Special Seals

Objectives

- Tell why slight leakage through shaft seals is necessary.
- Name the type of stuffing box required for pumps operating under suction lift conditions.
- Give a typical application each for cotton, Teflon®, and aluminum packing.
- Describe the procedure involved in replacing pump packing.
- Describe a packingless seal.

Lesson 10: Pump Maintenance

Topics

Pump Bearings; Sleeve Bearings; Antifriction Bearings; Special Bearings; Bearing Lubrication; Bearing Seals; Pump Installation; Pump Maintenance; End-Suction Centrifugal Pumps; Vertical Turbine Pumps; Rotary Pumps; Reciprocating Pumps; Difficult Material Pumps; Other Maintenance Problems

Objectives

- Name three types of antifriction bearings.
- Name three factors to consider when preparing pump lubrication schedules.
- Describe a typical application for each of the following bearing seals: felt, leather, synthetic.
- Tell the two major maintenance problems encountered in rotary pumps.
- Explain how to identify worn piston rings in a reciprocating pump.

Piping Systems

Course 306: Piping Systems

Covers piping and tubing systems used for fluid transport in the plant: hydraulic fluids, steam, liquefied product, refrigerant, and water. Shows typical metallic and nonmetallic piping systems, pipe-joining methods, and how tubing and hoses differ from piping. Covers valves, pipe fittings, hangers, supports, and insulation. Shows how tubing is sized, fitted, bent, and joined. Explains uses of traps, filters, and strainers.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Introduction to Piping Systems

Topics

Piping Systems; Fluids; Protecting Steam Lines; Keeping Fluids Clean and Moving; Piping Systems Maintenance; Valves and Fittings; Pipe Hangers and Supports; Temperature Effects; Piping Insulation; Typical Piping Systems; Maintenance Considerations

Objectives

- Describe what typical piping systems consist of, and explain their importance to plant operations.
- Identify common valves and fittings, pipe hangers and supports.
- Describe the effects of temperature on piping system components, and explain the need for insulation.
- List routine maintenance considerations for piping systems.

Lesson 2: Metal Piping

Topics

Pipes; Pipe Schedules; Other Pipe Codes; Types of Systems; Characteristics of Metals; Pipe-Manufacturing Methods; Behavior of Fluids in Piping; Piping Applications; Steam Piping; Water Piping; Maintenance Considerations; Joining Pipes

Objectives

- Explain how metal pipes are sized and designated according to standard codes and schedules.
- Identify the characteristics of metals that make them suitable for a variety of piping applications.
- Describe the different methods of connecting sections of metal pipe, including bell-and-spigot joints, welded, soldered, or brazed joints, screwed or threaded joints, and flanged joints.
- Discuss the major considerations involved in the maintenance of metal piping.

Lesson 3: Nonmetallic Piping

Topics

Nonmetallic Piping Materials; Clay Pipe; Concrete Pipe; Asbestos-Cement Pipe; Plastic Pipe; Limitations of Plastic Pipe; Joining Plastic Pipe; Maintaining Plastic Pipe; Glass Pipe; Other Piping Materials; Maintenance Requirements

Objectives

- Name the basic nonmetallic piping materials, and discuss the advantages and disadvantages of each.
- Identify the different forms of clay pipe and concrete pipe.
- Explain the difference between thermoplastic and thermosetting plastic pipe.
- Discuss the limitations of plastic pipe.
- Describe how to join sections of nonmetallic pipe, and how to maintain them.

Lesson 4: Tubing

Topics

Tubing; Advantages of Tubing; Tube Joining; Types of Tubing; Tubing Applications; Plastic Tubing; Other Applications; Tubing Maintenance

Objectives

- Compare piping and tubing, and list the major advantages of tubing.
- Describe the methods of cutting, bending, and joining sections of tubing.
- List the main types of metal tubing, and describe the kinds of industrial applications in which they are used.
- List the main types of plastic tubing, and describe the kinds of industrial applications in which they are used.

Lesson 5: Hoses

Topics

Hoses; Codes and Sizes; Hose Classifications; Hose Terminology; Reinforced Nonmetallic Hose; Nonmetallic Hose; Metallic Hose; Hose Couplings; Maintenance

Objectives

- Explain how hoses are sized, classified, and constructed.
- Define basic hose terminology.
- Discuss the respective advantages of metallic hose, nonmetallic hose, and reinforced nonmetallic hose.
- Describe the common types of hose couplings used in industrial service.
- List the primary maintenance requirements of hoses.

Lesson 6: Fittings

Topics

Functions of Fittings; Screwed Connections; Flanged Connections; Other Fittings; Welded Connections; Tube Fittings; Drawing Symbols

Objectives

- Discuss the main functions of fittings.
- Identify common pipe and tube fittings.
- Contrast screwed, flanged, and welded connections, and tell why one type of joint may be preferred for a given application.
- Explain how expansion joints and vibration dampeners work.
- Demonstrate a knowledge of the symbols used to represent joints and fittings on schematic drawings of piping systems.

Piping Systems

Lesson 7: Common Valves

Topics

Valves; Valve Construction; Valve Sizes and Functions; Types of Industrial Valves; Gate Valves; Globe Valves; Needle Valves; Ball Valves; Butterfly Valves; Plug Valves; Check Valves; Quick-Opening Valves; Valve Maintenance; Valve Connections

Objectives

- Explain the various ways in which valves control fluid flow in piping systems.
- Identify gate, globe, needle, ball, butterfly, plug, and check valves, and tell what each is used for.
- Explain how and why quick-opening valves are used in industrial piping applications.
- Describe routine inspection, lubrication, and maintenance procedures for common valves.

Lesson 8: Special Valves

Topics

Constructions and Materials; Diaphragm Valves; Blowoff Valves; Pressure-Regulating Valves; Temperature-Regulating Valves; Safety Valves; Relief Valves; Reducing Valves; Valve Operators; Magnetic Operators; Pneumatic and Hydraulic Operators; Remote Control

Objectives

- Explain how diaphragm valves work.
- Describe the functions of the three main types of blowoff valves.
- Tell how regulating valves, relief valves, and reducing valves are used in industrial piping systems.
- Describe how different kinds of actuators open and close valves in response to pneumatic, hydraulic, or electrical signals.

Lesson 9: Strainers, Filters, and Traps

Topics

General Applications; Strainers; Filters; Steam; Traps; Vent Valves; Trap Maintenance; Typical Piping System

Objectives

- Discuss the protective uses of strainers and filters in piping systems.
- Explain how the relationship between pressure and temperature affects steam lines, and creates the need for steam traps.
- Describe proper steam trap maintenance.
- Explain how and why air-vent and water-drain valves are used.
- Describe how a heat exchanger works in a fluid system.

Lesson 10: Accessories

Topics

Pressure Gauges; Temperature Gauges; Rotary Pressure Joints; Vacuum Breakers; Accumulators; Receivers; Actuators and Intensifiers; Pneumatic Pressure Line Accessories; Heat Exchangers; Wrenches; Maintenance

Objectives

- Describe how different types of gauges are used to measure pressure and temperature in piping systems.
- Explain why rotary pressure joints are necessary in some applications.
- Describe the functions of accumulators and receivers.
- Tell how actuators and intensifiers are used in fluid-power systems.
- Discuss the principles of preventive maintenance and repair maintenance as they apply to piping systems.

Basic Hydraulics

Course 307: Basic Hydraulics

Covers hydraulic principles, types of hydraulic fluids and their characteristics. Describes components of the hydraulic system and their functions, including filters and strainers, reservoirs and accumulators, pumps, piping, tubing and hoses, control valves, relief valves, and actuating devices. Covers a variety of cylinders and hydraulic motors.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Principles of Hydraulics

Topics

Fluid Power and Hydraulics; Force, Weight, and Mass; Pressure; Work, Power, and Energy; Incompressibility and Nondiffusion; Hydrostatic Pressure; Pascal's Law; Transmission of Fluid Power; Fluid Flow in Pipes; Bernoulli's Principle; The Effect of Heat on Liquids; Hydraulic Power Systems

Objectives

- Explain the difference between absolute and gauge pressure.
- Demonstrate how power is calculated.
- Explain Pascal's Law.
- Describe the difference between laminar and turbulent flow.
- Name the main components of a hydraulic system.

Lesson 2: Hydraulic Fluids

Topics

Functions of Hydraulic Fluids; Physical Properties; Viscosity; Viscosity Index; Viscosity and Pressure; Pour Point; Fluid Selection; Component Protection; Chemical Properties; System Contamination; Water; Dissolved Air; Foaming; Corrosion and Rusting; Types of Hydraulic Fluids

Objectives

- List the most important properties of hydraulic fluids.
- Explain how viscosity is measured.
- Explain the meaning of the viscosity index.
- Describe the effect of fluid temperature on viscosity.
- Name the causes of corrosion and fluid oxidation.
- Identify various types of hydraulic fluids.

Lesson 3: Strainers and Filters

Topics

Hydraulic System Requirements; Settling; Degree of Filtration; Performance Characteristics; Performance of Different Media; Strainers; Reservoir Strainers; In-Line Strainers; Filters; Fiber Media; Nonfibrous Surface Media; Magnetic Media; Filter and Strainer Installations

Objectives

- Name contaminants found in hydraulic systems.
- Explain the difference between a strainer and a filter, and describe the main function of each.
- Describe the two basic types of filter/strainer media.
- Draw graphic symbols for strainers and filters.

Lesson 4: Reservoirs and Accumulators

Topics

System Demands; Fluid Reservoir Requirements; Baffles; Air Separation; Reservoir Cooling; Reservoir Accessories; Accumulators

Objectives

- Explain the functions of fluid reservoirs.
- Explain the purpose of reservoir baffles.
- Describe various methods of counteracting high operating temperatures.
- Identify important accessories used with reservoirs.
- Demonstrate pressure ratio calculation for a differential-piston accumulator.

Lesson 5: Hydraulic Pumps

Topics

Pump Classification; Rating and Selecting Factors; Capacity; Pressure; Energy Consumption; Drive Speed; Efficiency; Reliability; Fluid Characteristics; Size and Weight; Control Adaptability; Service Life; Installation and Maintenance Costs; Types of Pumps; Gear Pumps; External Gear Pumps; Internal Gear Pumps; Axial-Flow (Screw) Pumps; Cycloidal Pumps; Vane Pumps; Piston Pumps

Objectives

- Name the main classification of hydraulic pumps.
- List factors affecting pump selection and pump performance.
- Define volumetric efficiency and overall efficiency.
- Identify the most common types of positive-displacement pumps, and describe their operation.

Lesson 6: Piping, Tubing, and Fittings

Topics

Hydraulic Piping; Flow and Velocity; Hydraulic Pressure; Pressure Loss; Losses in a Line; Steel Pipe; Pipe Fittings; Pipe Installation; Tubing; Tube Bending; Tube Fittings; Hoses; Hose-End Fittings; Quick-Connect/ Disconnect Couplings; Hose Installations

Objectives

- Discuss the chief considerations in hydraulic line selection.
- Demonstrate how flow velocity and pressure loss are calculated.
- Explain pipe size schedules.
- Describe various types of fittings used in hydraulic systems.
- Explain the reason for using steel pipe.
- List the main advantages of tubing.

Basic Hydraulics

Lesson 7: Directional Control Valves

Topics

Directional-Control Valves; Manually Operated Valves; Automatic Two-Way Valves; Check Valves; Pilot-Operated Check Valves; Spool Valves; Two-Way Spool Valves; Hydraulic-Motor Control; Normally Open and Closed Valves; Holding Valves; Four-Way and Five-Way Valves; Rotary Valves; Valve Actuators; Flow Ratings; Accessories

Objectives

- Explain the classification of directional control valves.
- Describe how manually operated valves work.
- Explain the difference between direct-acting and pilot-operated valves.
- Describe the operation of a check valve, a spool valve, a three-way valve, a four-way valve, and a rotary valve.
- Explain the difference between normally closed and normally open valves.

Lesson 8: Pressure-Control Valves

Topics

Pressure-Control Valves; Pressure-Relief Valves; Poppet Valves; Spool Valves; Sequence Valves; Counterbalance Valves; Holding Valves; Unloading Valves; Pressure-Reducing Valves; Shock Suppressors; Flow-Control Valves; Pressure and Temperature Compensation

Objectives

- Explain the functions of a pressure-control valve, a pressure-relief valve, and a pressure-reducing valve.
- Describe the operation of a spool valve, a poppet valve, and a sequence valve.
- Explain the purpose of holding valves, unloading valves, and counterbalance valves.
- Name the operations performed by flow-control valves.
- Describe how pressure compensation and temperature compensation work.

Lesson 9: Cylinders

Topics

Description of Cylinders; Double-Acting Cylinders; Single-Acting Cylinders; Two-Piston Cylinders; Positional Cylinders; Cylinder Construction; Piston Rings and Seals; Rod Packings; Cylinder Mounting; Selecting a Cylinder; Flow Capacity; Cushioning; Piston Rod Strength; Cylinder Applications

Objectives

- Describe the purpose of a hydraulic cylinder, and explain how a double-acting cylinder works.
- Explain the difference between “pull-type” and “push-type” single-acting cylinders.
- Describe the construction of a hydraulic cylinder.
- Explain the various methods of mounting cylinders.
- Demonstrate how to calculate the flow capacity of a hydraulic cylinder.

Lesson 10: Hydraulic Motors

Topics

Motor Classification; Rating and Selection Factors; Hydraulic-Motor Construction; Gear, Vane, and Piston Motors; Rotary Actuators

Objectives

- Explain the classification of hydraulic motors.
- Demonstrate how the torque of a hydraulic motor is calculated.
- Calculate the horsepower output of a hydraulic motor.
- Discuss cost factors and other considerations affecting motor selection.
- Describe the construction of a hydraulic motor.
- Explain the operating principles of a gear motor, a vane motor, and a piston motor.

Hydraulic Troubleshooting

Course 308: Hydraulic Troubleshooting

Covers understanding the systems, using schematic diagrams, installation procedures, cleanliness and safety. Includes tubing cutting, bending, and flaring, identification and selection of proper fluid, and charging the system. Discusses planned maintenance, specific repair/replacement recommendations, system diagnosis, and troubleshooting.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Hydraulic Systems

Topics

Hydraulic Systems; Pumps and Their Drive Units; Actuators; Control Valves; Conductors and Connectors; Hydraulic Fluids; Fluid Storage and Conditioning Equipment; Tracing the System; Getting to Know the System; Circuit and System Diagrams; Cutaway Drawings; Mechanical Setup; Understanding Components; Convertible Components; System Operation

Objectives

- Name the six basic elements of a hydraulic system.
- Explain the functions of hydraulic pumps, actuators, control valves, conductors and connectors, hydraulic fluid, and fluid storage and conditioning equipment.
- Describe how to trace a system.

Lesson 2: Hydraulic Schematic Diagrams

Topics

Types of Hydraulic Diagrams; What is a Schematic?; Characteristics of Schematics; Lines; Symbols; What Kind of Schematic?; Guidelines for Reading Schematics; Look for Flow Patterns; Look for Guides; Read Diagrams Carefully; Read Symbols Carefully; Use the Step-by-Step Approach; Basic Elements of a Hydraulic System; Pumps; Actuators; Control Valves; Conductors and Connectors; Fluid Storage and Conditioning Equipment; A Hydraulic Circuit; Sequence-Valve Circuit

Objectives

- Name three basic types of hydraulic diagrams, and explain the purposes of each.
- Describe how a valve symbol is constructed.
- List the steps to follow when reading a schematic diagram.
- Identify common hydraulic symbols.

Lesson 3: Installing Hydraulic Components

Topics

Installation Considerations; Cleanliness; Installation Safety; Pump and Drive Installations; Pump Start-up; Control Valve Installation; Extra Valve Ports for Convenience; Valve Port Identification; Mechanical Valve Installation; Pneumatically Actuated Valves; Electrically Controlled Valves

Objectives

- Explain the importance of cleanliness in hydraulic installations.
- Describe possible consequences of neglecting safety precautions.
- Explain how motor and pump shafts are aligned before coupling.
- Explain the correct method for checking direction of pump rotation.
- List several useful hints for solenoid valve installation.

Lesson 4: Installing Pipes and Tubes

Topics

Installing Conductors and Connectors; Hydraulic Pipe; General Installation Procedures; Hydraulic Tubing; Tube Flaring; Checking the Flare; Tube Bending; Tubing Assembly; Hydraulic Hose; Hose Installation; Seal Installation; Reservoir Installation; Filter Installation; Cooler and Heat Exchanger Installation; Actuator Installation

Objectives

- Explain how pipe sizes are specified.
- Name the common types of pipe joints.
- List six important rules for good piping installation.
- Describe the advantages of hydraulic tubing over pipes.
- Describe the correct methods for bending and flaring tubing.
- List the key points for correctly installing hydraulic hoses, seals, reservoirs, filters, and actuators.

Lesson 5: Selecting Hydraulic Fluids

Topics

Hydraulic Fluid Selection; Lubricating Properties; Viscosity and Viscosity Index; Resistance to Chemical and Physical Changes; Low-Temperature Properties; Demulsibility; Antirust Properties; Fire Resistance; Compatibility; Fluid Selection; Filling the System; Filter Installation

Objectives

- List ten important properties of hydraulic fluids.
- Explain the difference between hydrodynamic and boundary lubrication.
- Explain what a fluid's viscosity index means.
- Define demulsibility and emulsibility.
- Describe how to read a viscosity-temperature chart.
- List the proper procedures for installing hydraulic fluid.

Lesson 6: Planning System Maintenance

Topics

Classifying Maintenance; Inspections; Organizing the Maintenance Plan; Maintenance Requirements; Regular Inspections; Reservoir Fluid Level; Reservoir Fluid Temperature; External Leaks; External Condition of System Structures; Operating Pressure; Fluid Quality; Filters; Machine Performance; Repair Planning; Reconditioning Planning; System Servicing; A Typical System Plan

Objectives

- List the major categories of hydraulic system maintenance.
- Name and describe the six essential items in a maintenance file.
- List the steps involved in reconditioning a hydraulic component.
- Explain how to set up a maintenance plan for a typical hydraulic system.

Hydraulic Troubleshooting

Lesson 7: Troubleshooting Systems

Topics

What is Troubleshooting?; Diagnosis and Symptoms; Evaluating Recent Maintenance History; Evaluating Symptoms; Determining the Cause; Providing the Solution; Tools and Gauges; Wrenches; Gauges; Typical Troubleshooting Application; Troubleshooting Charts

Objectives

- Describe the troubleshooting process.
- Explain how to evaluate recent maintenance history.
- List typical symptoms of common hydraulic system problems.
- Explain how to determine the cause of and provide a solution to a problem.
- Explain how a portable tester works.
- Describe how to keep and use troubleshooting charts.

Lesson 8: Troubleshooting Valves

Topics

Valve Problems; Valve Test Procedures; Repair Procedures; Disassembly; Cleaning; Inspection; Repair or Replacement; Inspection Troubleshooting; Solenoid Problems; Reassembly; Testing

Objectives

- Name five common valve problems and explain the sequence of steps to be followed in troubleshooting them.
- Describe the proper procedures for valve disassembly, cleaning, and inspection.
- Explain how to determine whether to repair or replace a malfunctioning valve.
- Describe the reasons for hydraulic “wire drawing.”
- List the reasons for electrical and mechanical failures of solenoid valves.
- Explain the procedures for reassembling, reinstalling, and testing valves.

Lesson 9: Troubleshooting Cylinders

Topics

Cylinder Descriptions; Troubleshooting a Cylinder; Cylinder Testing; Cylinder Repair; Cylinder Installation; Shock Absorbers

Objectives

- Name the most common types of hydraulic cylinders and identify their major parts.
- List the symptoms of internal and external cylinder misalignment.
- Explain what to do if you find internal leakage in a cylinder.
- Name the cylinder components most frequently replaced.
- Explain the purpose of a piston rod boot.
- Describe the symptoms of shock absorber failure.

Lesson 10: Troubleshooting Pumps and Motors

Topics

Pumps and Motors; Troubleshooting; Gear Pump Problems; Vane Pump Problems; Vane Motors; Axial-Piston Pump Problems; Radial-Piston Pump Problems; Pump and Motor Repair; Pump Maintenance Checks; Troubleshooting Chart (Pumps); Troubleshooting Chart (Motors)

Objectives

- List the proper procedures for troubleshooting pumps and motors.
- Name some common causes of pump failure.
- Describe typical causes of cavitation.
- Discuss the major sources of problems in gear pumps and vane pumps.
- Describe the effects of contaminants in axial-piston and radial-piston pumps.
- Explain the differences between a vane motor and a vane pump.

Basic Pneumatics

Course 309: Basic Pneumatics

Covers how work, force, and energy are applied to principles of pneumatics. Shows operating principles of reciprocating, positive displacement, rotary, and dynamic air compressors. Covers primary and secondary air treatment. Includes valves, logic devices, cylinders, and air motors.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Pneumatic Principles

Topics

Fluid Power Systems; Pneumatic Systems; Force, Weight, and Mass; Pressure; Work and Energy; Diffusion and Dispersion; Separation of Gases and Liquids; Compressibility; Laws of Pneumatics; Transmission of Pneumatic Fluid Power; Pneumatic Leverage; Air Properties; Air Flow in Pipes; Viscosity of Air; Bernoulli's Law; Components of Pneumatic Power Systems

Objectives

- Explain how force is transmitted in a pneumatic system.
- Calculate force and work.
- List two factors that affect the results of pressure calculations.
- Explain pneumatic leverage.
- Briefly explain the physical laws affecting the behavior of a confined gas.

Lesson 2: Reciprocating Compressors

Topics

Compressor Operation; Compressor Classification; Positive-Displacement Compressors; Reciprocating Compressor Operation; Single- and Double-Acting Compressors; Compressor Construction; Horsepower Cooling Requirements; Compressor Lubrication; Nonlubricated Compressors; Compressor Controls; Compressor Accessories; Advantages of Reciprocating Compressors

Objectives

- Differentiate between a positive-displacement compressor and a dynamic compressor.
- Describe the operation of a reciprocating compressor.
- List one advantage of using a multistage compressor.
- Identify the cooling arrangements for reciprocating compressors.
- Compare the operation of compressor controls in large and small units.

Lesson 3: Rotary Compressors

Topics

Compressor Classification; Vane Compressors; Rotary-Screw Compressors; Low-Pressure High-Volume Compressors; Diaphragm Compressors; Dynamic Compressors; Centrifugal Compressors; Axial-Flow Compressors; Compressor Selection; System Capacity Requirements; Compressor Capacity; Checking Compressor Capacity; Accessories; Packaged Compressors

Objectives

- Compare the power output of a single-stage vs a two-stage vane compressor.
- Describe the main types of positive-displacement rotary air compressors.
- Explain the advantages and disadvantages of both types of dynamic compressors.
- Describe four methods of controlling centrifugal compressor output.
- Tell how to compensate for a low-speed drive in rotary screw compressors.

Lesson 4: Primary Air Treatment

Topics

Air Treatment; Preliminary Filtering; Relative Humidity; Effects of Moisture; Water Removal; Dew Point; Moisture Separators; Oil Scrubbers; Air Dryers; Air Receivers

Objectives

- Describe techniques for cleaning compressor filters.
- Define relative humidity and dew point.
- Explain the effects of temperature and pressure on the air's ability to hold moisture.
- Describe aftercooler operation.
- Explain the functions of separators, oil scrubbers, and air dryers.

Lesson 5: Secondary Air Treatment

Topics

Methods of Treatment; Contaminant Separation; Contaminant Filtration; Filter Classification and Rating; Types of Media; Surface Filters; Depth Filters; Adsorption Filters; Absorption Filters; Lubricating the Air

Objectives

- Describe the two main methods of contaminant separation.
- Explain how filters are classified.
- List contaminant particle sizes and particle contamination categories as they occur in filters.
- List applications for the most common types of filter media.
- Identify system location for lubrication equipment installation.

Lesson 6: Piping, Hoses, and Fittings

Topics

Piping Requirements; Airflow; Piping; Pipe Applications; Metallic Tubing; Tube Bending; Tube Fittings; Tubing Installation; Nonmetallic Tubing; Hoses; Hose Fittings; Quick-Disconnect Couplings; Hose Installation

Objectives

- State the importance of laminar flow.
- List the factors that affect pressure loss in a pipe.
- State direction and amount of slope for compressor discharge pipes.
- Discuss procedures for pipe, tube, and hose installation.
- Describe safe working procedures for disconnecting air hoses.

Basic Pneumatics

Lesson 7: Directional Control Valves

Topics

Control Valves; Manually Operated Valves; Automatically Operated Valves; Control Valve Elements; Two-Way Valves; Three-Way Valves; Four-Way Valves; Five-Way Valves; Valve Accessories

Objectives

- Describe the four methods of identifying control valves.
- List four basic types of manually operated, two-way valves.
- Describe the operation of a two-position, direct acting, normally closed solenoid valve.
- Explain one major advantage of using a four-way valve.
- Describe the construction of a three-way valve.

Lesson 8: Pressure-Control Valves

Topics

Controlling Pressure; Venting Excess Pressure; Relief Valve Construction; Pressure Regulators; Regulator Modifications; Logic Functions

Objectives

- List two ways a valve can control compressor pressure output.
- Describe construction of two basic types of pressure-relief valves.
- Contrast a pressure regulator with a pressure-relief valve.
- State the limit imposed by Federal Law on the pressure allowed when an air hose is used to blow off chips.

Lesson 9: Pneumatic Cylinders

Topics

Pneumatic Cylinders; Double-Acting Cylinders; Single-Acting Cylinders; Two-Piston Cylinders; Cylinder Construction; Rod Packings; Cylinder Mounting; Selecting a Cylinder; Cushioning

Objectives

- Tell the difference between pneumatic and hydraulic cylinders.
- Describe the construction and operation of a single-acting cylinder.
- State the purpose of an exhaust flow control metering valve.
- Describe the action of a pivoted cylinder.
- Explain the size relationship between a cylinder port and a valve port.

Lesson 10: Pneumatic Motors and Rotary Actuators

Topics

Pneumatic Motors; Motor Classification; Rating and Selection Factors; Pneumatic Motor Construction; Rotary Vane Motors; Piston Motors; Rotary Actuators; Portable Air Tools; Air Boosters

Objectives

- Explain pneumatic motor classification.
- Define torque.
- Describe pneumatic motor construction.
- Calculate a motor's horsepower, given its torque and speed.
- Differentiate between a pneumatic motor and a rotary actuator.

Pneumatic Troubleshooting

Course 310: Pneumatic Troubleshooting

Covers pneumatic systems, schematic symbols and diagrams, installing system components, planned maintenance, system diagnosis, and troubleshooting. Includes maintenance of air compressors, control valves, air motors, electrical components, and hybrid systems.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Pneumatic Systems

Topics

The Pneumatic System; The Air-Supply System; Reciprocating Compressors; Regulation and Control; Rotary Compressors; Cooling; Compressor Preventive Maintenance; The Delivered-Air System; Air-Line Filters; Air-Line Lubrication; Troubleshooting the Pneumatic System

Objectives

- Explain the operation of linear actuators—cylinders—in a typical pneumatic circuit.
- Describe the various types of compressors and how they work.
- Define intercooling and aftercooling.
- Describe basic preventive maintenance procedures for compressors.
- List the components of an effective delivered-air system and explain how they work together.
- Describe the three main types of air-line lubrication.

Lesson 2: Pneumatic Schematic Diagrams

Topics

Types of Symbols; How Schematic Symbols are Constructed; Diagraming an Air-Supply System; A Simple System; Timing Circuits; Safety Circuits; Symbols for Special Devices; System Schematics

Objectives

- Explain the different types of symbols used in pneumatic schematic diagrams—how they are constructed and what they show.
- Describe the operation of timing and safety circuits.
- Analyze the schematic diagram of a fluid-power system.

Lesson 3: Installation of System Components

Topics

The Compressor and Auxiliaries; Compressor Intakes; Compressor Foundations; Aftercoolers; Receivers; Dryers; Pipe Installation; Pipe Support; Pipe Threads; Tubing; Tubing Fittings; Hose Installation; Control Systems; Control-Valve Installation; Solenoid Coils; Cylinder Installation

Objectives

- Describe the proper installation of the compressor and its auxiliaries.
- Describe the installation of aftercoolers, receivers, and dryers.
- Explain the correct procedures for installing pipes, tubes, and hoses in pneumatic systems.
- Describe the installation of control valves, solenoid coils, and cylinders.

Lesson 4: System Maintenance

Topics

Planned Maintenance; Compressor Maintenance; System Maintenance; Control-System Maintenance; Tool Maintenance; Maintenance Logs and Records

Objectives

- Explain the concept of planned maintenance.
- Describe the basic procedures for maintaining the compressor and other important components in a pneumatic system.
- Describe the maintenance of industrial control circuit components.
- Explain the proper maintenance of pneumatic tools.
- Discuss the various types of maintenance logs and explain what kind of information is recorded in each.

Lesson 5: Determining System Failures

Topics

Understanding the System; Troubleshooting Procedures; Locating Troubles; The Operations Manual; Checking the Air Supply; Troubleshooting the Actuator; Checking the Control Valve; Checking a Control-Valve Actuator; Checking Sequence Valves; Checking Master Control Valves; Checking Interlocks; Making Final Adjustments; System Operation

Objectives

- List, in proper sequence, the steps to be taken in troubleshooting a pneumatic system.
- Name and describe the five important parts of every pneumatic system's operations manual.
- Describe procedures for troubleshooting the actuator.
- Explain how to check control valves, sequence valves, and interlocks.

Lesson 6: Troubleshooting Air Compressors

Topics

Cooling Reciprocating Compressors; Compressor Lubrication; Compressor Valves; Crankcase Ventilation; Piston Rings and Bearings; Control Systems; Rotary Compressors; Vane Compressors; Rotary-Screw Compressors; Centrifugal Compressors

Objectives

- Describe methods of cooling and lubricating reciprocating compressors.
- Explain the proper maintenance of compressor valves.
- Identify problems associated with the control system of a compressor.
- Describe the basic maintenance requirements of rotary, vane, rotary-screw, and centrifugal compressors.

Pneumatic Troubleshooting

Lesson 7: Troubleshooting Control Valves

Topics

Troubleshooting Controls; Troubleshooting a Circuit That Will Not Start; Checking Manual Overrides; Checking the Circuit Sequence; Checking for Locked Controls; Checking for Mechanical Interference; Electrical Solenoids; Checking an AC Solenoid; Checking a DC Solenoid; Troubleshooting Improper Sequence Operation; Improper Valve Shifting; Valves Shifting Without a Shift Signal; Changes in Control Timing; Miscellaneous Control-Element Problems; Lubrication Problems

Objectives

- Outline how to isolate a control malfunction in a pneumatic circuit.
- Explain how to troubleshoot a nonstarting or nonoperating circuit, improper sequencing of the circuit, and miscellaneous problems related to the equipment.
- Describe the proper procedures for checking electric solenoids.
- Explain how to check for problems related to valve shifting, control timing, and lubrication.

Lesson 8: Troubleshooting Cylinders

Topics

Cylinder Definitions; Cylinder Construction; Troubleshooting and Repair; Correct Cylinder Size; Adequate Air Pressure; Checking for Misalignment; Worn Packings; General Installation Techniques; Speed Controls

Objectives

- Define the different types of pneumatic cylinders.
- Describe the construction of a typical cylinder.
- Describe the proper procedures for troubleshooting cylinders, including checking for misalignment, worn packings, and adequate air pressure.
- Explain general installation techniques for cylinders and accessories.

Lesson 9: Troubleshooting Air Motors

Topics

Uses for Air Motors; Checking for Sufficient Air; Contaminated Air; Lubrication; Air-Motor Abuse; Hose and Clamp Maintenance; Air-Motor Troubleshooting; Vane Motors; Radial-Piston Motors; Axial-Piston Air Motors; Percussion Tools

Objectives

- Explain how to check for sufficient clean air when troubleshooting an inoperative air motor.
- Explain how to keep hoses, clamps, and couplings in good condition.
- Describe the operation and maintenance of vane, radial piston, and axial-piston air motors.

Lesson 10: Pneumatic/Hydraulic Systems

Topics

Air-Oil Tanks; Air-Hydraulic Boosters; Pressure Boosters; Single-Pressure Booster Systems; Dual-Pressure Booster Systems; Hydraulic-Control Cylinders; Fast-Advance Cylinders; Combined Air-Oil cylinders; Pneumatic Cushioning; Air-Hydraulic System Interlock; Pneumatic Servos; Troubleshooting Air-Oil Systems

Objectives

- Explain why and how compressed air and hydraulic pressure are combined.
- Describe the role of boosters in pneumatic/hydraulic systems.
- Explain how single-pressure and dual-pressure booster systems work.
- Describe the advantages and disadvantages of combined air-oil cylinders.
- Explain how pneumatic and hydraulic actions can be interlocked.
- Discuss the proper troubleshooting procedures for air-oil systems.

AIR CONDITIONING AND REFRIGERATION

This Air Conditioning and Refrigeration Series covers the basic principles of refrigeration and air conditioning. It emphasizes the function and design of each of the major system components. Service, adjustment, and troubleshooting procedures are outlined, as well as the use of special testing equipment and tools. There is also a thorough explanation of air-conditioning controls, types of refrigerants, refrigerant handling, and piping system configurations. The series expands to cover heating systems equipment and operation.

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The Refrigeration Cycle

Course 431: The Refrigeration Cycle

Introduces the basic concepts needed for an understanding of refrigeration. Traces the basic refrigeration cycle. Explains the concepts of heat, temperature, humidity, dewpoint, enthalpy, and simple psychrometrics. Concludes with a lesson on the tools and instruments needed for refrigeration servicing and safe work practices.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Refrigeration and Air Conditioning Basics

Topics

Definition of Refrigeration; Definition of Air Conditioning; The Composition of Matter; The States of Matter

Objectives

- Define refrigeration and air conditioning and explain how they differ.
- Describe the two methods of lowering the temperature of a material.
- Name the three physical states of matter.
- Identify what causes matter to change its state.

Lesson 2: Heat, Pressure, and Change of State

Topics

Heat; Temperature; Methods of Heat Transfer; Sensible and Latent Heat; Heat Quantity; Pressure; How Pressure Change Affects Boiling Point; The Importance of Pressure in Refrigeration

Objectives

- Explain the difference between sensible and latent heat.
- Compare the Fahrenheit and Celsius temperature scales and convert temperatures from one to another.
- Name and describe the three methods of heat transfer.
- Define latent heat of fusion and latent heat of vaporization.
- Explain the difference between absolute pressure and gauge pressure.
- Describe the effect of pressure changes on boiling point.

Lesson 3: The Basic Refrigeration Cycle

Topics

The Vapor-Compression Refrigeration Cycle; Evaporation; Compression; Condensation; Liquid Metering; The Refrigerant in Action; Types of Evaporators; Types of Compressors; Types of Condensers; Types of Metering Devices

Objectives

- Explain the function of each of the major refrigeration system components: evaporator, compressor, condenser, and metering device.
- Define the terms subcooling and superheating.
- Explain the function of the refrigerant in a refrigeration system and trace its path.
- Contrast dry-expansion and flooded evaporators.
- Name the five main types of compressors.
- Define cooling medium and name the two most commonly used.
- Explain the operation of the six most common metering devices.

Lesson 4: Air Properties and Simple Psychrometrics

Topics

Air Properties; Temperature; Humidity; Specific Volume; Enthalpy; The Psychrometric Chart; Determining Dewpoint Temperature; Determining Specific Humidity; Determining Relative Humidity; Determining the Enthalpy of Air

Objectives

- State the definition of psychrometrics.
- List the four air properties important in psychrometrics.
- Differentiate between dry- and wet-bulb temperature and tell how each is measured.
- Define the term saturated air.
- Define specific humidity and relative humidity.
- Define enthalpy and explain how it is calculated.
- Demonstrate how to use the psychrometric chart to determine dewpoint temperature, specific humidity, relative humidity, and enthalpy.

Lesson 5: Tools, Test Instruments, and Safe Work Practices

Topics

Tools and Instruments; Pressure Gauges; Pulling a Vacuum; Vacuum-Measuring Instruments; Leak Detectors; Thermometers; Hygrometers; Air-Handling Tools and Test Instruments; Electric Test Equipment; Recording Instruments; The Importance of Safety

Objectives

- Describe a gauge manifold and tell how it is used.
- Tell what it means to evacuate a refrigeration system and tell how it is done.
- List and describe at least three methods of leak detection.
- Explain the construction of a sling psychrometer and tell how and why it is used.
- Name the instrument used to measure relative humidity.
- Name the instrument used to measure each of the following electrical values: potential difference, current, resistance, and electric power.
- List the four classes of work area hazards, and give an example of each.

Refrigerants and Refrigerant Oils

Course 432: Refrigerants and Refrigerant Oils

Covers physical properties of refrigerants, including pressure-temperature relationships. Discusses various kinds of refrigerant and their safe handling. Examines effects of refrigerants on the atmosphere and related EPA requirements. Discusses filters, driers, leak detection equipment, gauge manifold set. Explains system charging, evacuation and dehydration, refrigerant recovery/recycling, and oil maintenance and servicing.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Physical Properties of Refrigerants

Topics

Refrigerant; Pressure-Temperature Relationships; Enthalpy; Pressure-Enthalpy Diagram; The Ideal Refrigeration Cycle; Using the P-H Diagram; Liquid Subcooling; A Practical Refrigeration Cycle

Objectives

- Explain the relationship between pressure and boiling point in a liquid.
- Define the term enthalpy, and differentiate between the enthalpy of saturated liquid, the enthalpy of evaporation, and the enthalpy of saturated vapor.
- Use a P-H diagram to show the process of evaporation, compression, condensation, and liquid metering.
- Calculate the compression ratio, refrigerating effect, refrigerant flow rate, heat of compression, compressor horsepower, and coefficient of performance for a system.
- Determine compressor discharge temperature, compressor volume displacement, superheat, subcooling, and total heat rejection in the condenser, using a P-H diagram.
- Explain the purpose and methods of liquid subcooling.

Lesson 2: Refrigerant Classification and Applications

Topics

The History of Refrigerants; Refrigerant Identification; Refrigerant and Oil Mixtures; Common Halocarbon Refrigerants; Refrigerant Mixtures; Ammonia; Safety Classifications and Precautions; Handling Refrigerant Containers; Refrigerants and Construction Materials

Objectives

- Identify several properties of the ideal refrigerant.
- Explain the ASHRAE standard for refrigeration identification.
- Discuss in detail some common refrigerants in use today—their advantages, disadvantages, characteristics, and applications.
- Define the terms blend, fractionation, temperature glide, and azeotrope.
- Describe how refrigerants are classified for safety purposes.
- Explain the safety precautions that must be taken when handling and storing refrigerants.

Lesson 3: Refrigerants and the Atmosphere

Topics

The Ozone Layer; The Ozone Hole; The Cause of the Hole; CFCs and Ozone; Increase in the Greenhouse Effect; The Search for Alternative Refrigerants; Changes in Servicing Procedures; Changes in Installation Practices

Objectives

- Define ozone and tell why it is important.
- Explain how CFCs deplete the ozone layer and contribute to the greenhouse effect.
- Explain how refrigeration system servicing procedures have changed in response to the discovery of ozone depletion.
- Name the “three Rs” and define each term.
- Identify several ways in which good installation practices can prevent refrigerant leaks.

Lesson 4: Refrigerants and the EPA

Topics

The U. S. Government vs. Ozone Depletion; The Clean Air Act; Definitions; Overview of Section 608 Requirements; Refrigerant Recovery Equipment; Releases and Leaks; Enforcement; Logs and Reports; Certification Testing; Purchasing Refrigerant; Record Keeping

Objectives

- Name some of the steps being taken by the United States government to control the depletion of stratospheric ozone.
- List the five main elements of the EPA regulations concerning recycling, emission reduction, and disposal.
- Contrast active and passive recovery equipment.
- Define the three types of refrigerant releases permitted by EPA regulations.
- List the reports you should keep concerning refrigerant purchase and use.
- Explain the levels of technician certification.

Refrigerants and Refrigerant Oils

Lesson 5: Refrigerant Filters and Driers

Topics

Refrigeration System Contaminants; Filters, Driers, and Filter-Driers; Desiccants; Location of Filter-Driers; Installing Filter-Driers; Filter-Drier Construction; Selecting Filter-Driers; Replacing Filter-Driers; Installation Precautions; Strainers; Suction Filters

Objectives

- List the contaminants that can infiltrate or form within a refrigeration system.
- Describe the various types of filters, driers, filter-driers, and strainers used in mechanical refrigeration systems.
- Distinguish between absorption-type and adsorption-type desiccants.
- Explain the importance of proper location when installing filters, filter-driers, and strainers.
- List the important factors to consider when selecting a filter-drier.
- List several safety precautions to follow when working with filter-driers.

Lesson 6: Tools and Procedures for Working with Refrigerants

Topics

Service Tools and Equipment; Leak Detection; Vacuum Pump; Gauge Manifold Set; Connecting the Gauge Manifold; Removing Air from the Manifold; Checking System Operating Pressure; Checking the Refrigerant Charge; Evacuation and Dehydration; Charging the System with Refrigerant; Adding the Correct Amount of Refrigerant; Recovering/Recycling Refrigerant

Objectives

- Describe the various methods of locating leaks in a refrigeration system.
- Explain how to connect a gauge manifold to a system and how to remove air from the manifold.
- Explain how to check the refrigerant charge in a system.
- Name and describe the two methods of evacuating and dehydrating a refrigeration system.
- Describe the procedures for vapor charging and liquid charging a system.
- Identify and explain the various methods of adding the correct amount of refrigerant to a system.
- Contrast active and passive refrigerant recovery.

Lesson 7: Refrigerant Oils, Oil Maintenance, and Service Procedures

Topics

Purposes of Refrigerant Oil; Oil Properties; Types of Oil; Compressor Lubrication; Oil-Related System Problems; Oil Separators; Oil Contaminants; Oil Maintenance and Servicing; Compressor Service Valves; Checking Oil Level and Adding Oil; Removing Oil; Storing and Handling Oil

Objectives

- Explain the purposes oil serves in a refrigeration system.
- Define the following properties of oil: stability, viscosity, miscibility, floc point, and flash point.
- Name the two broad categories of oils and the sub-categories of each.
- Explain how oil becomes mixed with the refrigerant and the problems its presence can cause in a refrigeration system.
- Describe the function of an oil separator.
- List several problems that can be caused by water in a refrigeration system.
- Describe the procedures for checking oil level and adding or removing oil.

Compressors

Course 433: Compressors

Explains the function of the compressor in a refrigeration system. Introduces information on the construction and use of reciprocating, rotary, helical, scroll, and centrifugal compressors. Covers compressor motors, control, and protection. Concludes with a lesson on preventive maintenance for compressors as well as troubleshooting and repair.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Introduction to Compressors

Topics

Function of the Compressor; Types of Compressors; Open Compressors; Hermetic Compressors; Reciprocating Compressors; Rotary Compressors; Helical (Screw) Compressors; Scroll Compressors; Centrifugal Compressors; Multiple Compressor Applications; Compressor Replacement Considerations

Objectives

- List the five kinds of air conditioning and refrigeration compressors.
- Contrast the operation of positive-displacement and kinetic-displacement compressors.
- Explain how each kind of the five kinds of compressor raises the pressure of the refrigerant vapor.
- Define staging and cascading and explain why each is used.
- List important considerations in compressor replacement.

Lesson 2: Reciprocating Compressors

Topics

Reciprocating Compressor Construction; Compressor Housings; Pistons; Connecting Rods; Crankshafts; Main Bearings; Open-Compressor Shaft Seals; Oil Pumps and Sight Glasses; Cylinder Heads; Types of Valves; Cylinder Unloaders; Vibration Control and Isolation; Noise Control

Objectives

- Describe the general construction of open, semi-hermetic, and full-hermetic reciprocating compressors.
- Explain how the basic parts of a reciprocating compressor are assembled.
- Identify common designs of housings, pistons, connecting rods, crankshafts, bearings, seals, cylinder heads, and valves used in reciprocating compressors.
- Explain how a cylinder unloader controls the capacity of a reciprocating compressor.
- Explain how compressors are lubricated.
- Explain how compressor vibration and noise are controlled.

Lesson 3: Rotary, Helical, and Scroll Compressors

Topics

Rotary Compressors; Rotary Compressor Advantages; Rotary Vanes; Rotary Compressor Bearings and Lubrication; Hermetic Motor Cooling; Accumulators; Helical Compressors; Twin-Screw Helical Compressors; Single-Screw Helical Compressors; Helical Compressor Bearings and Lubrication; Helical Compressor Capacity Control; Scroll Compressors

Objectives

- Describe the operation of single-vane and multiple-vane rotary compressors, including how each raises refrigerant pressure.
- List several advantages of rotary compressors over reciprocating compressors.
- Define slugging and cavitation.
- Tell the two functions of an accumulator in a rotary compressor.
- Compare and contrast rotary and helical compressors.
- Describe the operation of the single-screw and twin-screw helical compressor.
- Describe the operation of a scroll compressor.

Lesson 4: Centrifugal Compressors

Topics

Centrifugal Compressor Characteristics; Construction; Bearings; Lubrication; Purging Noncondensables; Capacity Control; Compressor Repair

Objectives

- Describe the operating principle of a kinetic-displacement compressor.
- List advantages and disadvantages of centrifugal compressors as compared to positive-displacement types.
- Explain reverse hydrostatic sealing.
- Explain how centrifugal compressors deal with thrust forces.
- Trace the operation of a typical centrifugal compressor lubrication system.
- Tell the purpose of a purge system.
- Describe the capacity control methods used in centrifugal compressors.

Lesson 5: Compressor Motors

Topics

Basic Compressor Motor Requirements; Basic Motor Types; Single-Phase Motors; Split-Phase Induction Motors; Capacitor Motors; Direction of Motor Rotation; Dual-Voltage Motors; Starting Switches for Hermetic Motors; Repulsion Motors; Three-Phase Motors Repair

Objectives

- Explain the basic requirements of a compressor motor.
- Name the different types of single-phase and three-phase motors used to power compressors and tell which ones can be used in hermetic compressors.
- Explain how to reverse the direction of rotation of a motor.
- Explain how to change voltages on a dual-voltage motor.
- Describe the operation of the current and potential relays used for starting single-phase hermetic compressor motors.

Compressors

Lesson 6: Compressor Control and Protection

Topics

The Need for Motor Control and Protection; Motor-Starting Devices; Part-Winding Starters; Wye-Delta Starters; Autotransformer Starters; Primary Resistance Starters; Multipoint Resistance Starters; Motor Overload Protection; High-Pressure Protection; Low-Pressure Protection; Oil-Pressure Safety Switches; Crankcase Heaters; Compressor-Related Accessories

Objectives

- Name the two basic categories of motor-starting devices and tell how each operates.
- Explain the function of a reduced-voltage starter and name the five kinds used with compressor motors.
- Describe the three kinds of motor overload protection commonly used with compressor motors.
- Discuss the causes of, effects of, and solutions for high discharge pressure, low suction pressure, and low oil pressure.
- Explain the function of a suction-line accumulator.
- Explain why crankcase heaters are sometimes necessary.
- Explain how heat exchangers improve the performance of a compressor.

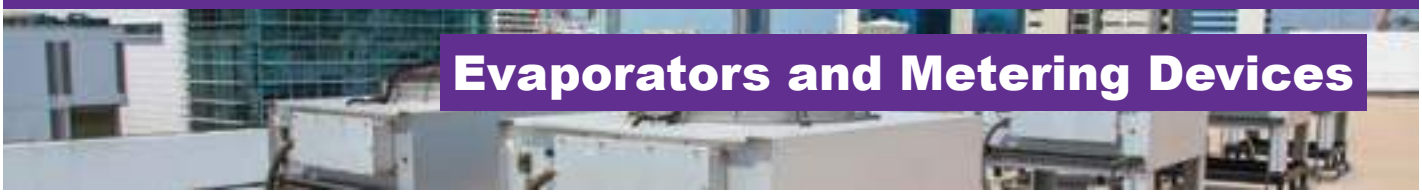
Lesson 7: Compressor Maintenance, Troubleshooting, and Repair

Topics

PREVENTIVE MAINTENANCE: The Importance of PM; COMPRESSOR TROUBLESHOOTING: Common Mechanical Problems; Other Mechanical Problems; Troubleshooting Tips by Compressor Type; Electrical Problems COMPRESSOR REPAIR: Repair Basics; Disassembling Compressors; Cleaning and Inspection; Reassembling Compressors; Compressor Motor Burnout; System Cleanup

Objectives

- State the first rule of preventive maintenance for compressors and related components.
- List preventive maintenance procedures common to most compressors.
- Explain how to calculate voltage imbalance in a three-phase motor.
- Name at least three possible causes of a low compressor oil level.
- Name at least three possible causes of compressor overheating.
- Explain how electrical problems can cause various system malfunctions
- Explain how to pump down a compressor for repairs.
- Describe compressor disassembly, cleaning, inspection, and reassembly procedures.
- Describe motor spot burnouts and cookouts, list their possible causes, and explain how to determine the severity of a burnout.
- Explain how to clean up a system after a motor burnout.



Evaporators and Metering Devices

Course 434: Evaporators and Metering Devices

Explains function and construction of evaporators. Covers: direct-expansion, dry-expansion, and flooded evaporators; and, systems using multiple evaporators. Discusses boosting evaporator performance. Explains evaporator defrosting, maintenance, and troubleshooting. Describes function, operation, and maintenance of metering devices, including hand-operated, automatic, thermostatic, thermal-electric.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Introduction to Evaporators

Topics

The Function of the Evaporator; How the Evaporator Works; Effects of Latent and Sensible Heat; Evaporator Capacity; Temperature Differential; Evaporator Construction; Contact Surface Area; Circulation Velocity; Effects of Water Vapor

Objectives

- Explain the function of the evaporator in a refrigeration system.
- List five main factors affecting evaporator capacity, and explain how each can be optimized to gain the greatest possible evaporator capacity.
- Describe the basic evaporator configurations.
- Explain the function of headers and distributors in multiple-circuit evaporators.
- Explain how comfort coolers reduce both air temperature and humidity.

Lesson 2: Direct Expansion Evaporators and Secondary Refrigeration Systems

Topics

Direct-Expansion Evaporators; Dry-Expansion Evaporators; Flooded Evaporators; Evaporator Configurations; Secondary-Refrigeration Systems; Secondary Refrigerants; Compound Secondary-Refrigeration Systems; Multiple-Evaporator Refrigeration Systems; Multiple-Staging Refrigeration Systems; Cascade Refrigeration Systems

Objectives

- Compare and contrast dry-expansion and flooded evaporators.
- List the main types of flooded evaporators.
- Explain the process of secondary refrigeration.
- Define eutectic solution and eutectic temperature.
- Describe three types of multiple-evaporator systems.
- Identify cascade and multiple-staging refrigeration systems.

Lesson 3: Improving Evaporator Performance

Topics

Applying Thermodynamics; Net Refrigeration Effect; Superheating and Subcooling; Accumulators; Common Types of Heat Exchangers; Headers; Oil Separation; Circulating Fluids through Evaporators

Objectives

- Explain how the laws of thermodynamics apply to refrigeration.
- Describe how to increase the net refrigerating effect of an evaporator.
- Demonstrate—using simple arithmetic—the amount of increase in net refrigerating effect caused by subcooling.
- List several advantages of using a heat exchanger in a refrigeration system.
- Describe three ways of keeping oil out of an evaporator.
- Explain why the circulation of air or water through an evaporator coil improves evaporator performance.

Lesson 4: Defrosting, Maintaining, and Troubleshooting Evaporators

Topics

Defrosting Systems; Condensate Disposal; Manual Defrost Method; Ambient-Air Defrost Methods; Heated-Air Defrost Method; Water Defrost Method; Brine Defrost Methods; Hot-Gas Defrost Methods; Reverse-Cycle Defrost Method; Electric Defrost Method; Fin Straightening; Cleaning Coil Surfaces; Tube Fouling; Water Coil Winterizing; Troubleshooting Frost Problems; Troubleshooting Low-Capacity Problems; Troubleshooting Shell-Type Evaporators; Troubleshooting Flooded Evaporator

Objectives

- Explain why periodic defrosting of evaporator coils is necessary.
- List and describe at least five different methods of defrosting an evaporator.
- Explain the differences between the hot-gas and reverse-cycle defrost methods.
- Explain how to clean an evaporator coil, drain pan, and drain line.
- Describe how to remove rust, scale, and sludge from shell-and-tube evaporators.
- List two ways evaporator coils can be winterized.
- Tell how low airflow and excessive moisture increase frost buildup on coil surfaces.
- Explain how dirty coils and damaged fins reduce an evaporator's cooling capacity.

Lesson 5: Metering Device Types, Maintenance, and Troubleshooting

Topics

The Function of Metering Devices; Expansion Valves; Hand-Operated Expansion Valve; Automatic Expansion Valve (AXV); Thermostatic Expansion Valve (TXV); Bulb Charge in the TXV; Capacity of the TXV; Installing the TXV; TXVs for Special Applications; Thermal-Electric Expansion Valve (TEV); Capillary Tubes; Float Valves; Metering Device Maintenance and Troubleshooting; Symptoms of Expansion-Valve Problems

Objectives

- Explain the primary function of a metering device.
- Name the five main types of expansion valve, and describe the operation of each.
- Contrast the operation of an internally equalized and an externally equalized TXV.
- Explain how to adjust the superheat on a TXV.
- Describe the structure, operation, and application of high- and low-side float valves.
- Identify three causes of floodback and describe the corrective action for each.
- List the common problems of TXVs along with their solutions.

Condensers and Cooling Towers

Course 435: Condensers and Cooling Towers

Covers the function, construction, and operation of both air- and water-cooled condensers and related devices. Discusses cooling towers and spray ponds, including maintenance and troubleshooting. Includes a lesson on evaporative condensers. Concludes with a discussion of water-related problems and how to solve them.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Air-Cooled Condensers

Topics

The Function of a Condenser; Condenser Capacity; Air-Cooled Condenser Construction; Types of Air-Cooled Condensers; Effects of Ambient Temperature; Pumpdown Circuit; Low-Ambient Controls; Receivers; Pressure-Relief Devices; Air-Cooled Condenser Maintenance; Troubleshooting Air-Cooled Condensers

Objectives

- Contrast the two types of air-cooled condensers—natural draft and forced air.
- Describe the construction of an air-cooled condenser, including the tubes, fins, headers, and subcooling circuit.
- Name the factors that affect condenser capacity.
- Explain the effects of ambient temperature on the capacity of an air-cooled condenser.
- Describe various types of low-ambient controls for air-cooled condensers.
- Explain how spring-loaded pressure-relief valves and fusible plugs protect against possible explosions caused by high pressure.
- List the periodic maintenance procedures common to most air-cooled condensers.

Lesson 2: Water-Cooled Condensers

Topics

Water-Cooled Condenser Systems; Types of Water-Cooled Condensers; Pressure-Relief Devices; Water-Regulating Valves; Strainers; Water-Cooled Condenser Maintenance; Cleaning and Inspection; Troubleshooting Water-Cooled Condensers

Objectives

- Name and describe the basic types of water systems used by water-cooled condensers.
- Define the terms makeup water and fouling factor.
- Describe the construction of the various kinds of water-cooled condensers.
- Explain the purpose of the accessories used with water-cooled condensers—pressure-relief devices, water-regulating valves, and strainers.
- Explain water-cooled condenser maintenance procedures, including inspection for leaks and chemical and mechanical cleaning.

Lesson 3: Cooling Towers and Spray Ponds

Topics

The Function of Cooling Towers and Spray Ponds; Cooling Tower and Spray Pond Capacity; Types of Cooling Towers; Spray Ponds; Cooling Tower and Spray Pond Systems; Cooling Tower Controls; Cooling Tower Systems for Winter Operation; Cooling Tower and Spray Pond Maintenance; Troubleshooting Cooling Towers and Spray Ponds

Objectives

- Explain the function of cooling towers and spray ponds and the factors that affect their capacities.
- Identify the basic types and construction of cooling towers and spray ponds.
- Describe the components required in a cooling-tower or spray-pond water-circulating system and explain the purpose of each.
- Describe the various devices used to control cooling-tower capacity.
- Explain cooling-tower and spray-pond maintenance procedures.

Lesson 4: Evaporative Condensers

Topics

Types of Evaporative Condensers; Refrigerant-Circulation System; Air-Circulation System; Water-Circulation System; Evaporative-Condenser Capacity Control; System Operation Under Freezing Conditions; Evaporative-Condenser Maintenance; Troubleshooting Evaporative Condensers

Objectives

- Identify the basic types of evaporative condensers.
- Describe the components that make up the three circulation systems in an evaporative condenser—refrigerant, air, and water—and explain the operation of each.
- List the kinds of capacity controls used on evaporative condensers and explain the operation of each.
- Explain how to provide freeze protection for an evaporative condenser.
- Outline evaporative-condenser maintenance procedures.

Condensers and Cooling Towers

Lesson 5: Controlling Water-Related Problems

Topics

Chemical Water Treatment; Types of Water Problems; Causes of Corrosion; Corrosion Control; Causes of Scale; Types of Scale; Scale Control; Biological Fouling; Control of Biological Fouling; Wood Deterioriation and Its Control; Chemical Feeding

Objectives

- Describe the three categories of water problems encountered in the water systems of water-cooled equipment.
- Name the five causes of corrosion and explain how to control them.
- Describe the three most common types of scale, their causes, and how to control them.
- List the three types of organisms that grow in water systems and explain how to control them.
- Describe the three types of wood deterioration and explain how to control them.
- Explain the operation of three chemical-feeding devices used in water systems.

Piping

Course 436: Piping

Examines piping system materials and sizing. Includes coverage of codes, valves and fittings, and the cutting and joining of piping and tubing. Explains the function and unique requirements of the discharge line, liquid line, and suction line. Concludes with a lesson on piping system maintenance, including handling dirt and scale, expansion, vibration, corrosion, and leaks.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Piping Materials and Fittings

Topics

The Refrigeration Piping System; Compatibility of Materials; Sizing Refrigeration Piping; Oil Migration in Refrigeration Piping; Pipe vs. Tubing; Pipe Materials; Standard Pipe Sizes; Pipe Schedules and Codes; Valves and Pipe Fittings; Cutting Pipe Accurately; Methods of Joining Pipe; Uses for Tubing in Refrigeration; Tubing Material and Sizes; Advantages of Tubing; Cutting Tubing; Flaring Tubing; Bending Tubing; Fittings for Tubing; Soldering Tubing Fittings; Brazing Tubing Fittings; Safety in Soldering and Brazing

Objectives

- Name the three main lines of piping in a refrigeration system.
- Explain why air conditioning and refrigeration piping must be sized correctly.
- Contrast pipe and tubing and explain why tubing is often preferred over piping.
- Explain how pipe is classified according to schedule.
- Name three methods of joining steel pipe.
- Explain how tubing is cut, flared, bent, and joined.
- Describe the step-by-step procedure for making a brazed joint.

Lesson 2: Discharge Line

Topics

Functions of the Discharge Line; Condition of the Refrigerant at Discharge; Pressure Drop in Refrigerant Piping; Effects of Pressure Drop on System Operation; Oil Circulation in the Discharge Line; Sizing the Discharge Line; Discharge Piping Layout; Refrigerant Migration on Off-Cycle; Discharge-Line Accessories; Complex Refrigeration Systems; Hot-Gas Bypass Piping; Line Selection Based on Refrigerant Type

Objectives

- List the four functions of the discharge line in a refrigeration piping system.
- Explain the importance of pressure drop in piping and its effects on system operation.
- Define the term entrainment and explain why entrainment of oil is important.
- State the flow velocity needed for refrigerant vapor to entrain oil in horizontal piping and in vertical risers.
- Name some practical steps you can take to assure a good flow of refrigerant in horizontal piping.
- Describe ways of preventing refrigerant and oil migration to the compressor.
- Name and explain the purposes of three discharge-line accessories.

Lesson 3: Liquid Line

Topics

Functions of the Liquid Line; State of Refrigerant in the Liquid Line; Effects of Pressure Drop on System Operation; Oil Circulation in the Liquid Line; Sizing the Liquid Line; Liquid-Line Layout; The Liquid Receiver; Liquid-Line Components and Accessories; Insulating the Liquid Line; Pressure Relief for Closed Containers

Objectives

- Name the functions of the liquid line.
- Explain why it is desirable to have subcooling in the liquid line.
- Describe the effects of pressure drop in the liquid line on the operation of a refrigerant system.
- Describe the effects of flash gas formation on the performance of the system.
- Explain the purpose of a liquid receiver.
- Explain why each of the following devices is used in the liquid line: sight glass, solenoid valve, check valve.

Lesson 4: Suction Line

Topics

Functions of the Suction Line; Lubricating Oil in the Suction Line; Pressure Drop in the Suction Line; Suction-Line Accumulators; Suction-Line Heat Exchanger; Suction-Line Controls; Suction-Line Valves; Suction-Line Filters; Vibration Eliminators; Suction-Line Insulation; Suction Lines for Multiple Compressors; Suction Lines for Multiple Evaporators

Objectives

- Describe the functions of the suction line, its structural demands, and special design features.
- Explain why suction lines are pitched down toward the compressor.
- Explain how a double suction riser moves oil along with the refrigerant.
- Explain the function of an accumulator and a heat exchanger in a suction line.
- Describe the basic differences between evaporator pressure regulators and crankcase pressure regulators.
- Explain why it is necessary to insulate the suction line.
- Explain how a suction line for multiple compressors differs from a suction line for a single compressor.

Piping

Lesson 5: Piping Systems Maintenance

Topics

Causes of Piping Problems; Dirt and Scale in Piping; Allowing for Piping Expansion; Support for Refrigeration Piping; Protecting Piping from Vibration; Corrosion in Piping; Piping Leaks; Protecting Piping from Freezing; Eliminating Liquid Hammer; Thermal Insulation for Piping; Troubleshooting the Liquid Line; Troubleshooting Moisture Indicators; Troubleshooting the Suction Line

Objectives

- Name at least four factors that cause piping problems and can lead to operating problems.
- Explain why cleanliness is essential when assembling refrigeration piping.
- Name at least three ways to allow for the expansion of piping.
- Describe the various ways of supporting horizontal and vertical pipe runs.
- Describe the damage that can be caused by vibration and tell how to protect piping from it.
- Define corrosion and explain how it can be prevented in refrigerant and water piping.
- Explain the importance of thermal insulation for refrigeration system piping.

Control Systems

Course 437: Control Systems

Introduces the need for control, control methods, and system basics. Includes information on self-powered, pneumatic, hydraulic, electric, and electronic systems. Covers various sensors and controlled devices. Covers basics of two-position, floating, and proportional control systems and their maintenance and troubleshooting. Discusses processes requiring control in a refrigeration or air-conditioning system.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Introduction to Control Systems

Topics

The Need for Controls; Automatic Control; Control System Basics; Control Methods; Two-Position Control; Floating Control; Proportional Control; Open- and Closed-Loop Control; Control System Operating Power; Self-Powered Control System; Pneumatic and Hydraulic Control Systems; Electric and Electronic Control Systems

Objectives

- Explain why control systems are needed and name devices used to control environmental conditions.
- Define the terms used to describe control systems—controlled variable, controller, controlled device, setpoint, control point, and controlled medium—and name the basic elements of a control system.
- Describe the action of two-position, floating, and proportional control.
- Explain how anticipators work.
- Compare open-loop and closed-loop control.
- Compare the basic requirements of pneumatic/hydraulic control systems to those of electric/electronic control systems.

Lesson 2: Sensors and Controlled Devices

Topics

Sensors; Temperature Sensors; Humidity Sensors; Pressure Sensors; Controlled Devices; Dampers; Valves; Variable-Speed Drives

Objectives

- Explain the need for a sensor in a control system.
- Name and explain the operation of three kinds of temperature sensors.
- Define relative humidity, state the range required for human comfort, and describe common humidity sensors.
- Name three common pressure sensors and explain their operation.
- Explain the operation of two-position dampers and valves in shutoff and throttling applications.
- List the advantages of variable-speed drives over older methods of speed control.

Lesson 3: Automatic Control Systems

Topics

Two-Position Electric Control; Floating Electric Control; Proportional Electric Control; Pneumatic Control Systems; Pneumatic Controllers; Pneumatic Actuators; Pneumatic Relays and Switches; Electronic Control Systems; Proportional Band and Gain; PID Control

Objectives

- Describe the operation of two-position, floating, and proportional electric controllers.
- List the equipment needed for a pneumatic control system.
- Name several pneumatic relays and switches, and explain why each is used.
- Discuss the advantages and basic operation of electronic controls.
- Define resolution, sensitivity, proportional band, and gain, and explain how they are related.
- Distinguish between integral and derivative action, and explain how each can improve system performance.

Lesson 4: Control of Refrigeration and Air-Conditioning Processes

Topics

Primary Control; Low-Pressure Control; High-Pressure Control; High-Temperature Cutout Control; Low-Water-Temperature Cutout Control; Anti-Recycle Timers; Condenser Pressure Regulators; Oil-Pressure Controls; Oil-Level Float Controls; Motor Overload Protection; Capacity Controls; System Interlock; Control of Air-Conditioning Systems; Flow Control in Hydronic Systems; Space-Temperature Control; Seasonal Changeover; Pressure Regulation; Flow Switches; Control of a Complex Air-Handling System

Objectives

- Explain how pumpdown control operates and why pumpdown is often preferred over other methods of primary control.
- Describe the location, function, and operation of a high-pressure control.
- Name three ways to control condenser pressure and at least three ways to control system capacity.
- Explain how a differential oil pressure safety control works.
- Compare the two methods of modulating the flow of water to hydronic terminals.

Control Systems

Lesson 5: Maintaining and Troubleshooting Controls

Topics

Establishing a PM Program; Maintaining Pressure Controls; Maintaining Thermostats; Maintaining Float Switches and Valves; Maintaining Oil-Pressure Controls; Maintaining Timers; Maintaining Condenser Controls; Maintaining Compressor Capacity Controls; Maintaining Valves and Accessories; Maintaining Instrument Air; Maintaining Pneumatic Controllers; Maintaining Pneumatically Controlled Devices; Maintaining Pressure Switches and Pneumatic Relays; Maintaining Electric/Electronic Power Sources; Maintaining Electric Controllers; Maintaining Electronic Controllers; Maintaining Electrically Controlled Actuators; Maintaining Electric and Electronic Switches; Troubleshooting a Control System; Following Up

Objectives

- List the four basic steps involved in setting up a PM program.
- Explain the importance of high-pressure controls as safety devices and explain their testing procedures.
- Explain how oil pressure is maintained in various kinds of compressors.
- Describe the testing and maintenance required for condenser water regulating valves and compressor capacity controls.
- Explain how to check for oil and water contamination in control air and what measures to take to minimize them.
- Explain the major maintenance requirements of a pneumatic control system.
- Describe the maintenance required by electric and electronic controllers.
- Explain how to use a troubleshooting chart.

Air-Handling Systems

Course 438: Air-Handling Systems

Covers airflow basics, including how air moves, types of airflow, and pressure relationships. Compares and contrasts various fans and fan motors. Examines types of ducts, fittings, connections, insulation, and terminal devices. Covers methods of cleaning and filtering air, as well as balancing and troubleshooting the air-handling system. Concludes with a lesson on indoor air quality and sick building syndrome.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Air Movement and Distribution

Topics

The Air-Handling System; Comfort Air Conditioning; Process Air Conditioning; Heat and Moisture Transport; How Air Moves; Types of Airflow; Pressure Relationships; Controlling Ventilation and Pressurization; Dual-Duct Systems; System Velocity

Objectives

- List the variables controlled by an air-handling system.
- Define comfort and explain how to predict whether or not people in a space will be comfortable.
- Define the following terms: laminar flow, turbulent flow, streamlining, and eddy currents.
- Differentiate between static pressure, velocity pressure, and total pressure in an air-distribution system.
- Compare a dual-duct system to a single-duct system in both structure and operation.

Lesson 2: Fans and Fan Motors

Topics

Fan Construction; Centrifugal Fans; Axial-Flow Fans; Fan Performance Curves; System Characteristics; Preventive Maintenance for Fans; Impeller Maintenance; Belts and Drive-Train Maintenance; Bearing Maintenance and Replacement; Fan Motor Problems; Troubleshooting a Noisy Fan

Objectives

- Describe the two basic types of fans used in air-conditioning systems.
- Define the terms system characteristic and point of operation.
- Explain why a knowledge of fan laws and performance curves is necessary when altering an air-handling system.
- Describe preventive-maintenance procedures for typical fans.
- Explain how to replace the bearings in a centrifugal fan.

Lesson 3: Ductwork Types, Fabrication, and Repair

Topics

Types of Ducts; Duct Designations; Duct Systems; Duct Fittings and Connections; Insulation; Diffusers and Other Terminal Devices; Fabricating Sheet Metal Ducts; Duct Reinforcement; Duct Maintenance

Objectives

- Define the term aspect ratio.
- Compare and contrast a radial duct system and an extended plenum system.
- Describe the structure and purpose of dampers and turning vanes.
- Identify a variety of fittings and connections used in a sheet metal ductwork system.
- Explain how and why ducts are insulated and reinforced.
- Identify common types of sheet metal seams and describe how each is fashioned.
- Explain the basic servicing and inspection procedures for ductwork systems.

Lesson 4: Air Filtration

Topics

The Process of Air Filtration; Mechanical Air Filters; Establishing a Service Schedule; Servicing Impingement Filters; Replacing Dry Media Filters; Installing HEPA Filters; Selecting Replacement Air Filters; Electronic Air Cleaners; Maintaining Electronic Air Cleaners

Objectives

- Explain the function of an air filter.
- Describe the two main types of mechanical air filters.
- Explain how to establish a service schedule for air filters.
- Explain how to clean and/or replace the filters in your HVAC system.
- Explain the operation of electronic air cleaners and tell how they are serviced.

Lesson 5: Air System Balancing and Troubleshooting

Topics

A Systematic Procedure; Measuring Instruments; Auxiliary Instruments; Pretest Data Collection; Preparing the System; Measuring and Adjusting the Main Airflow; Measuring and Adjusting Branch Ducts; Adjusting Registers and Diffusers; Troubleshooting Air-Handling Systems

Objectives

- Explain why air-handling systems need to be balanced.
- Describe the instruments used to test and balance an air-handling system.
- Demonstrate how to measure velocity pressure and show how airflow rates are calculated from these pressure readings.
- Describe a pitot-tube traverse.
- Explain in step-by-step fashion how to test and balance an air-handling system.
- Name common complaints related to air-handling systems and give common causes.

Lesson 6: Indoor Air Quality and Sick Building Syndrome

Topics

Sick Building Syndrome (SBS) Characteristics; Investigating a Potential SBS Problem; Internal SBS Contributors; External SBS Contributors; HVAC Systems as Contaminant Sources; Particulates and IAQ; Pollutant Pathways; Odors and Contamination; Building-Related Illness (BRI)

Objectives

- Discuss the characteristics of sick building syndrome (SBS).
- Describe the process for investigating an SBS complaint and explain how to conduct a facility site review.
- Discuss ways a facility can minimize the probability of perceived SBS problems.
- Discuss internal and external SBS contributors, including HVAC systems, and discuss ways to eliminate or reduce the problems.
- Describe specific ways to control particulates, odors, and other contaminants.
- Define the abbreviations SBS, IAQ, BRI, VOC, and MCS.

System Troubleshooting

Course 439: System Troubleshooting

Discusses the keys to effective troubleshooting and emphasizes the importance of safety. Details a step-by-step procedure to use when troubleshooting. Covers the use of a troubleshooting flowchart. Examines three sample problems, leading the trainee through the steps necessary to locate the problem in each example.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Preparation for Troubleshooting

Topics

Mechanical Refrigeration Systems; Keys to Effective Troubleshooting; Safety in Troubleshooting; Tools and Equipment; Supplies (Consumables); Human Relations Skills

Objectives

- Give an example of each of the following applications: process refrigeration, commercial refrigeration, process air conditioning, comfort air conditioning.
- Tell what knowledge is essential for an effective troubleshooter to have.
- Tell what safety precautions must be followed when dealing with the mechanical, electrical, chemical, and environmental hazards involved in troubleshooting.
- List the necessary tools, equipment, and supplies needed to perform troubleshooting procedures.
- Explain why human relations skills are important to the refrigeration system troubleshooter.

Lesson 2: Troubleshooting Procedures

Topics

Six Steps of Troubleshooting; Step One—Stating the Problem; Step Two—Collecting Data; Routine Preliminary Checks; Detailed Checks; Not Enough Cooling Example; Step Three—Analyzing the Data; Step Four—Deciding on an Action; Step Five—Making the Repairs; Step Six—Checking the Results; Avoiding a Recurrence of the Problem

Objectives

- Name the six basic steps in the troubleshooting procedure.
- Explain why it is important to collect information from the equipment operator when a system is malfunctioning.
- Explain what type of information is contained on a nameplate and in the operations log of a system.
- Explain the structure and use of troubleshooting charts.
- Explain how to set up a preliminary checklist and how to select the most likely components and subsystems for further examination.
- List items to check out after making repairs to a refrigeration system.

Lesson 3: Troubleshooting Electric Controls

Topics

A Troubleshooting Flowchart; Checking the Contactor; A1 Procedures: Armature, Transformer, and Bad Connections; A2 Procedures: Faulty Coils, Relays, and Switches; B Procedures: The Power Side

Objectives

- Explain how to use a troubleshooting chart.
- Explain how to isolate a control circuit failure from a motor circuit failure.
- List the causes of abnormally high control circuit resistance.
- Explain the difference between using an ohmmeter and using a voltmeter to check for a closed electric switch.
- Describe how to check contactor coils and motors for shorts and opens.

Lesson 4: Troubleshooting Pneumatic Controls

Topics

Equipment and Tools; The Problem—Unstable Control; Checking the Control Air Supply; Output Pressure Test; Checking for Air Leaks; Checking Other Controllers; Actuator Problems; Thermostat Adjustments; When All Else Fails

Objectives

- Describe the symptoms of control air contamination and explain how to remedy it.
- Explain how to check thermostat output pressure.
- List at least three kinds of actuator problems and explain how to solve them.
- Describe the calibration procedure and explain its purpose.
- Explain how to calibrate a pneumatic controller.

Lesson 5: Troubleshooting the Refrigerant Circuit

Topics

Preliminary Checks; Analyzing the Complaint; Checking Refrigerant Pressures; Checking Refrigerant Charge; Checking for Refrigerant Leaks; Compressor Cycling; Checking High-Side Components; Low-Side Problems; Distribution System Problems

Objectives

- Distinguish between a refrigerant circuit problem and a conditioned-medium problem.
- Explain the procedure for checking refrigerant charge.
- Name major causes of variance in head and suction pressures.
- Explain how to isolate the cause of compressor short cycling.
- Explain how to use head-pressure readings and suction-pressure readings in diagnosing refrigeration problems.

Absorption Chillers

Course 440: Absorption Chillers

Covers the basic principles of absorption refrigeration as compared to mechanical refrigeration. Introduces absorption terminology and common absorption fluid pairs. Examines water/lithium bromide systems, ammonia/water systems, and evolving systems. Concludes with a discussion of chiller selection factors, cost of operation, and absorption system applications.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Principles of Absorption Chiller Systems

Topics

Basics of Mechanical Refrigeration Systems, Basics of Absorption Refrigeration Systems; History of Absorption Systems; Absorption Terminology; Simple Single-Effect Absorption Cooling Cycle; Common Absorption Fluid Pairs

Objectives

- Explain the differences between a mechanical refrigeration system and an absorption system.
- Describe the basic components in a simple absorption system and their functions in the refrigeration cycle.
- Distinguish between the characteristics of a weak solution and a strong solution and explain the function of each in the absorption cycle.
- Define the terminology associated with absorption systems.
- Describe the steps in a simple single-effect absorption cooling cycle.

Lesson 2: Water/Lithium Bromide Absorption Systems

Topics

Water/Lithium Bromide Absorption Systems; Double-Effect Direct-Fired Absorption System; Solution Flow Cycles; Operating Characteristics; Crystallization

Objectives

- Discuss basic characteristics of water/lithium bromide absorption systems and name common industrial uses.
- Describe the differences between single-effect and double-effect absorption systems.
- Discuss the action of the solution and the refrigerant throughout a solution cycle within absorption systems used for heating only, cooling only, and simultaneous heating and cooling.
- Compare reverse, series, and parallel solution flow cycles.
- Discuss operating characteristics of various absorption machines and explain how the coefficient of performance (COP) is used in equipment selection.
- Describe the cause of crystallization and its effect on an absorption system.

Lesson 3: Lithium Bromide Absorption

Topics

General Limitations; Control Scheme; Start, Run, and Shutdown Sequence; Operating Limits and Safety Controls; Unit Setup; System Maintenance; Insulation; Noncondensable Gases

Objectives

- Discuss the general operating limits of absorption units, including ASHRAE 15 machine room safety requirements.
- Describe the basics and benefits of today's microprocessor-based operation and capacity control.
- Describe the normal absorption unit start, run, and shutdown sequences.
- Name various kinds of system operating controls and safety controls and explain their functions.
- Describe general setup and maintenance requirements and the procedures that keep the absorption chiller operating efficiently.
- Discuss the necessity for insulation and control of noncondensable gases, including air.

Lesson 4: Ammonia/Water Absorption Systems

Topics

Ammonia System Background; Ammonia Characteristics; Basic Ammonia/Water Absorption System; Industrial Ammonia/Water Absorption Systems; Domestic Ammonia Absorption Systems; Ammonia System Advantages; Ammonia System Controls and Maintenance

Objectives

- Discuss the solubility of ammonia in water and other characteristics, including hazards, that affect ammonia absorption systems.
- Explain the function of the analyzer and rectifier in an ammonia absorption system.
- Define the terms strong aqua and weak aqua as related to the ammonia water solution and compare them with the terms strong solution and weak solution as related to a lithium bromide system.
- Describe typical applications for industrial ammonia absorption systems and small residential and commercial ammonia absorption systems.
- Explain the operation of the Platen-Munters ammonia/water/hydrogen system.
- Name reasons why ammonia absorption systems are likely to be used increasingly in the future.

Absorption Chillers

Lesson 5: Evolving Absorption Systems

Topics

Research to Improve COPs; GAX Heat Pump Cycles; Triple-Effect Cycles; Special Applications; Double Use of Steam Energy; Single-Effect System with Heat Recovery from Hot Processes; Double-Effect System with Solar Heating Source; Power Plant Heat Recovery; Special Absorption Unit Solution Pairs; Hybrid Liquid Desiccant/Absorption System; Hybrid High-Lift Heat Pump with Mechanical Compression

Objectives

- Discuss reasons for continuing testing and development of advanced absorption systems.
- Describe current developments in the GAX ammonia/water residential heat pump systems.
- Describe triple-effect systems and compare absorption and adsorption cycles.
- Explain how special-application absorption systems use recovered heat, waste heat, or a solar array to provide the energy for operation.
- Describe the properties of non-standard solution pairs.
- Explain how two kinds of hybrid arrangements incorporate the absorption system.

Lesson 6: Absorption Systems vs. Mechanical Compression Systems

Topics

Review of Water/Lithium Bromide Absorption Chillers; Review of Ammonia/Water Absorption Units; Mechanical Compression Systems; Chiller Selection Factors; Economic Perspective; Cost of Chiller Operation; Absorption System Application

Objectives

- Describe important characteristics of both single-effect and double-effect water/lithium bromide absorption chillers and ammonia/water absorption units.
- Briefly describe the operation and characteristics of centrifugal chillers.
- Briefly describe the operation and characteristics of reciprocating and screw positive-displacement chillers.
- Name factors that must be considered in selecting air-conditioning equipment for specific applications and compare COPs for the various kinds of equipment.
- Discuss general cost criteria for the various types of energy used to drive the equipment and describe an appropriate absorption system application.

Heat Pumps

Course 441: Heat Pumps

Introduces the heat pump concept and related terminology. Covers water-to-water, water-to-air, ground-to-air, air-to-air, solar-assisted, geothermal, dual-fuel, and split systems, as well as packaged units. Defines balance points, coefficient of performance, energy efficiency ratio, and degree days. Covers components, controls, installation, checkout, and startup.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Introduction to Heat Pumps

Topics

What Is a Heat Pump?; Basic Heat Pump Operation; Advantages of Heat Pumps; Heat Pump Cycles; Cooling Cycle; Heating Cycle; Defrost Cycle; Kinds of Systems; Balance Point; Degree-Days; Unit Sizing; Operating Costs

Objectives

- Explain how a heat pump differs from standard air-conditioning equipment.
- List the benefits of heat pump systems.
- Describe the heating, cooling, and defrost heat pump cycles.
- Define degree-day.
- List considerations in sizing heat pumps.

Lesson 2: Heat Pump Systems

Topics

Heat Pump System Designations; Water-to-Water Systems; Water-to-Air Systems; Ground-to-Air Systems; Air-to-Air Systems; Solar-Assisted Systems; Geothermal Systems; Dual-Fuel Systems; Split Systems and Packaged Units

Objectives

- Compare the operation of water-to-water and water-to-air heat pump systems.
- Compare the operation of ground-to-air and air-to-air heat pump systems.
- Describe the operation of solar-assisted heat pump systems.
- Describe the operation of geothermal heat pump systems.
- Describe the operation of dual-fuel heat pump systems.
- Discuss the differences in configuration and installation of split and packaged heat pump units.

Lesson 3: Balance Points and Cost of Operation

Topics

Balance Points and System Capacity; Determining Balance Points; Supplemental Heating Control; Performance Ratings; Heating Seasonal Performance Factor (HSPF); Coefficient of Performance (COP); Seasonal Energy Efficiency Ratio (SEER); Energy Efficiency Ratio (EER); Operating Costs; Estimating Costs by Heating Degree-Day Method; Estimating Costs by Cooling Degree-Day Method; Estimating Costs by Bin Method; Common Heating-Mode Problems

Objectives

- Determine heat pump system balance points and explain their relationship to system capacity.
- Discuss the use and control of supplemental heat.
- Discuss ARI single-point and seasonal heating and cooling ratings for heat pump equipment.
- Explain how several common variables affect heat pump operating costs.
- Describe how to use the heating degree-day, cooling degree-day, and bin methods of estimating heat pump system energy use.
- Describe common problems of heat pump systems in the heating mode.

Lesson 4: Heat Pump Components

Topics

Accumulator; Indoor and Outdoor Coils; Indoor Unit; Heat Pump Compressors; Reversing Valve; Check Valves; Equalizer Tank; Heat Exchanger; Filter-Driers; Indoor Thermostat; Outdoor Thermostat; Optional Controls; Defrost Control Methods

Objectives

- Explain why heat pump systems include an accumulator.
- Describe the indoor and outdoor coils, indoor air handling components, and various metering (flow-control) devices.
- Briefly discuss the requirements of reciprocating and scroll compressor operation as used in heat pump systems.
- Discuss the use and operation of the reversing valve and check valves in heat pump systems.
- Explain the functions of the equalizer tank, heat exchanger, and filter-driers in heat pump systems.
- Briefly describe indoor and outdoor controls and popular defrost control systems.

Heat Pumps

Lesson 5: Heat Pump Controls

Topics

Defrost Controls; Pressure Differential Defrost; Temperature Differential Defrost; Timed Defrost; Time-and-Temperature Defrost; Solid-State Defrost; Pressure Controls; Heat Sequencers; Emergency Heat Relay; Starting Components; Lockout Relays; Transformer and Contactors; Overload Protectors

Objectives

- Describe the operation of the pressure differential and temperature differential defrost methods.
- Compare the advantages and disadvantages of the timed defrost and time-and-temperature defrost methods.
- Compare the construction and operation of electromechanical and solid-state defrost controls.
- Explain the functions of pressure controls, heat sequencers, and the emergency heat relay in heat pump systems.
- Describe typical starting and lockout devices used on heat pumps and explain why systems include transformers, contactors, and overload protectors.

Lesson 6: Heat Pump Installation

Topics

Outdoor Unit; Indoor Unit; Air Distribution System; Refrigerant Lines; Condensate Drain Line; Electrical System; Packaged Heat Pumps

Objectives

- Discuss considerations in selecting the best location for outdoor unit installation.
- Discuss considerations in selecting the best location for indoor unit installation.
- Describe installation practices that help the air distribution system fulfill its purpose.
- Discuss procedures for installing refrigerant lines and primary and auxiliary drain lines.
- Discuss the requirements for installing electrical wiring.
- Describe additional requirements for installing a packaged heat pump unit.

Lesson 7: Heat Pump Checkout and Startup

Topics

Crankcase Heater; Air Distribution System; Mountings; Leak Test and Charging; Insulation; Piping; Electrical System; Miscellaneous Post-Installation Checks; System Thermostat; Defrost Controls; Electrical Connections; Blower Output; Operator Instructions

Objectives

- Describe basic checkout procedures for the compressor crankcase heater, air distribution system, and all heat pump mountings.
- Describe basic steps in leak testing and charging a heat pump unit and discuss basic requirements for post-installation checkout of heat pump insulation and piping.
- Describe both the general post-installation checkout of the electrical system and tests to check specific electrical connections.
- Explain how to check the operation of the system thermostat, outdoor thermostats, and defrost controls.
- Name ways to increase blower output and explain why operator instructions are important.

Heating System Basics

Course 442: Heating System Basics

Covers fundamental information on all types of heating systems. Begins with the concept of heat energy, heat transfer, and temperature scales. Examines factors affecting human comfort. Introduces all types of heating equipment and its operation. Includes a Lesson on combustion and thermal efficiency. Concludes with a lesson on duct systems.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Heat Energy

Topics

Heating System Requirements; Heat and Energy; Temperature; Sensible Heat and Latent Heat; Heat Transfer; Energy Conversions; Electric Motors

Objectives

- Name the three main requirements of heating systems and various kinds of energy related to heating systems.
- Define terms related to the basic concepts of heating systems.
- Describe differences between standard temperature scales and explain how to convert between Fahrenheit and Celsius scales.
- State the two basic laws of heat transfer and describe the three ways heat is transferred from one location to another.
- Explain how to convert between kilowatts (kW) and brake horsepower (bhp).
- Briefly describe various kinds of single-phase motors used in heating systems.

Lesson 2: Personal Comfort and Heat Distribution Systems

Topics

Personal Comfort; Humidity; Humidifiers; Heat Delivery Systems; Forced-Air Furnaces; Heat Pumps; Hot Water Heating Systems; Room Heating Panels

Objectives

- Discuss the effects of temperature, humidity, and air velocity on personal comfort.
- Describe various kinds of humidifiers used in furnaces.
- Describe the basic operation of a forced-air furnace.
- Discuss the use of heat pumps.
- Explain the main difference between forced-air and hot water (hydronic) heating units.
- Describe the basic operation of floor, wall, and ceiling heating panels.

Lesson 3: Combustion

Topics

Combustion Facts; Combustion Reactions; Heating Value; Compensation for Altitude; Fuel Classification; Solid Fuels; Liquid Fuels; Gaseous Fuels; Thermal Efficiency; Combustion Products as Pollutants

Objectives

- Define combustion and describe what happens to the fuel and oxygen supplied during the process.
- Describe characteristics of stoichiometric combustion and discuss problems associated with incomplete combustion.
- Define the terms ignition temperature, upper and lower flammability or explosive limits, higher and lower heating values, and flash point.
- Discuss the general differences between solid, liquid, and gaseous fuels and describe their characteristics.
- Explain how thermal efficiency applies to heating systems.

Lesson 4: Chimneys and Venting

Topics

Chimney and Gas Venting Terminology; Need for Combustion Air; Draft Control Methods; Basic Chimney Requirements; Chimney Operation Factors; Gas Furnance Venting; Oil-Fired Furnance Venting; Fireplace Chimneys; Vent and Chimney Accessories

Objectives

- Define terms related to chimneys and venting.
- Describe several methods of draft control used on chimneys.
- Discuss factors that affect chimney operation.
- Discuss the relationship between chimney height and draft and explain why correction factors may be needed.
- Discuss the basics of gas furnace venting and oil furnace venting.
- Discuss the general principles affecting the operation of fireplaces and their chimneys.

Lesson 5: Forced-Air Duct Systems

Topics

Duct System Basics; Forced-Air System Components; Supply Outlets; Duct Dampers; Damper Motors and Actuators; Blowers (Fans); Duct System Pressure; Duct System Integrity; Duct System Design

Objectives

- Explain how the duct system delivers warm air throughout the building and describe two common ductwork layouts.
- Describe the various components of the duct system and explain why centrifugal blowers are preferred within the system.
- Discuss pressure variations within the duct system and explain how manometers and pitot tubes are used to measure pressure.
- Discuss the importance of duct system integrity as it relates to system efficiency and name factors that contribute to this integrity.
- Describe typical duct system designs and explain how the equal friction method is used.

Heating System Equipment

Course 443: Heating System Equipment

Covers the hardware associated with heating systems, including gas and oil furnaces, electric systems, solid-fuel and hydronic systems, and finally some alternative systems—solar heating, heat pumps, and fuel cells. Includes a discussion of furnace performance criteria, return air systems, and the importance of filters.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Gas Heating Equipment

Topics

Gas Heating Basics; Gaseous Fuels; Combustion Air; Furnace Categories; Furnace Components for Heat Production; Furnace Ignition Systems; Furnace Components for Venting; Conditioned Air System; Heating System Controls; Service Procedures

Objectives

- Describe the main parts of the furnace system, both those that produce the heat and those that distribute the heated air, and describe the four basic furnace configurations.
- Discuss the differences between natural gas and liquefied petroleum gas (LPG), the hazards associated with each fuel, and the heating rates of each fuel.
- Discuss the purposes of the primary and secondary air supplies to the combustion chamber and compare the characteristics of category I, III, and IV gas furnaces.
- Describe how the gas is introduced, mixed with the air, and burned in the heat-producing components of the furnace.
- Describe several burner ignition methods and safety shutdown measures in case of flame failure.
- Discuss the basic sequence of furnace operation and the controls required.
- Describe common service procedures for gas heating systems and discuss safety.

Lesson 2: Oil Heating Equipment

Topics

Oil Heating Basics; Fuel Oils; Oil Burner Components; Fuel Oil Pumps; Nozzles; Blowers; Electrodes; Transformer and Controls; Fuel Supply; Heat Exchangers and Combustion Chamber; Combustion Efficiency; Service Procedures

Objectives

- Discuss the similarities and differences between oil furnaces and gas furnaces.
- Name two common fuel oils and discuss the relationships between grades of fuel, viscosity, and temperature.
- Compare the requirements and operation of oil burner systems having the storage tank above the furnace to those having the tank below the furnace.
- Explain the reason for atomizing fuel oil and describe nozzle action and spray patterns.
- Describe the function of blower components that provide combustion air.
- Explain the purpose of the electrodes, transformer, and controls in an oil burner system.
- Discuss various ways of testing for combustion efficiency and describe common servicing procedures for oil burner systems.

Lesson 3: Electric Heating Systems

Topics

Electrical Heating Basics; Advantages and Disadvantages of Electric Heating; Electric Heating System Applications; Electric Baseboard Heating; Radiant Ceiling Heating Panels; Electrically Heated Walls; Electrically Heated Floors; Forced-Air Electric Furnaces; Forced-Air Control System; Service Tips

Objectives

- Describe the characteristics of the electric wire used for resistance heating elements.
- Discuss the advantages and disadvantages of electric heating systems.
- Explain how electric baseboard heating is applied to smaller facilities.
- Describe basic designs for radiant systems and discuss heating element safety.
- Describe the function of each main component in an electric forced-air furnace.
- Follow a wiring diagram to discuss the operation of an electric furnace including startup, shutdown, and safety features.

Lesson 4: Solid-Fuel Furnaces and Furnace Performance Criteria

Topics

Coal Furnaces; Stoker Classifications; Coal Furnace Control Systems; Wood Furnaces; Dual-Fuel Furnaces; Furnace Performance Criteria

Objectives

- Explain why coal is in decline as a heating fuel and describe the layout of a coal furnace.
- Compare various kinds of mechanical stokers and explain why each kind is used.
- Describe the functions of furnace safety and operating controls.
- Discuss the basic requirements of wood-burning furnaces.
- Discuss the benefits and function of dual-fuel furnaces.
- Explain how to use furnace efficiency formulas, including the AFUE system.

Heating System Equipment

Lesson 5: Hydronic Systems

Topics

Hydronic Basics; Thermal System; Hydraulic System; Distribution Systems; Additional System Components; Radiant Panel Systems; Heating/Cooling Systems; Control Methods; Domestic Water Heating; MTW and HTW Systems; Freeze Protection; Altitude Considerations; Air Elimination

Objectives

- Discuss how water can be used in residential and light commercial buildings to provide heating and cooling.
- Discuss the relationships between the five basic components of hydronic systems and describe the functions of the expansion tank and centrifugal pump.
- Compare the layouts and uses of series (one-pipe) and parallel (two-pipe and four-pipe) distribution systems.
- Discuss the use of radiant panels, heating/cooling systems, and domestic water heating.
- Name characteristics that make MTW and HTW systems economical for large commercial and industrial systems and explain why the simpler LTW systems are used for residences and small commercial buildings.
- Explain how to provide freeze protection, how to adjust for high altitude, and how to eliminate air from the system.

Lesson 6: Other Heating System Equipment

Topics

Fireplaces; Other In-Space Heaters; Solar Heating; Heat Pump Systems; Fuel Cells; Return Air Systems; Filters

Objectives

- Describe various kinds of fireplaces and the resulting level of efficiency.
- Discuss the three flue-venting arrangements in newer fireplaces.
- Discuss various kinds of in-space heaters and their use in residences and commercial and industrial facilities.
- Discuss the basics of solar heating and describe various kinds of solar heaters used for building cooling and heating.
- Discuss the emerging technology of fuel cells for heating and electric power generation.
- Explain why certain locations are preferred for supply and return vents in forced-air heating systems.
- Discuss today's filtration systems and IAQ concerns.

AMMONIA REFRIGERATION

The Ammonia Refrigeration Series introduces the trainee to the growing field of ammonia refrigeration. Beginning with the nature of ammonia and the characteristics of an ammonia refrigeration system, the lessons then cover the various components that make up the system. The final course offers in-depth coverage of the many safety regulations regarding the use of ammonia as a refrigerant.

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Ammonia Refrigeration Basics

Course 461: Ammonia Refrigeration Basics

Covers all aspects of using ammonia as a refrigerant. Describes both single-stage and two-stage ammonia systems. Explains the importance of accumulators and intercoolers in ammonia refrigeration. Concludes with coverage of liquid recirculation system operation.

TPC Training Systems is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Ammonia Characteristics

Topics

Ammonia sources, uses, and chemical characteristics; Environmental, hazardous material concerns; Temperature-pressure relationships; Materials compatibility; MSDS criteria; Safety

Objectives

- Name common uses of ammonia and describe benefits of ammonia refrigerant in terms of ozone depletion and global warming potentials (ODP and GWP).
- Describe the properties of ammonia and explain how they affect the use of ammonia as a refrigerant.
- Discuss the toxicity and flammability of ammonia and its classification as a hazardous material.
- Discuss important features of ammonia saturation curves, reactions with metals, and MSDS criteria.
- Name two standards governing ammonia refrigeration systems and describe the four main ammonia safety concerns, steps for their prevention, and first aid treatment in the event of exposure.

Lesson 2: Single-Stage Ammonia Systems

Topics

Positive-displacement systems; Refrigeration loads; Primary, secondary refrigeration system components; Components in parallel; Superheat; Single-stage pressure-enthalpy diagram

Objectives

- Briefly compare absorption and mechanical compression systems, compare dynamic and positive-displacement compressors, and name those generally used in industrial ammonia refrigeration systems.
- Explain how a positive-displacement compressor increases the ammonia vapor pressure.
- Define British thermal unit (Btu), specific heat, sensible heat, latent heat, and tons of refrigeration.
- Name four primary components in single-stage ammonia refrigeration systems and describe their functions.
- Describe the functions of the oil separator, high-pressure liquid receiver, king valve, and suction accumulator in single-stage ammonia refrigeration systems.
- Define superheat, enthalpy, and entropy and explain how they are used on the pressure-enthalpy (P-H) diagram.

Lesson 3: Two-Stage Ammonia Systems

Topics

Compression ratio; Compressor capacity; Two-stage system division, Booster desuperheater, intercooler; Two-stage system components, performance; Complex two-stage systems

Objectives

- Define compression ratio and explain its importance in single-stage and two-stage industrial ammonia refrigeration systems.
- Explain why flash gas removal, booster discharge-vapor desuperheating, and interstage liquid cooling are desirable in the two-stage system.
- Plot a two-stage refrigeration system on an ammonia pressure-enthalpy (P-H) diagram.
- Name the primary and secondary components of a two-stage refrigeration system and describe component functions.
- Explain why a two-stage system requires less overall power than a single-stage system.

Lesson 4: Suction Accumulators and Intercoolers

Topics

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

Objectives

- Explain why suction accumulators are needed and describe the damage that can result from liquid entering the compressor.
- Discuss the purposes and reasoning behind the design features, including the boil-out coil, of suction accumulators.
- Describe the various ammonia refrigerant liquid/vapor separation criteria.
- Explain how the intercooler deals with flash gas and desuperheats the booster discharge.
- Describe basic differences between a flash intercooler and a shell-and-coil intercooler.
- Describe typical configurations for alternate intercoolers provided with internally compounded compressors.

Ammonia Refrigeration Basics

Lesson 5: Liquid Overfeed (Recirculation) Systems

Topics

Liquid overfeed, recirculation systems; Recirculation system advantages and disadvantages; Recirculation vessel design; Pumper drum system; Controlled pressure receiver system

Objectives

- Describe the various functions performed within the recirculation vessel.
- Discuss the advantages and disadvantages of recirculation systems.
- Describe design features of horizontal and vertical recirculation vessels.
- Discuss the surge-volume requirements of a recirculation system and reasons for high-level alarm/cutout controls on the recirculation vessel.
- Describe the features and drawbacks of various kinds of liquid-refrigerant pumps.
- Describe the operation of pumper drum (gas-pressure) recirculation systems and controlled pressure receiver (CPR) recirculation systems.

Positive-Displacement Compressors

Course 462: Positive-Displacement Compressors

Begins with coverage of reciprocating compressors—their design, lubrication, efficiency, and application. Covers rotary vane compressor operation and limitations. Details screw compressors and the operation of related drive, lubrication, capacity control, and safety systems. Discusses oils and the importance of system lubrication.

TPC Training Systems is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Reciprocating Compressors

Topics

Features of industrial ammonia reciprocating compressors; Capacity control; Lubrication; Efficiency; Application data; Compound compressors

Objectives

- Briefly describe the evolution of ammonia reciprocating compressors.
- Describe typical design features of today's reciprocating compressors.
- Explain how capacity control and proper lubrication are achieved in ammonia reciprocating compressors.
- Explain how to use volumetric and adiabatic efficiency data and the performance factor in sizing or selecting compressors for an application.
- Describe the function and basic design requirements of internally compounded reciprocating compressors.

Lesson 2: Sliding-Vane Rotary Booster Compressors

Topics

Rotary vane compressor design and operation; Fixed volume ratio; Applicability; Limitations; Capacity control

Objectives

- Describe the basic operation of sliding-vane rotary booster compressors.
- Explain the principle of fixed volume ratio compressors.
- Describe typical rotary compressor design features.
- Explain why sliding-vane rotary compressors have been replaced by screw compressors.
- Discuss the reasons for rotary vane compressor speed limitations and the causes and effects of blade wear.
- Describe how capacity control is achieved in rotary compressors.

Lesson 3: Oil-Flooded Screw Compressors

Topics

Oil-flooded screw compressor operation; Fixed volume ratio; Capacity control in fixed, variable compressors; Efficiency; Compound compressors; Application criteria

Objectives

- Discuss the developments that led to the use and acceptance of the oil-flooded screw compressor in industrial refrigeration.
- Describe typical design features of single-screw and twin helical screw compressors.
- Explain how the compression system works within screw compressors.
- Compare fixed and variable volume machines and their applications.
- Explain how the capacity-control slide valve and variable Vi slide stop function.
- Describe the general range of application for screw compressors.

Lesson 4: Screw Compressor Units

Topics

Screw compressor systems; Drive systems; Lubrication, refrigerant/oil separation, oil cooling, economizer/side load, capacity control, microprocessor control, and safety systems

Objectives

- Explain why screw compressors are provided as units and describe the main systems that make up the screw compressor unit.
- Explain why a vertical or horizontal oil separator may be preferred and explain why check valves are used on the unit inlet and outlet connections.
- Discuss drive methods and oil distribution methods used on screw compressors and describe tasks provided by the lubricant within the compressor.
- Explain how the refrigerant vapor/oil separation system operates and list the methods and benefits of oil cooling in screw compressor units.
- Discuss the beneficial uses of the side port and the operation of the screw compressor capacity reduction slide valve control system.
- Name the codes and other criteria with which ammonia refrigeration systems must comply to establish and maintain a safe work environment.

Lesson 5: Ammonia Systems Lubrication/Oil Management

Topics

Need for lubrication; Miscibility; Viscosity; Lubricants and oils; Lubricant selection, handling and management; Separators; Low-side oil recovery

Objectives

- Discuss the purposes of lubricants in ammonia systems.
- Define the terms used to describe and specify lubricants and oils and discuss the importance of the miscibility and viscosity relationships between lubricants and ammonia.
- Describe the proper methods for handling lubricants.
- Explain how oil is separated from the refrigerant vapor within the screw compressor system.
- Describe the IIAR-approved method for removing oil from the system low-side oil pots.
- Name lubricants recommended for use with ammonia systems and explain the importance of using only specified lubrication products.

Evaporators, Condensers, and Controls

Course 463: Evaporators, Condensers, and Controls

Covers gravity feed, overfeed, dump trap, CPR, and DX supply systems. Describes evaporator and evaporative condenser design, selection, and operation. Discusses various defrost systems—hot gas, electric, water, and glycol spray. Examines stop, shutoff, relief, check, solenoid, expansion, pressure-regulating, and float valves.

TPC Training Systems is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Liquid Ammonia Evaporator Supply Methods

Topics

Gravity feed, liquid overfeed, pumped overfeed, dump trap, controlled pressure receiver, direct expansion, and flooded liquid chiller systems

Objectives

- Explain how refrigerant flows in a thermosyphon system and describe the requirements for a surge drum in a gravity feed system.
- List the benefits of a machine room liquid recirculation unit and benefits compared to direct expansion systems.
- Describe the various level controls used in a recirculation unit and explain how the liquid refrigerant is pumped from the recirculation unit through the evaporator coils.
- Describe how a dump trap functions and how it differs from a pumped overfeed system.
- Discuss the differences between a recirculation unit and a CPR system.
- Explain how a thermal expansion valve works and why a DX coil must have more heat transfer surface than an overfeed coil.
- Describe the liquid feed and operation of flooded ammonia shell-and-tube fluid coolers.

Lesson 2: Evaporators

Topics

Evaporator operation and heat transfer principles; Tube design; Chillers; Air coils; Freezers; Ice makers; Specialty evaporators

Objectives

- Discuss basic details of evaporator operation, including the use of secondary coolant.
- List basic principles affecting evaporator heat transfer ability in DX and liquid overfeed systems.
- Discuss the reasons for coil fins and enhanced tube designs.
- Describe common DX and flooded liquid chillers.
- Discuss the construction and operation of evaporators used as air coils (coolers), including the benefits of penthouse installation.
- Describe the operation of various common kinds of freezers and ice makers.
- Explain how subcoolers, intercoolers, and thermosyphon oil coolers function as evaporators.

Lesson 3: Air Unit Defrost Systems

Topics

Reasons for defrost; Hot gas, soft hot gas, electric, water, continuous glycol spray, and room air defrost; Defrost cycle initiation and termination

Objectives

- Explain why ice and frost form on a coil and discuss the problems resulting from this formation.
- Describe the basic process of defrosting by means of hot gas from the compressor discharge.
- Explain how the soft hot gas defrost system protects large industrial coils.
- Describe common defrost methods that do not use hot gas—electric, water, continuous glycol spray, and room air.
- Describe preset timer defrost methods.

Lesson 4: Evaporative Condensers

Topics

Evaporative condenser basics and design features; Condenser selection; Condenser location; Refrigerant piping; Winter operation and capacity control; Water treatment

Objectives

- Describe the basic differences between air-cooled, water-cooled, and evaporative condensers and discuss the main operating features of each.
- Discuss the benefits of the evaporative condenser and explain why it has the lowest condensing temperature.
- Describe the design components of an evaporative condenser and explain how they work together to provide cooling.
- Discuss both the process of condenser selection and good and bad practices in locating condensers.
- Describe proper piping and equalization practices for both single and multiple condenser installations.
- Explain the need for condenser winterization and capacity control and discuss proper water treatment to control mineral and bacterial content.

Evaporators, Condensers, and Controls

Lesson 5: Control Valves and Switches

Topics

Safety relief, stop and shutoff, check, solenoid, hand expansion, pressure regulating, and float valves; Float valve switches and controllers

Objectives

- Discuss the relief valve safety requirements as specified by the ASHRAE 15 code.
- Explain why dual relief valves are used, describe proper positioning of the three-way diverting valve, and explain how to calculate relief valve flow capacity.
- Describe the functioning of the various stop valves used on ammonia systems and explain why angle valves are preferred.
- Describe the various kinds of check valves and solenoid valve uses in automatic control on ammonia refrigeration systems.
- Describe the operation and functions of the hand expansion valve and describe typical pressure regulating valve applications and methods by which the valve is controlled.
- Discuss system high-side and low-side float valve uses and describe the operation of mechanical float switches.
- Discuss the benefits of the newer electronic level controllers in the automatic control of liquid levels, safety alarms, and system shutdown procedures.

Purging, Piping, and Safety

Course 464: Purging, Piping, and Safety

Explains the effects of noncondensables on an ammonia system and the importance of their removal. Covers a wide range of piping considerations—sizing, flow rate, pressure drop, and others. Concludes with a thorough coverage of safety codes and programs, including ANSI/ASHRAE, IIAR, OSHA, and EPA information.

TPC Training Systems is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Purging Air and Noncondensables

Topics

Materials to be purged; Effects of noncondensables; Power penalty; Purge point locations; Automatic purging; Economics of purging

Objectives

- List common noncondensable vapors and discuss their effects in a refrigeration system.
- Discuss the power penalty resulting from noncondensable gases in terms of compression and loss of refrigeration capacity.
- Explain how to determine the presence of concondensables.
- Explain how to minimize the entrance of noncondensables and describe common entry points.
- Compare the features and operation of manual and automatic purging equipment and name the best connection points for the purge unit.
- Discuss the economic benefits of the purge unit in terms of typical payback times.

Lesson 2: Ammonia System Piping

Topics

Pressure drop in pipes; Laminar and turbulent flow; Line sizing, flow rate, suction line pressure drop, discharge line pressure charts; Special piping situations

Objectives

- Discuss the relationship between pressure drop requirements and pipe sizing.
- Discuss the factors that affect the pressure drop in a pipe.
- Explain the significance of the Reynolds number and the distinction between laminar and turbulent flow.
- Discuss the use of various kinds of line sizing charts including flow rate tables, equivalence tables for fittings and valves, and pressure drop charts.
- Explain how to select the proper suction line, discharge line, and liquid line sizing for an ammonia system.
- Discuss special piping situations that require alternative sizing or installation.

Lesson 3: Ammonia System Safety Codes and Guidelines

Topics

Codes for ammonia refrigeration systems; ANSI/ASHRAE 15-1994; ASMEB 31.5; IIAR2; IIAR bulletin 111; IIAR bulletin 112

Objectives

- Describe the basic differences between ASHRAE and ASME codes and IIAR standards and guidelines.
- Discuss several main points in the ASHRAE 15-1994 safety code for mechanical refrigeration.
- Describe code requirements based on the occupancy classifications, leak probability classifications, and refrigerant characteristic classifications.
- Describe several requirements in the ASME B 31.5 refrigeration piping code concerning the materials and fabrication of refrigeration piping systems.
- Name several safety requirements specified by IIAR 2 for ammonia refrigeration equipment.
- Describe the kinds of information provided by IIAR bulletins.

Lesson 4: OSHA Process Safety Management

Topics

OSHA regulations; PSM requirements; Estimation of ammonia inventory; PSM plan development; Process safety information, hazard analysis; Standard operating procedures; Contractor procedures

Objectives

- Discuss the purposes of Process Safety Management and describe the thirteen elements that make up PSM.
- Describe the process for estimating a plant's ammonia inventory and establishing a plant ammonia library and explain why each is needed.
- Discuss the personnel and steps involved in developing a PSM plan for a specific refrigeration plant.
- Describe the process hazard analysis (PHA) and explain how it can reduce the likelihood of ammonia accidents and spills.
- Describe the requirements for preparing standard operating procedures (SOPs) for all normal plant service, repair, and maintenance.
- Discuss contractor responsibilities for PSM.
- Discuss the importance of management-of-change procedures in keeping paperwork up to date.

Purging, Piping, and Safety

Lesson 5: EPA Regulations and Ammonia Safety

Topics

40 CFR 68; Worst case/alternate ammonia release scenario; Elements in common with OSHA PSM; Penalties for nonconformance

Objectives

- Describe the purposes of the EPA Risk Management Plan and compare it to the OSHA Process Safety Management program.
- Explain the reasoning behind the dual hazard assessment requirements of a worst-case ammonia release and the more practical alternative ammonia release.
- Discuss the toxic end point criteria for an ammonia release and distinguish between rural and urban end points and differences in requirements.
- Discuss the importance and difficulties of presenting the required release data and plan to the community.
- Discuss the hazards of working with ammonia and the importance of using personal protective equipment to avoid or minimize the effects of an ammonia release.
- Describe correct first aid procedures pertaining to contact with ammonia vapor and liquid.

BUILDING AND GROUNDS MAINTENANCE

Provide your trainees the skills required to maintain a physical plant, both inside and out with TPC's Building and Grounds Maintenance Series. Our series provides the essentials for repairing and maintaining the plumbing systems, building and repairing a flat-roof structure, maintaining the grounds, and installing and maintaining locks and key systems.

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Introduction to Carpentry

Course 361: Introduction to Carpentry

Gives the new trainee a grasp of the basics of carpentry. Aims to familiarize persons who have had no carpentry experience with the tools and materials of the trade. Covers specifications, estimating procedures, codes, and how to read prints and plans.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Layout and Hand Tools

Topics

Introduction; Dressing for Carpentry Work; Safety Accessories and Equipment; Layout Tools; Straightedge; Marking Gauge; T-Bevel and Protractor; Framing Square; Testing a Framing Square; Chalk Box and Line; Work-Holding Vises and Clamps; Hand Tools; Your Toolbox

Objectives

- Identify the safety equipment that a carpenter should wear to protect his eyes, hands, and feet.
- List the twelve common layout tools mentioned in this lesson.
- Describe how to check the accuracy of a framing square.
- Tell how you would acquire the hand tools you need as a carpenter trainee.
- Point out the features that you'd look for when buying your own toolbox.

Lesson 2: Carpenter's Power Tools

Topics

Rules for Power Tool Safety; The Circular Saw; Blades for Circular Saws; Correct Use of a Circular Saw; The Saber Saw; Reciprocating Saw; The Power Drill; The Power Plane; The Router; Belt Sander; Finishing Sander; Specialty Tools for Carpenters; Nailers and Tackers; Power Actuated Fastening Tools; The Screw Gun

Objectives

- List the twelve safety rules for power tools mentioned in this Lesson.
- Explain how to mount a new blade properly in a circular saw.
- Tell how to start and finish a cut with a circular saw.
- Describe how to drill wood safely with a power drill.
- Tell how to shape an edge with a router.
- Identify the three steps involved in sanding a surface with a finishing sander.

Lesson 3: Lumber, Wood Products, and Fasteners

Topics

Hardwood vs. Softwood; Lumber Sizes; Lumber Grading; Lumber Defects; Moisture Content; Milling Methods; Millwork; Plywood; Plywood Grading; Working with Plywood; Hardboard; Particleboard; Proper Storage of Lumber; Standard Nails; Special Nails; Wood Screws

Objectives

- Describe the difference between the actual and nominal dimensions of lumber.
- Tell how defects such as checks, knots, and warping limit the value and use of lumber.
- Explain how kiln drying of lumber produces different results from air drying.
- Point out the differences between solid core and veneer core plywood.
- Describe the construction and uses of particleboard.
- Compare common nails, casing nails, and finishing nails.
- List the information you must give your supplier when ordering wood screws.

Lesson 4: Estimating Carpentry Costs

Topics

Units for Ordering Material; Reducing Waste Material; Using Waste Material; Bill of Materials; Preparing a Cost Estimate; Overhead; Guides for Cost Estimating; Tips on Organizing a Task

Objectives

- Explain the difference between a board foot and a linear foot of lumber.
- Describe the relationship between a bundle and a square of roofing shingles.
- List the information contained in a bill of material.
- Name the factors you need to prepare a cost estimate for labor on a job.
- Point out some of the things you must do before beginning a job, so the work goes smoothly.

Lesson 5: Plans, Specifications, and Codes

Topics

Architectural Drawings; Presentation Drawings; How to Read Drawings; Dimensions on Drawings; Symbols Used in Drawings; Equipment Schedules; A Full Set of Plans; Specifications for Construction; Building Codes and Zoning Laws; Building Permits; Making Your Own Drawings

Objectives

- Name the features of a building that you'll find in the plan and elevation views.
- Demonstrate how to use an architect's scale and a draftsman's scale.
- List at least four building features whose details are contained in the specifications.
- Explain why building codes are necessary in the construction industry.
- Describe the information you must submit to obtain a building permit.

Constructing the Building Shell

Course 362: Constructing the Building Shell

Covers basic building techniques common to most structures, including methods of laying foundations, framing, covering walls, and roofs.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Footings, Foundations, and Forms

Topics

Laying Out Building Lines; A Right Angle Without Instruments; Using a Transit Level and a Builder's Level; Setting Up Batterboards; Grading and Excavating; Safety in Excavating; Footings; Concrete: How It Works; Forms for Foundation Walls; Openings in Foundation Walls; Reinforced Concrete; Pouring Concrete Slabs; Waterproofing Your Concrete; Care of Concrete Forms

Objectives

- Demonstrate how to lay out a right angle without using instruments.
- Explain how to set up batterboards and building lines for an excavation.
- Tell what you can do to assure your own safety when working around an excavation.
- Describe how to erect a form for a concrete footing.
- Show how to mix a small batch of concrete using the "bottomless box."
- Describe how to prevent concrete slabs from cracking.

Lesson 2: Framing the Structure

Topics

The Most Common Framing Method; Mounting the Sill; Supporting the Floor Joists; Laying Out Floor Joists; Framing the Floor to Support Walls; Framing Openings in the Floor; Bridging between Floor Joists; Cantilever Framing; Thicknesses of Flooring Materials; The Subflooring; Framing the Inner Walls; Construction of Corners; Cross Bracing and Corner Bracing; Wall Sheathing; Estimating Framing Materials

Objectives

- Demonstrates how to lay out anchor bolt holes in sills.
- Describe the two methods of framing a cantilever.
- Compare cross bridging and solid bridging between floor joists.
- Explain how to construct and erect an inner stud wall.
- Tell why carpenters prefer to use plywood for sheathing walls.

Lesson 3: Framing the Roof with a Framing Square

Topics

Roof Designs; Parts of a Roof Frame; Principles of Rafter Layout; Pitch and Slope of a Roof; Principle of the Framing Square; Estimating the Length of Rafters; Framing the Upper Story Ceiling; How to Lay Out Roof Rafters; Setting the Roof Frame in Place; Laying Out Studs for End Frames; Framing a Hip Roof; Jack Rafters; Cripple Jacks; Roof Trusses; Roof Sheathing

Objectives

- Point out differences in heel, plumb, and seat cuts in a rafter.
- Identify the information printed on the face and back of a framing square.
- Explain how to use a framing square to determine the line length of a rafter.
- Describe how to lay out studs for a gable end.
- Tell how to determine the length of hip rafters.

Lesson 4: Installing Windows and Exterior Doors

Topics

Types of Windows Available; Types of Sash for Windows; Glazing; Heat Gain/Loss through Windows; Terminology for Window Parts; Dimensions for Installing Windows; Materials and Finishes for Windows; Installing a Window Unit; Installing Fixed Glass in Windows; Exterior Doors for a Building; Types of Exterior Doors; Standard Sizes of Doors; Constructing a Door Jamb; Cutting a Door to Size; Mounting Hinges and Hanging Doors; Weatherproofing Exterior Doors; Pre-hung Door Units; Overhead Doors

Objectives

- Explain how awning-type and hopper-type casement windows differ in operation.
- Name three or four of the common glazings and tell the advantages of each.
- List the critical dimensions for preparing and installing window units.
- Describe how to install a window unit.
- Tell how to mount a fixed glass in a picture window.
- Explain how to install mortise hinges on a door, and hang the door in the jamb.

Lesson 5: Installing Roofing and Siding

Topics

Common Materials for Roofing; Applying Built-Up Roofing; Applying the Hot Plies; Working Safely with Hot Tar; Applying Mineral-Surface Roofing; Applying Roofing Shingles; Installation of Flashing; Treatment of Valleys; Capping a Roof at the Ridge; Constructing Cornices; Estimating Materials for Roofing; Types of Modern Siding; Applying Wood Siding; Applying Other-than-Wood Siding; Applying Shingled Siding; Applying Vertical Siding; Door and Window Trim; Estimating Materials for Siding

Objectives

- Explain how a built-up roof is constructed.
- Give some of the safety precautions to follow when working with hot tar.
- Describe how to apply asphalt shingles to a roof.
- Tell how to estimate the amount of roofing required for a building.
- Tell how to estimate the amount of roofing required for a building.
- Describe how to use a story pole in the application of wood siding to a building.
- Explain how to install cornerboards for exterior trimming.

Finishing the Building Interior

Course 363: Finishing the Building Interior

Covers constructing stairways, installing doors, and finishing procedures. Emphasizes interior walls, ceilings, and floors.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Interior Walls and Ceilings

Topics

Plasterboard Construction; Application of Plasterboard Panels; Methods of Fastening Plasterboard; Methods of Cutting Plasterboard; Treatment of Corners and Edges; Construction of Drywall; Taping and Cementing Procedures; Metal Stud Drywall Systems; Prefinished and Plywood Paneling; Solid Lumber Paneling; Finishing Plaster Walls; Preparing Masonry Walls; Finishing Plasterboard Ceilings; Acoustical Tile Ceilings; Suspended Tile Ceilings

Objectives

- Explain how to fasten single-ply plasterboard panels to the stud framing for interior walls.
- Describe the three-step procedure for cementing and taping drywall construction.
- Name the advantages of a drywall system that uses metal studs.
- Explain how to install interior plywood paneling.
- Differentiate between the three coats of plaster required for plaster wall construction.
- Identify the main parts of the framing system for suspended tile ceilings.

Lesson 2: Laying Flooring

Topics

Concrete Floors; Wood Flooring; Installing Strip Flooring; Strip Flooring over Concrete; Estimating Strip Flooring; Installing Wood Block Flooring; Finishing Wood Flooring; Prefinished Wood Flooring; Underlaying for Other Floors; Resilient Floor Coverings; Ceramic Tile Floors; Wood Decking

Objectives

- Tell the differences between strip, block, and plank flooring.
- Explain how to lay flooring strips, keep them straight, and make adjustments when they are not straight.
- Tell how to plan and make a careful layout for installing a wood block floor.
- Give the sequence of sanding operations for a newly installed wood strip floor.
- Name the materials you can use for underlaying a resilient or ceramic floor.
- Explain how to lay a tile floor with the tile veneer method.

Lesson 3: Stair Construction

Topics

Prefabricated Stairs; Common Stairway Configurations; Parts of a Stairway; Framing Stairways; Number of Treads and Risers; Determining the Height of Risers; Determining the Run of a Stairway; Determining the Length of Stringers; Laying Out with a Story Pole; Laying Out Stringer; Semi-Housed and Housed Stringers; Riser and Tread Assembly; Assembling and Anchoring Stairways; Railings for Stairs; Ordering Prefabricated Stairs; Spiral Staircases

Objectives

- Describe some of the common stairway configurations: open, closed, L-shaped, U-shaped, etc.
- Starting with the stringers, name all the parts in a stair assembly.
- Explain how to use a story pole to check stair calculations.
- Tell how to anchor a flight of stairs.
- Name the guidelines for constructing handrails or railings in stairways.

Lesson 4: Interior Doors and Door Jambs

Topics

Sizes of Interior Doors; Types of Interior Doors; Specifying the Hand of a Door; Hinge Construction and Operation; Common Hinges for Doors; Other Hinges for Doors; Installing Hinges in Doors; Constructing a Door Jamb; Installing a Single-Swing Door; Installing Double Doors; Installing Sliding Doors; Installing Bifold Doors; Locking Devices for Doors

Objectives

- Explain how hollow-core, fiber-core and solid-core doors differ in construction.
- Tell how to remove a door hung on hinges with fixed pins. Also with loose pins.
- Give the guidelines for placing three hinges on the edges of a door.
- Describe how to install a single-swing door.
- Differentiate between pocket-type and bypass-type sliding doors.
- Name a few of the types of locks used on interior doors.

Lesson 5: Installing Interior Trim

Topics

Types of Molding; Joints for Molding; Using a Miter Box; Installing Door Trim; Installing Window Trim; Installing Baseboard Molding

Objectives

- Differentiate between a base shoe molding and a baseboard molding.
- Give the uses of cove, crown, and half-round moldings.
- Describe how to make a scarf joint and coped joint.
- Demonstrate how to cut a 45° miter with a miter box.
- Tell how to install the casing around a door opening
- Explain how to construct the interior casing for a window.

Structural Painting

Course 364: Structural Painting

Covers the techniques of selecting and applying paints and coatings to buildings, inside and out. Describes the composition of paints and other coatings, and how to use brushes, rollers, spray guns, and other tools of application. Also describes how to prepare new and existing surfaces for coating, and explains the easiest, most successful techniques of application.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Paint Selection for Normal Conditions

Topics

Why Paint?; Ingredients of Paint; General Types of Paint; Coating Selection; Substrate; Ferrous Metals; Nonferrous Metals; Concrete; Wood; Environment; Other Factors

Objectives

- Explain the three basic reasons for using paint.
- Identify the ingredients of paint and explain the importance of each.
- Name several generic paint types and describe their uses in normal industrial applications.
- Compare the characteristics of ferrous and nonferrous metals, concrete, and wood as substrates.
- Discuss environmental factors that influence paint choices.

Lesson 2: Coatings for Extreme Conditions

Topics

Extreme Conditions; Causes of Corrosion; Galvanic Couplings; Storage Tanks; Waste-Treatment Plants; Chemical Plants; Food and Beverage Plants; Safety Markings; Pipe Identification

Objectives

- Give at least four examples of extreme workplace conditions.
- Explain the electrochemical process of corrosion and its effect in a galvanic coupling.
- Identify some paint types used for storage tanks and in waste-treatment plants.
- Discuss coatings appropriate for chemical plants and various areas of food and beverage plants.
- Explain the meaning of the colors used in the standard safety and piping codes.

Lesson 3: Painting Tools

Topics

Brushes; Rollers; Spray Applications; Air Spray Guns; Airless Sprayers; Other Spray Equipment; Types of Blasting Equipment; Wet Blasters; Abrasives; Testing and Inspection Tools

Objectives

- Describe the different types of paint brushes.
- Explain the uses of different roller constructions and different lengths of roller nap.
- Discuss the various types of spray equipment.
- Compare the different types of blasting equipment and the abrasives used with them.
- Explain how film gauges, holiday detectors, and surface profile devices work.

Lesson 4: Surface Preparation

Topics

Importance of Surface Preparation; SSPC and NACE Standards; Chemical Cleaning; Cleaning with Hand Tools; Cleaning with Power Tools; Abrasive Blasting; Concrete Preparation; Preparing Special Surfaces; Inspection

Objectives

- Discuss the importance of correct surface preparation and compare SSPC and NACE standards.
- Compare the various methods of chemical cleaning.
- Name the hand tools and power tools used for cleaning.
- Explain the characteristics and applications of the different grades of abrasive blasting.
- Describe surface preparation techniques for concrete, galvanized metal, wood, mildewed surfaces, and chain-link fencing.

Lesson 5: Painting Techniques

Topics

Mixing and Thinning; Brush Application; Roller Application; Spray Application; Blasting; Coating Failures; Calculating Coverage; Follow-Up Records

Objectives

- Describe correct mixing and thinning methods.
- Point out the dos and don'ts of brush and roller usage.
- Explain how to use and troubleshoot spray equipment correctly and how to set up blasting equipment.
- Discuss the causes of common coating failures and explain how to prevent them.
- Calculate estimated coverage and keep satisfactory records.

Lesson 6: Ground and Aerial Supports

Topics

Developing a Safe Attitude; Special Conditions; General Safety Rules; Ladders; Raising a Ladder; Using Ladders Safely; Stationary Scaffolds; Scaffold Planking; Ropes and Cables; Using Stationary Scaffolds Safely; Portable Support Systems; Using Portable Supports Safety; Rigging Systems; Using Rigging Safely; Lifelines

Objectives

- Explain the importance of attitude in preventing injury, and how heat, cold, wind, and heights can be dangerous.
- Compare different types of ladders and tell how to use them safely.
- Discuss stationary scaffolding and accessories.
- Describe boom and scissors lifts and tell how to use them safely.
- Compare bosun's chairs, work cages, and swinging scaffolds and platforms.
- Point out safety measures necessary when using cable-supported or suspended units.

Structural Painting

Lesson 7: Handling Hazardous Materials Safely

Topics

Hazardous Materials; Fire Hazards; Explosives; Prevention of Fires; Health Hazards; Toxic Materials; Dermatitic Materials; Threshold Limit Value; Avoiding Health Hazards; Respiratory Protection; Safety in Confined Spaces; Protective Clothing; Material Safety Data Sheet

Objectives

- Explain how painting materials cause fire or explosions and tell how to reduce these hazards.
- Define six categories of health hazards and name ways to avoid them.
- Give examples of toxic and dermatitic painting materials and explain the purpose of threshold limit values.
- Compare types of respirators and their uses, and list the rules for working safely in confined spaces.
- Describe appropriate uses for safety clothing and tell how to use an MSDS.

Flat Roof Maintenance

Course 366: Flat Roof Maintenance

Introduces roofing, including flat roof systems and various types of decks. Examines insulating and water-proofing materials, and techniques of application. Discusses roofing damage, how to repair roofs, and how to make a proper roof inspection. Explains types of preventive maintenance, how to plan preventive maintenance, and how to select the proper materials to use.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Introduction to Flat Roof Systems

Topics

Introduction to Roofing; Flat Roof Systems; The Structural Deck; Wood Decks; Concrete Decks; Steel Deck; The Vapor Barrier; The Thermal Insulation; Where to Place the Insulation?; The Waterproofing Membrane; Waterproofing Materials; Building Up the Membrane; Aggregate and Flood Coats; Service Walkways

Objectives

- Name and define the four basic components that make up a flat roof system.
- Explain the differences among a pre-stressed concrete deck, a pre-cast deck, and a reinforced deck.
- Explain the functions of a vapor barrier.
- Tell why thermal insulation is applied above deck in some applications, and below deck in others.
- List three benefits of coating a flat roof with aggregate or crushed slag.

Lesson 2: Roof-Related Components

Topics

Why a Flashing?; Description of Flashing; Base Flashings; Counter Flashings; Flashings for Vents; Flashings for Irregular Roof Penetrations; Flashings for Pitch Pockets; Expansion Joints; Roof Drainage Systems; Gutters; Roof Sumps; Interior Drains; Gravel Stops; Raised Edge Flashings; Parapet Walls; Scuppers; Conductor Heads; Downspouts

Objectives

- Explain how a base flashing and a counter flashing work together to protect a roof.
- Tell how and why a hot vent is usually flashed differently from a cold vent.
- Name three roof conditions that make it necessary to install expansion joints.
- Describe how the components of a flat roof drainage system work together
- Tell how to keep moisture out of parapet walls.

Lesson 3: Causes of Common Roof Problems

Topics

Why Does a Flat Roof Leak?; Failure of Roofing Membrane; Bare Spots; Blisters; Ruptures or Punctures; Splits; Membrane Slippage; Dirt and Debris; Alligatoring; Failure of Roofing Components; Results of Poor Installation; Ponding on a Flat Roof; Venting Damp Insulation; Roof-Mounted Equipment; Preventing Roof Problems

Objectives

- Describe the causes of blisters, bare spots, and punctures.
- Explain how dirt and debris create maintenance problems on flat roofs.
- Name the most common reasons for vent flashing failure.
- List the steps to take to prevent water from ponding on a flat roof.
- Tell how to set heavy equipment on a flat roof without damaging the membrane.

Lesson 4: Roof Inspection

Topics

The Bonded Roof; The Need for Roof Inspection; Inspecting a Roof Under Construction; Selecting the Inspector; Making the Inspection; Inspecting a Roof in Service; Before the Inspection; Making the Inspection—Indoors; Is It Asphalt or Coal Tar?; Making the Inspection—Outdoors; Hidden Sources of Trouble; Inspecting the Roof Membrane; Moisture in the Roof

Objectives

- Tell what a roofing bond or guarantee usually covers and doesn't cover.
- List the materials and information that a roof inspector should have for his guidance.
- Describe two ways of telling whether the roofing bitumen is asphalt or coal tar.
- Explain how water can seep through roof penetrations, pitch pockets, and parapet walls.
- Describe a simple means for measuring the moisture content in a roof system.

Lesson 5: Preventive Maintenance and Repair

Topics

Planned Preventive Maintenance; Types of Preventive Maintenance; Materials for Preventive Maintenance; Maintaining the Roofing Membrane; Bare Spots; Blisters; Roof Vents for Removing Moisture; Ruptures and Punctures; Splits; Maintaining Flashings; Maintaining Pitch Pockets; Maintaining Drains and Gutters; Maintaining Parapet Walls; Making Emergency Repairs; Effects of Snow and Ice; Be Prepared!; Safety on the Roof

Objectives

- Name the basic materials that should be stocked for making roof repairs.
- Tell how to repair a split membrane if sealing tape isn't available.
- Describe how to repair a hole in a base flashing.
- Explain how moisture can cause a parapet wall to crack and crumble.
- Explain how to channel a roof leak to a floor drain.
- Describe how to use tools, ladders, and hoists safely when repairing roofs.

Lesson 6: Single-Ply Roofing

Topics

What Is Single-Ply Roofing?; Thermoplastic Polymers; Elastomers; Modified Bitumen; Roof-Laying Methods; Installation and Maintenance; Inspection Checklist

Objectives

- Name and describe the three types of single-ply roofing materials.
- Detail the roof-laying methods used with each of these types.
- Identify actions that would void a typical roof warranty and explain why it is important to keep the warranty in effect.
- Explain the six key points that should be checked in the inspection of a single-ply roof.

Plumbing Systems Maintenance

Course 367: Plumbing Systems Maintenance

Covers maintaining plumbing systems in a factory, plant, or other industrial or commercial site. Describes the structure and function of on-site plumbing systems (water supply, sanitary waste, and storm water), and explains how the major fixtures in these systems work. Tells how to take care of common plumbing problems.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Introduction to Plumbing

Topics

Codes and Standards; Basic Plumbing System; Sanitary Drainage, Waste, and Vent System (DWV); Drainage Line Flow; Stacks; Traps and Connection Methods; Combined Sewer System; Venting System; Plumbing Fixtures; Storm Water Drainage System; Cold Water Supply and Distribution; Water Flow; Installation and Maintenance; Hot Water Supply and Distribution; Pressure-Boosting Systems

Objectives

- Describe a basic plumbing system.
- Name the parts of a DWV system and explain their functions.
- Explain the purpose of the different elements in an industrial cold water supply and distribution system.
- Describe a basic system for industrial hot water supply and distribution.
- Describe three basic systems for boosting in coming water pressure.

Lesson 2: Plumbing Fixtures

Topics

Water Closets; Flush Valve (Flushometer); Flush Tank; Water Closet Chair Carrier; Leaks and Stoppages; Urinals; Lavatories; Trim and Faucets; Two-Handle Washer Faucets; Two-Handle Washerless Faucets; Single-Handle Faucets; Sinks; Showers; Drinking Fountains

Objectives

- Describe six lavatory categories and compare the different flushing systems used in water closets and urinals.
- Explain the operation of different types of faucets.
- Give examples of industrial showers, sinks, and drinking fountains.

Lesson 3: Sanitary Drainage Systems

Topics

Function; Materials; Fittings and Joints; Piping; Subdrains; Floor Drains; Leaks; Stoppages; Indirect Wastes; Cleanouts

Objectives

- State the function of sanitary drainage systems and describe the materials, fittings, and joints used in them.
- Discuss the installation and connection of the piping components of a sanitary drainage system.
- Explain the purpose of floor drains and cleanouts, and where they are needed.
- Tell how to repair leaks and clear stoppages in sanitary piping.

Lesson 4: Vent Systems

Topics

Function of Vent Systems; Materials for Pipes, Fittings, and Joints; Piping; Fixture Trap Vents; Types of Vents; Vent Terminals

Objectives

- List the components of a vent system and explain their functions.
- Discuss the materials used for vent pipes, fittings, and joints.
- Explain the importance of air pressure and water flow in DWV systems.
- Discuss the requirements for the installation of piping in a vent system.
- Describe several types of vent system and their applications.

Lesson 5: Storm Water Drainage

Topics

Storm Water Drainage Systems; Materials; Fittings and Joints; Piping; Subdrain System; Site Drainage System; Roof Drains; Expansion and Contraction; Subsoil Drainage

Objectives

- Explain the function and installation of the elements in storm water and site drainage systems.
- Name the materials, fittings, and joints used in storm water and site drainage systems.
- Describe how the piping components of storm water and site drainage systems should be installed.
- Compare six different roof drains and give details of their installation.

Lesson 6: Potable Water Distribution

Topics

Function; Materials; Fittings and Joints; Pressure and Velocity; Hydraulic Shock; Limiting Flow and Pressure; Pressure-Boosting Systems; Piping; Valves; Cross-Connections and Contamination

Objectives

- Tell how the separate components of a potable water distribution system work together in its operation.
- List the materials suitable for use in a potable water system, the fittings used with them, and the factors to be considered in selecting them.
- Discuss the effects of water pressure and flow in a potable system.
- Give installation details for piping and valves in a potable eater system.
- Explain how a potable water system can be contaminated and how contamination can be prevented.

Plumbing Systems Maintenance

Lesson 7: Hot Water Distribution

Topics

Function; Materials, Fittings, and Joints; Water Heaters; Indirect Water Heaters; Safety Requirements; Circulation; Temperature; Expansion and Contraction

Objectives

- Explain the selection of materials and the installation of components for a hot water system.
- Describe the operation and application of different water heaters.
- Explain the safety requirements for hot water tanks and heaters.
- Describe a hot water circulation system, tell when it must be installed, and explain the advantages of strip heaters.
- Tell how water temperature affects the equipment and layout of a hot water distribution system.

Lesson 8: Valves

Topics

Function; Types and Construction; Gate Valves; Globe Valves; Check Valves; Quarter-Turn Valves; Plug Valves; Ball Valves; Butterfly Valves; Materials; Applications

Objectives

- Compare the function and applications of plumbing system valves.
- Tell how the main types of valves end connections.
- Compare the different types of valve end connections.
- Name the factors to be considered in the selection of materials for valves.

Lesson 9: Piping Assembly Procedures

Topics

Cast Iron Soil Piping; Brass and Steel Piping; Wrenches; Copper Tubing; Plastic Piping

Objectives

- List three joints used in iron piping and tell how to make them.
- Explain how to assemble screwed and flanged joints in brass and steel piping.
- Give example of the proper use of different pipe wrenches and vises.
- Tell how to assemble copper tubing with soldered, compression, and flared joints.
- Review the procedures for making joints in PVC and CPVC piping.

Lesson 10: Maintaining Plumbing Systems

Topics

Care of Hand Tools; Maintaining Plumbing Fixtures; Maintaining Water Heaters; Maintaining Waste Systems; Opening Clogs; Other Types of Clogs; Maintaining Valves; Preventive Maintenance of Valves; Maintaining Plumbing Insulation; Maintaining Pumps; Repairing Leaks

Objectives

- Name the chief points involved in the care and correct use of hand tools.
- Describe how to open the clogs and repair leaks in plumbing fixtures.
- Compare maintenance procedures for different types of valves.
- Tell how to clear stoppages and repair leaks in the drainage system.
- Explain the maintenance of water heaters, pumps, and pipe installation.

Locks and Key Systems

Course 374: Locks and Key Systems

Covers basic lock types: mortise, auxiliary or rim, tubular bolt, key-in-know, narrow stile, and unit lock. Explains how they operate, how to install, maintain, and adjust them. Also describes key control, master key systems, panic bars, and other accessories for building security.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Commonly Used Doors and Locks

Topics

Terminology of Locks and Doors; Door Function and Operation; Door Construction and Material; Hinge Construction and Operation; Installing Hinges; Levels of Building Security; Mortise Lock; Auxiliary, or Rim, Lock; Tubular Bolt Lock; Key-in-Knob Lock; Unit Lock; Narrow-Stile Lock

Objectives

- Use standard lock and door terminology.
- Differentiate between right-hand and left-hand doors, and between hollow-core and solid-core doors.
- List four different types of hinges.
- Explain installation procedures for full-mortise, half-mortise, full-surface , and half-surface hinges.
- Identify the mortise lock, auxiliary lock, tubular bolt lock, key-in-knob lock, unit lock, and narrow-stile lock.

Lesson 2: How Locks Operate

Topics

Mortise Lock Mechanism; Mortise Lock Installation; Rim Spring-Bolt Locks; How Rim Bolt Locks Work; Jimmy-Resistant Lock Operation; Tubular Bolt Locks; Operation of Key-in-Knob Lock; Unit Lock Functions; How Narrow-Stile Locks Work

Objectives

- Describe how a mortise lock mechanism works.
- Tell what operations are involved in installing a mortise lock.
- Compare the functions of rim spring-bolt locks, rim bolt locks, and jimmy-resistant locks.
- Diagram the construction of a tubular bolt lock.
- Explain how key-in-knob locks, unit locks, and narrow-stile locks operate.

Lesson 3: Installing Locks

Topics

Care in Installation; Installing the Mortise Lock; Installing the Auxiliary Lock; Installing the Tubular Bolt Lock; Installing the Key-in-Knob Lock; Installing the Unit Lock; Installing the Narrow-Stile Lock; Care and Handling of Lock Tools

Objectives

- Explain how to position a mortise lock with the proper setback for installation.
- Describe installation procedures for an auxiliary lock, tubular bolt lock, key-in-knob lock, unit lock, and narrow-stile.
- List the tools needed to install locks.

Lesson 4: Maintaining and Adjusting Locks

Topics

How Lock Problems Develop; How to Disassemble Locks; Opening a Cylinder With a Key; Opening a Cylinder Without a Key; Cleaning Lock Mechanism; Lubrication and Lubricants; Malfunctions of Locks; Symptoms of Problems With Keys; Symptoms of Bolt and Latch Malfunctions; Problems Caused by Misalignment; Problems With Settling; Problems With Steel and Kalamein Doors

Objectives

- Describe how lock problems can develop.
- List preventive maintenance practices that promote good lock function.
- Describe the process of opening a cylinder both with and without a key.
- Tell how to clean and lubricate lock mechanisms.
- List common problems with bolts and latches and their remedies.

Lesson 5: Key Control and Master Key Systems

Topics

What Is Master Keying?; Master Key Systems; Advantages and Disadvantages; Alternatives to Master Keying; Key Control; Advanced Key Control; Importance of Record Keeping; Key Storage; Key Tagging Procedures; Check Existing Systems; Custom Systems; Other Access Control Systems

Objectives

- Describe how a master key system operates.
- List the advantages and disadvantages of master keying.
- Differentiate between the maison system, keyed-alike system, and sectional system.
- List the information that must be included in the security survey plan, key progression chart, and key issuance files.
- Identify other access control systems, such as card-key systems, electronic systems, and push-button locks.

Landscaping Maintenance

Course 375: Landscaping Maintenance

Covers the major features of landscaping maintenance, from the basics of how plants develop to recognizing diseases and parasites. Details the selection and care of trees, ground covers, flowers, and grasses.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Basic Plant Care

Topics

The Need for Plant Identification; Structure of a Plant; Plants Need Soil; Organic Matter in Soils; Acidity and Alkalinity of Soils; Plants Need Water; Plants Need Nutrients; Macronutrients; Micronutrients; Plants Need Proper Temperatures; Soil Temperatures; Plants Need Air; Plants Need Light

Objectives

- Explain the importance of understanding and using a uniform plant identification system, and name the classifications into which plants are grouped.
- List six essentials of plant life.
- Describe the pH scale and tell how the acidity or alkalinity of a soil affects plant growth.
- Tell how to recognize the symptoms of overwatering and underwatering.
- Name at least four nutrients plants need, explain why is needed, and tell how to recognize a lack of overabundance of each.

Lesson 2: Shade Trees

Topics

Tree Shapes and Sizes; Tree Textures; Tree Colors; Hardiness; Growth Rates; Handling Nursery Stock; Transporting Nursery Stock; Storing Trees; Planting Trees; Watering Trees; Pruning Trees; Fertilizing Trees; Safety Procedures

Objectives

- Give examples of the following: course-textured, medium-textured, and fine-textured trees.
- Describe the three ways in which nursery stock is normally offered for sale.
- List and explain the five steps involved in planting a landscape tree.
- Tell why trees may require pruning and describe the two basic pruning cuts.
- Summarize the safety rules that apply when doing tree maintenance work.

Lesson 3: Turf Management

Topics

Grass and Turf; Cool Season Grasses; Warm Season Grasses; Mowing Turf; Fertilizing Turf; Watering Turf; Light and Shade; Seeding; Sodding; Plugging; Sprigging and Stolonizing; Pests and Weeds

Objectives

- Tell how lawns and grass plants differ from other types of landscape plants.
- Define and give examples of cool season grasses and warm season grasses.
- Discuss the importance of proper mowing.
- List three things to keep in mind when watering turf.
- Describe how to establish turf by plugging and discuss the advantages and disadvantages of this method.

Lesson 4: Shrub and Flower Care

Topics

Characteristics of Shrubs; Major Types of Shrubs; Hedges; Planting Shrubs; Care of Shrubs; Pruning Shrubs; Pruning Tips; Ground Covers; Vines; Flowers; Annuals; Biennials; Perennials; Bulbs, Corms, and Tubers

Objectives

- List several things to consider when selecting shrubs.
- Explain the different kinds of pruning required by different kinds of shrubs—for example, spring-flowering shrubs, roses, narrow-leafed evergreens, and hedges.
- Explain how to plant and care for vines.
- Name and define the three classes into which flowers fall.
- Give several examples of hardy bulbs and tender bulbs and compare and contrast the methods of care each requires.

Lesson 5: Pest and Disease Control

Topics

Viruses; Bacteria; Fungi; Insects; Galls; Weeds; Pesticides; Origins of Pesticides; Choosing a Pesticide; Pesticides Come in Many Forms; Spraying Equipment; Other Equipment for Pest and Weed Control; Using Pesticides Safely; In Case of Accidents

Objectives

- Recognize fungi and the symptoms of bacteria disease and tell how to control them.
- Identify several living things that help control insects.
- Name several different kinds of pesticides and the ways in which they work.
- Explain the different kinds of pesticides and the ways in which they work.
- List several things to consider when choosing where each is used.
- Describe some of the many forms in which pesticides come and ways in which they are applied.

CUSTODIAL MAINTENANCE

The Custodial Maintenance Series is perfect for beginners in the custodial maintenance field, but can also serve to upgrade the skills of experienced workers in commercial, educational, institutional, and industrial settings. Its 26 lessons provide in-depth coverage of a wide range of custodial care issues. It offers step-by-step instruction, stressing worker safety throughout.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
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453: Maintaining Floors and Other Surfaces					119
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Cleaning Chemicals

Course 451: Cleaning Chemicals

Covers the safe use of cleaning chemicals, including the OSHA Hazard Communication standard. Covers the basic chemistry of cleaning chemicals, then explains the correct use of detergents, soaps, solvents, disinfectants, and other cleaning chemicals. Explains how chemicals are packaged, labeled, mixed, and applied in order to make working with chemicals safer and the trainee more efficient.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Using Chemicals Safely

Topics

The OSHA Hazard Communication Standard; What Is an MSDS?; What Is a Chemical Hazard?; Exposure Routes; Controlling Chemical Hazards; Detecting Exposure Hazards

Objectives

- Identify the goals of the Hazard Communication Standard and the agency responsible for writing and enforcing the standard.
- Explain the purpose and basic content of an MSDS.
- Give examples of the health hazard information contained in MSDSs and how it is used.
- Give examples of the physical hazard information contained in MSDSs and how it is used.
- Describe typical MSDS instructions on special precautions and procedures.
- Define chemical hazard and name the two categories into which they are divided.
- Name and describe the six kinds of health hazards.
- Name the three basic routes of health hazard exposure.
- Discuss common methods of controlling chemical hazards.
- Explain how to detect exposure hazards and symptoms.

Lesson 2: Introduction to Cleaning Chemicals

Topics

Cleaning Chemicals Defined; Cleaning Agents; Disinfectants; Selecting the Correct Product; Correct Product Use

Objectives

- List the three kinds of cleaning chemicals.
- Explain the advantages and disadvantages of soaps.
- Compare and contrast soaps and detergents.
- Tell what protective equipment is required when working with solvents.
- Explain how solvent and abrasive cleaners work.
- Describe the purpose of a disinfectant.
- List the important factors to consider when selecting a cleaning product.
- Tell where to find information about correct product usage.

Lesson 3: Cleaning Agents

Topics

Why Use Cleaning Agents?; Detergency Processes; Physical Characteristics of Cleaning Agents; Chemical Characteristics of Cleaning Agents; Electrical Charges in Soaps and Detergents; Matching the Product to the Job; General-Purpose Cleaners; Strippers; Degreasers; Shampoos; Other Considerations

Objectives

- Name the chemicals in cleaning agents that dissolve grease and oil.
- Name and describe the four most important detergency processes.
- Define penetration, suspension, and viscosity as characteristics of cleaning agents.
- Tell how cationic soaps and detergents differ from anionic soaps and detergents.
- Name an advantage and a disadvantage of a multi-duty cleaners.
- Tell why wetting agents are used in degreasers.

Lesson 4: Disinfectants

Topics

Disease-Causing Microorganisms; How Microorganisms Live; Controlling the Growth of Germs; Disinfectants; Kinds of Disinfectants; Product Information; Preparing Disinfectants for Use; Cleaning and Disinfecting; Cleaner/Disinfectants

Objectives

- Define the term pathogenic.
- List four kinds of microorganisms capable of causing disease.
- Explain the difference between cleaning and disinfecting.
- List three factors that make killing germs a difficult task.
- Define the terms sanitization, disinfection, and sterilization.
- State an advantage and a disadvantage for each of the main kinds of disinfectant.
- Explain why it is important to follow product dilution information carefully.

Lesson 5: Special-Purpose Cleaning Chemicals

Topics

Acid Bowl Cleaners; Glass Cleaners; Absorbents; Dust Control Chemicals; Furniture Polishes; Metal Polishes; Hand Soaps and Cleaners; Graffiti Remover; Drain Cleaners; Deodorants

Objectives

- Explain why it is necessary to use an acid bowl cleaner on toilets and urinals.
- List the characteristics of a good glass cleaner.
- Explain the purpose of absorbents.
- Explain where and why dust control chemicals are used.
- Give three reasons for using furniture polish on unsealed wood.
- List the properties of a good hand cleaner.
- Describe the necessary precautions to take when using drain cleaners.
- Name the three common forms of room deodorant.

Floors and Floor Care Equipment

Course 452: Floors and Floor Care Equipment

Covers many different kinds of floors and flooring materials in use in many locations. Covers a variety of powered floor care equipment, explaining how to operate each device safely and efficiently. Explains how and why to use floor machines and vacuum cleaners and their various attachments. Also covers the use and maintenance of autoscrubbers, powered sweepers, pressure washers, and sanders.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Kinds of Flooring

Topics

Flooring; Resilient Flooring; Natural Hard Flooring; Synthetic Hard Flooring; Wood Flooring; Special Floorings

Objectives

- Tell how to identify the common resilient floorings, and explain the characteristics of each.
- Name the common natural hard floorings, and explain the characteristics of each.
- Explain how synthetic hard flooring is formed and installed.
- Explain why wood floors must be cleaned with care.
- List the main features of cork flooring.
- Explain where and why iron and steel, conductive, and pedestal floors are used.

Lesson 2: Floor Machines

Topics

Floor Machines; Machine Size and Speed; Distribution of Machine Weight; Machine Parts; Floor Machine Attachments; Operation of Floor Machines; Care of Floor Machines

Objectives

- Identify which size floor machine to use for various floor areas.
- Tell which speed range is best for scrubbing, stripping, buffing, and shampooing.
- Explain the relationship between electric motor horsepower ratings and machine size.
- Describe the function and operation of the transmission in a floor machine.
- Explain how to install pads, pad holders, and brushes on a floor machine.
- List the step-by-step operation and maintenance procedures for floor machines.

Lesson 3: Vacuum Cleaners

Topics

Types of Vacuum Cleaners; Dry-Tank Vacuum Cleaners; Attachments for Dry-Tank Vacuums; Operating a Dry-Tank Vacuum; Care of Dry-Tank Vacuums; Wet/Dry Vacuum Cleaners; Attachments for Wet/Dry Vacuums; Operating a Wet/Dry Vacuum; Care of Wet/Dry Vacuums; Upright Vacuum Cleaners; Operating an Upright Vacuum; Care of Upright Vacuums; Back-Pack Vacuum Cleaners

Objectives

- Explain the basic operating principle of a vacuum cleaner.
- Describe the four most widely used types of vacuum cleaners and their main parts.
- Identify which machine to use for a particular vacuuming task on a particular surface.
- List common vacuum attachments, and tell when each is used.
- Explain the step-by-step operation and maintenance procedures for the four types of vacuum cleaners.

Lesson 4: Automatic Scrubbers

Topics

Types of Automatic Scrubbers; Autoscrubber Drives; Autoscrubber Power Sources; Autoscrubber Controls; Preparing an Autoscrubber for Use; Where to Use an Autoscrubber; Operating an Autoscrubber; Cleaning an Autoscrubber; Maintaining an Autoscrubber

Objectives

- Name the three pieces of equipment contained in a single autoscrubber unit.
- Name the different types of drives, power sources, and controls that a typical autoscrubber has, and explain how each functions.
- Explain when and where not to use an autoscrubber.
- List the step-by-step procedures for preparing an autoscrubber to dry vacuum, dry buff, dry buff and dry vacuum, wet vacuum, wet scrub, wet scrub and wet vacuum, and strip.
- Tell how to clean and maintain an autoscrubber.

Lesson 5: Other Powered Equipment

Topics

Powered Sweepers; Vacuum Sweepers; Broom-and-Vacuum Sweepers; Compressed-Air-and-Vacuum Sweepers; Pressure Washers; Floor Sanders

Objectives

- Describe the three different types of powered sweepers and tell where to use each one.
- Name the three sources of power for powered sweepers, and describe the advantages and disadvantages of each.
- Identify which powered sweeper is best to use in a particular size area, surface, and type of soil.
- Explain the uses and advantages of pressure washers, and explain how they work.
- Describe the different kinds of floor sanders, and explain how to operate a floor sander.
- Tell why you need an edger when sanding wood floors.

Maintaining Floors and Other Surfaces

Course 453: Maintaining Floors and Other Surfaces

Covers the tasks involved in the daily, routine maintenance of floors. Lists floor coatings and uses. Explains periodic floor care tasks step-by-step, telling which particular methods to use on the various floors and floor coverings within buildings. Covers floor care problems trainees are likely to encounter. Concludes with a lesson on the cleaning of walls, windows, furniture, and other above-the-floor surfaces.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Routine Floor Care Tasks

Topics

Floor Size; How Dirty Is the Floor?; Removing Dry Dirt; Wet Cleaning; Disinfecting; Buffing

Objectives

- Calculate the area of a floor.
- Explain why it is important to remove dry dirt before wet cleaning.
- Name the four methods for removing dry dirt and tell when each is used.
- Name the three kinds of mopping (wet cleaning) and tell when each is used.
- Explain how to clean a floor using an autoscrubber.
- Explain why pressure washing sometimes does a better job of cleaning floors than scrubbing does.
- Describe the process of disinfecting a floor.
- Explain how to dry buff and spray buff a floor using a floor machine.

Lesson 2: Floor Coatings

Topics

Why Floors Need Coatings; Strippers; Using Strippers Safely; Floor Sealers; Floor Finishes; Natural Materials in Floor Finishes; Synthetic Materials in Floor Finishes; One-Step Floor Care; Testing a Floor Finish; Test Evaluation

Objectives

- List four reasons floors need coatings.
- Name the two kinds of floor strippers and tell when each is used.
- Describe the precautions that you must take when using solvent-base strippers.
- Explain the purposes of floor sealers.
- Tell why it is important that a sealer and finish have the same kind of base.
- List the properties of a good floor finish.
- Explain how to test and evaluate a floor finish.

Lesson 3: Periodic Floor Care Tasks

Topics

Scrubbing; Stripping; Etching; Screening; Sanding; Sealing; Refinishing; Safety in Refinishing Floors

Objectives

- List the equipment needed and describe the procedures used for scrubbing.
- List the equipment needed and describe the procedures used for stripping various floor coatings from different kinds of floors.
- Describe the processes of etching, screening, and sanding, and explain why each is used.
- Tell when to use water-base sealers and when to use solvent-base sealers, and explain how each is applied.
- Name the three basic types of floor finishes and tell how each is applied.
- Explain at least three safety points to remember when refinishing floors.

Lesson 4: Choosing a Floor Care Method

Topics

Resilient Flooring; Natural Hard Flooring; Synthetic Hard Flooring; Wood Flooring; Cork Flooring; Iron and Steel Flooring; Conductive Floors; Pedestal Floors

Objectives

- Describe the procedures and name the chemicals used for routine and periodic maintenance of resilient flooring.
- Describe the procedures and name the chemicals used for routine and periodic maintenance of concrete, terrazzo, marble, and other natural hard flooring.
- Describe the procedures and name the chemicals used for routine and periodic maintenance of synthetic hard flooring.
- Describe the procedures and name the chemicals used for routine and periodic maintenance of wood and cork flooring.
- Describe the procedures and name the chemicals used for routine and periodic maintenance of iron and steel flooring.
- Describe the procedures and name the chemicals used for routine and periodic maintenance of conductive and pedestal floors.

Lesson 5: Floor Care Problems

Topics

Resilient Flooring Problems; Problems Refinishing Resilient Flooring; Problems With Hard Flooring; Wood Flooring Problems; Adjusting Conductive Floors; Floor Stains

Objectives

- Identify resilient flooring problems and explain how to avoid and correct them.
- Describe problems encountered in the refinishing of resilient flooring and tell how to avoid and correct them.
- Identify hard flooring problems and explain how to avoid or correct them.
- Define warping and tell how to avoid it.
- Explain how to adjust the conductivity of conductive floors.

Maintaining Floors and Other Surfaces

Lesson 6: Other Cleaning Tasks

Topics

Emptying Trash; Maintaining Ashtrays; Dusting; Cleaning Lamps and Light Fixtures; Washing Walls; Caring for Wooden Furniture; Washing Windows and Mirrors; Cleaning Metal Surfaces; Cleaning Blinds; Cleaning Elevators; Cleaning Chalkboards and Dry-Mark Boards; Cleaning Drinking Fountains; Maintaining Kitchens

Objectives

- Explain the procedures for emptying trash cans and ashtrays, and tell why it is important to empty them daily.
- Describe the tools you need for dusting, and list the reasons why dusting is important.
- Discuss the cleaning procedures for lamps and lighting fixtures, drinking fountains, and wooden furniture.
- Describe the two methods for washing walls, and tell when to use each method.
- Explain how to keep a chalkboard clean.
- List the steps in cleaning a kitchen.

Rest Room Care

Course 454: Rest Room Care

Covers the fundamentals of rest room design and construction and the elements of routine rest room cleaning. Covers the specifics of cleaning rest room plumbing fixtures. Describes the periodic tasks required to keep rest rooms in good condition. Finally introduces the trainee to the topic of disinfection, its important in rest rooms, and methods of performing this task safely.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Rest Room Basics

Topics

Rest Room Design and Location; Rest Room Surfaces; Rest Room Floors; Rest Room Walls; Rest Room Ceilings; Plumbing Fixtures; Sinks; Specialized Sinks; Toilets; Urinals; Showers & Tubs; Public Rest Rooms; Factory and Shop Rest Rooms; Sports Arena Rest Rooms; Hospital Patient Rest Rooms; Food Service Rest Rooms

Objectives

- List the three kinds of rest room surfaces that you must clean, and tell how to clean each type.
- Describe the different rest room flooring materials, and tell how to recognize and clean each one.
- Describe the common types of walls and ceilings in rest rooms, and tell how to care for each one.
- Name the common types of rest room plumbing fixtures, and describe the features of each.
- Describe the differences among rest rooms in different kinds of buildings.

Lesson 2: Routine Rest Room Cleaning

Topics

Rest Rooms Must Be Germ Free; Preparing Cleaning Supplies; Clearing the Rest Room; Blocking the Rest Room; Removing Trash; Cleaning Ashtrays; Restocking a Rest Room; Cleaning Above-Floor Surfaces; Dry Cleaning Rest Room Surfaces; Wet Cleaning Rest Room Surfaces; Cleaning Plumbing Fixtures; Cleaning the Rest Room Floor; Taking Care of Cleaning Equipment

Objectives

- Explain how to gather and prepare supplies needed for routine cleaning tasks.
- Explain how to clear and block a rest room for daily cleaning.
- Explain how to remove trash from a rest room's trash cans, sanitary napkin disposals, and ashtrays.
- Explain how to restock paper products and hand soap.
- List the correct sequence of steps for cleaning the surfaces of a rest room.
- Explain daily dry cleaning and wet cleaning procedures for above-floor surfaces of a rest room.
- Explain procedures for daily cleaning of a rest room floor.

Lesson 3: Cleaning Plumbing Fixtures

Topics

Germs and Plumbing Fixtures; Equipment for Cleaning Sinks; Chemicals for Cleaning Sinks; How to Clean Sinks; Equipment for Cleaning Toilets; Chemicals for Cleaning Toilets; How to Clean Toilets; Equipment for Cleaning Urinals; Chemicals for Cleaning Urinals; How to Clean Urinals; Equipment for Cleaning Showers and Tubs; Chemicals for Cleaning Showers and Tubs; How to Clean Showers and Tubs

Objectives

- Explain safety precautions that you must take to protect yourself when cleaning plumbing fixtures.
- List the equipment and chemicals needed for cleaning sinks.
- Explain the proper procedure for cleaning sinks.
- List the equipment and chemicals needed for cleaning toilets and urinals.
- Explain the proper procedure for cleaning toilets and urinals.
- List the equipment and chemicals needed for cleaning showers and tubs.
- Explain the proper procedure for cleaning showers and tubs.

Lesson 4: Periodic Rest Room Cleaning

Topics

Frequency of Periodic Cleaning Tasks; Rest Room Ceilings; Washing Ceilings by Hand; Washing Ceilings with a Machine; Vacuuming Ceilings; Rest Room Walls and Partitions; Removing Graffiti from Walls; Washing Walls and Partitions by Hand; Washing Walls and Partitions with a Machine; Rest Room Floors; Scrubbing Rest Room Floors with Drains; Scrubbing Rest Room Floors without Drains; Pressure Washing Rest Room Floors; Stripping Rest Room Floors; Refinishing Rest Room Floors

Objectives

- Tell how often to clean rest room ceilings, walls, and partitions.
- Explain how to wash rest room ceilings by hand and with a machine.
- Tell which ceilings must be vacuumed and explain how to vacuum ceilings.
- Explain how to remove graffiti from rest room walls, and how to wash rest room walls and partitions.
- Tell how to scrub, pressure wash, strip, and refinish a rest room floor.
- Explain the difference between scrubbing and/or pressure washing a rest room floor that has a drain and one that does not.

Rest Room Care

Lesson 5: Rest Room Disinfection

Topics

What is Disinfection?; Germ Size and Growth; Conditions for Germ Life and Growth; Movement and Transfer of Germs; Chemicals That Kill Germs; Kinds of Cleaner/Disinfectants; Rest Room Odors; How to Disinfect Correctly; Applying Cleaner/Disinfectants; Aseptic Cleaning Method; Frequency of Disinfection

Objectives

- Describe germs in terms of size and reproduction.
- Tell what conditions germs need to live, grow, and multiply, and relate these conditions to rest rooms.
- Explain how germs move from one place to another in a rest room.
- List the kinds of disinfectants that kill germs, or stop them from growing.
- Contrast resident and transient odors in a rest room, and explain how to prevent resident odors.
- Explain how, why, and when to use deodorants in a rest room.
- Tell why disinfection must be done, how often it should be done, and how to do it correctly.

Carpet and Upholstery Care

Course 455: Carpet and Upholstery Care

Covers the many kinds of carpet in use today. Explains the importance of preventive maintenance. Gives step-by-step explanations of the various carpet-cleaning methods available, explaining which is best to use on different types of carpet. Covers stretching, bleeding, insect attack, and many other carpet problems, and suggests remedies. Concludes with a lesson on upholstery fabrics and their care.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Carpet Materials and Construction

Topics

A Brief History of Carpet; Definition of Carpets and Rugs; Carpet Construction; Pile Yarn Fibers; Backing Yarn Fibers; Types of Carpets; Carpet Padding; Padding Materials; Carpet Installation; The Effect of Carpet Color

Objectives

- Name the different parts of a carpet and explain the function of each.
- Compare the natural and synthetic fibers used in carpet yarns, and list the advantages and disadvantages of each.
- Describe the construction of the major types of carpet.
- Explain why padding or cushioning is used under carpet, and describe the different padding materials, both natural and synthetic.
- Explain how problems can develop in a carpet that is not installed correctly.

Lesson 2: Preventive Maintenance and Routine Carpet Cleaning

Topics

Why Carpets Need Care; Keeping a Carpet Clean; Dirt-Catching Devices; Policing; Routine Vacuuming; Vacuum Cleaners; Routine Carpet Sanitizing; Static Electricity Treatment; Protecting Carpet Yarn from Crushing

Objectives

- Name the sources of soil that make a carpet dirty.
- Name the common types of dirt-catching devices, and explain how each works and where it is used.
- List the steps that you should take to police an area for preventive carpet maintenance.
- Explain how weekly vacuuming differs from daily vacuuming, and tell what kind of equipment is used for each.
- Name the parts of a vacuum cleaner, and explain how the vacuum works.
- Explain how to care for carpet in germ-sensitive areas.
- List conditions that lead to static buildup, and explain how carpets can be treated to prevent it.
- Describe the devices that prevent furniture and chair legs from crushing carpet yarn.

Lesson 3: Periodic Carpet Cleaning

Topics

The Need for Shampooing Carpet; Frequency of Shampooing; Shampooing Methods; Making an Area Ready for Shampooing; Water Extraction; Features of Water Extraction; Dry Powder; Features of Dry Powder; Dry Foam Shampooing; Features of Dry Foam Shampooing; Wet Foam Shampooing; Features of Wet Foam Shampooing; Periodic Carpet Sanitizing; Soil Retardants; Stain-Resistant Carpet

Objectives

- List the factors that help to determine how often you should shampoo a carpet.
- Name the four most common carpet shampooing methods.
- Explain how to make an area ready for shampooing.
- Describe each of the following shampooing methods: water extraction, dry powder, dry foam, and wet foam.
- List advantages and disadvantages of each of the above shampooing methods.
- Explain how to “set the pile” of a carpet after shampooing and tell why it is important.

Lesson 4: Carpet Care Problems

Topics

Carpet Problems Requiring Special Care; Uneven Wear; Stretching, Buckling, and Rippling; Seam Problems; Shedding, Sprouting, and Pilling; Bleeding; Shading; Color Fading; Rapid Soiling; Crushed Pile Yarns; Mildew; Electric Shocks and Sparking; Insect Attack; Stain Removal; Cigarette Burns; Spot Repairs

Objectives

- Describe several ways of dealing with uneven carpet wear.
- Define the terms stretching, buckling, and rippling.
- Describe the problems that can occur in carpet seams.
- List the carpet problems commonly handled by a custodian as well as those that require the services of an expert.
- Explain how the problems of shedding, sprouting, and pilling differ.
- Name the five most common causes of rapid carpet soiling.
- Explain how to repair crushed pile yarns, cigarette burns, and mildew in carpet.
- Explain the step-by-step procedure for removing an unknown stain from a carpet.

Carpet and Upholstery Care

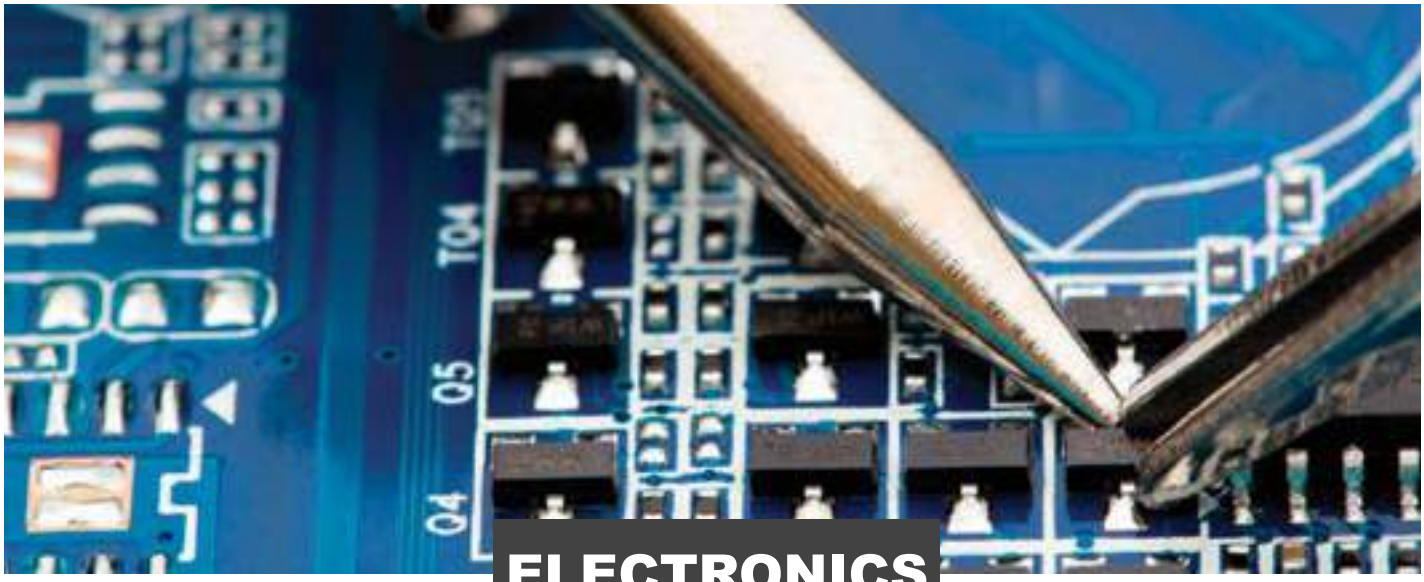
Lesson 5: Upholstery Care

Topics

Types of Upholstery Fabrics; Natural Fiber Materials; Synthetic Fiber Materials; Properties of Yarns; The Importance of Weave and Texture; Nonwoven Fabrics; Padding and Filling Materials; Routine Upholstery Care; Shampooing Upholstery; Upholstery Treatments; Upholstery Problems

Objectives

- List the natural and synthetic fibers most frequently used in upholstery fabrics.
- Name the tasks that you should perform as part of daily and weekly upholstery care.
- List the procedures and materials that you should use to remove stains from upholstery.
- Explain why it is important to know what padding or filling materials are underneath upholstery before you shampoo it.
- Describe the step-by-step procedure for preparing to shampoo upholstery.
- Describe wet foam, dry foam, water extraction, and liquid dry cleaning shampooing methods.
- Explain how to solve common upholstery problems, and recognize when to call an expert.



ELECTRONICS

The Electronics Series is designed to help trainees understand the basics of electronic systems, especially those used in industry. It lays the foundation for the trainee's work with electronic building blocks, from simple diodes to complex ICs. The series explains how semiconductor devices work and how components are combined to perform tasks, including amplification, oscillation, and signal and power supply regulation. It emphasizes good practices to keep systems running as they should and proper methods for troubleshooting and repair if they do not. The final course in this series provides the foundation for an understanding of how logic circuits work. It progresses from simple Boolean logic function - AND, OR, NOT, NAND, and NOR gates - to applications in today's common logic systems.

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Semiconductors

Course 251: Semiconductors

Describes semiconductor operation, various diodes, and transistors. Stresses proper environmental conditions, minimizing electrostatic discharge (ESD) and radio frequency interference (RFI). Discusses printed circuit board (PCB) and integrated circuit (IC) technology. Identifies semiconductor packages. Explains how to interpret manufacturers' spec sheets and analyze circuit performance by Q points and characteristics.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Introduction to Semiconductors

Topics

Electron Flow and Semiconductors; Semiconductor Materials; Structure of Semiconductors; Semiconductor Doping; Conventional vs Electron Flow; Junction Diodes; Diode Characteristic Curves; Diode Specifications; Light-Emitting Diodes; Photoelectric Devices

Objectives

- Discuss the basic structure of a semiconductor atom and the movement of free electrons and holes.
- Discuss the purification and doping of semi-conductors.
- Describe the p-type region, n-type region, and junction of a pn junction diode.
- Discuss the characteristic curves and specification ratings of a diode.
- Describe the operation of a light-emitting diode, a photoconductive device, and a photovoltaic device.

Lesson 2: Environmental Conditions

Topics

Semiconductors and the Environment; Temperature Protection; Electrostatic Discharge (ESD); Controlling Static Electricity; Wrist Straps; Work Area; Static-Free Workstation; Tools and Techniques; Shipping and Receiving Semiconductors; Line Power Conditioning; Radio Frequency Interference (RFI); Electromagnetic Interference (EMI)

Objectives

- Discuss the importance of various environmental conditions to semiconductor operation.
- Discuss the effect of ESD on semiconductor devices and list several ways of preventing ESD in any work area.
- Discuss the requirements of a static-free workstation, and the proper techniques for using tools at the workstation.
- Describe ways to minimize ESD problems during packing and shipping.
- Explain how power conditioning prevents line power problems.
- Describe ways of preventing damage from radio frequency interference (RFI) and electromagnetic interference (EMI).

Lesson 3: Printed Circuit Boards

Topics

Printed Circuits; Printed Circuit Boards; Materials for Boards and Conductors; Single-Sided PCBs; Double-Sided PCBs; Multilayer PCBs; Mounting Components; Surface Mount Technology; Soldering; PCB Connectors; Mounting PCBs; Repairing PCBs; PCB Surface Contamination and Corrosion

Objectives

- Discuss the advantages of PCBs over direct wiring.
- Explain why both flexible boards and rigid boards are used for printed circuits, and discuss the advantages and disadvantages of each.
- Explain how single-sided, double-sided, and multilayer boards are made.
- Describe the three classes of surface mount assemblies.
- Compare various soldering methods and discuss the advantages and disadvantages of each.
- Describe PCB connectors and mountings.
- Discuss PCB repair techniques and limitations.

Lesson 4: Transistors and Integrated Circuits

Topics

Purpose of Transistors; Structure of Transistors; Schematic Symbols; Performance Curves; Transistor Connections; Transistor Characteristics; Transistor Specifications; Transistor Switching; Integrated Circuits; Classifying ICs by Structure; Classifying ICs by Function; Other IC Classifications

Objectives

- Describe the differences between an npn transistor and a pnp transistor and identify the schematic symbol for each.
- Discuss transistor performance in the active region, saturation region, and cutoff region.
- Explain how the three kinds of transistor connections affect circuit values.
- Discuss four common transistor characteristics.
- Discuss various ways of classifying integrated circuits.

Lesson 5: Packages and Performance Analysis

Topics

Semiconductor Packages; Lead Identification; Mounting Components on Chassis and PCBs; Replacement Methods; Manufacturers' Data Sheets; Maximum Ratings; Electrical Characteristics; Transistor Operating Points; Analysis of Characteristics

Objectives

- Describe several kinds of semiconductor packages.
- Explain how to identify leads.
- Describe methods for mounting components on PCBs and chassis.
- Explain how to use manufacturers' data sheets.
- Discuss the analysis of circuits by Q points and by characteristics.

Power Supplies

Course 252: Power Supplies

Covers the four basic kinds of power supply conversions. Explains how to work with nonchemical cells as well as primary and secondary cells of various materials. Describes in detail the functions and operation of several kinds of rectifiers, filters, and voltage regulators and explains how they work together as power conditioners. Discusses basic tools, test devices, and procedures for troubleshooting.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Power Supplies and Power Conditioners

Topics

Functions of Power Supplies and Power Conditioners; AC-to-DC Power Supplies; AC-to-AC Power Supplies; AC-to-DC Power Supplies (Rectifiers); DC-to-AC Power Supplies (Inverters); Inverter Feedback Circuits; Power Conditioners; Safety Precautions

Objectives

- Discuss the basic functions of power supplies and power conditioners.
- Describe dc-to-dc, ac-to-ac, ac-to-dc, and dc-to-ac power supplies.
- Compare the operation of transformer-driven and oscillator-driven inverters.
- Discuss the functions of filters, voltage regulators, voltage dividers, switching power supplies, zand ferroresonant power supplies.
- Explain why low voltages can be dangerous.

Lesson 2: Cells and Batteries

Topics

Cells and Batteries; Electrochemical Cells; Kinds of Chemical Cells; Primary Cells; Secondary Cells; Lead-Acid Cells; Nickel-Cadmium Cells; Nickel-Metal-Hydride Cells; Nickel-Iron Cells; Maintenance of Chemical Cells; Hazards and Precautions; Nonchemical Cells; Cell and Battery Development

Objectives

- Explain the difference between a battery and a cell and identify symbols for each.
- Describe the parts of an electrochemical cell.
- Compare the characteristics and uses of Leclanché, high-energy, and alkaline carbon-zinc cells.
- Discuss battery-recharging problems and explain how to check for overcharging.
- Discuss ways to maintain and dispose of chemical cells and batteries safely.
- Discuss the use of five kinds of nonchemical energy sources and recent developments in cells and batteries.

.Lesson 3: Rectifiers

Topics

Diode Rectifiers; Diode Ratings; Parallel Diodes; Series Diodes; Silicon-Controlled Rectifiers (SCRs); Half-Wave Rectifiers; Full-Wave Rectifiers; Bridge Rectifiers; Three-Phase Rectifiers; Voltage Multipliers

Objectives

- Define the term rectifier.
- Explain how to interpret diode ratings on a manufacturer's specification sheet.
- Compare the effects of connecting diodes in parallel and in series.
- Describe the operation of a silicon-controlled rectifier.
- Compare the operation of half-wave and full-wave rectifiers.
- Discuss the operation of bridge and three-phase rectifiers and explain how voltage multipliers work.

Lesson 4: Filters

Topics

Kinds of Filters; Filters and Circuits; Ripple; Circuit Components; Kinds of Power Supply Filters; Bleeder Resistors; Bypass Filters; Input Filters

Objectives

- Name several kinds of filters used in power supplies.
- Discuss the effects of ripple and describe ways ripple is measured.
- Discuss the use of capacitors, inductors, and resistors in filter circuits.
- Compare the advantages and disadvantages of capacitance, inductance, RC, and LC power supply filters.
- Explain why capacitor power supplies should include bleeder resistors.
- Discuss the uses of bypass filters and input filters.

Lesson 5: Voltage Regulators

Topics

Voltage Regulators; Shunt Regulators; Series Regulators; Integrated Circuit (IC) Regulators; Switching Regulators; Primary Circuit Regulators

Objectives

- Discuss the purposes of voltage regulators in power supplies.
- Explain the function of the control circuit and the current limiting circuit in series voltage regulators.
- Discuss the advantages of IC voltage regulators.
- Describe the operation of switching regulators and explain how it differs from that of other kinds of regulators.
- Discuss the use of SCRs and triacs in primary circuit regulators.

Lesson 6: Troubleshooting Power Supplies

Topics

General Troubleshooting Approach; Preliminary Checks; Power-Off Visual Inspection; Power-Off Fuse Tests; Power-On Tests; Output Tests; Section Tests and Part Tests

Objectives

- Discuss at least five kinds of test equipment and tools used to troubleshoot power supplies.
- Describe the three main steps in troubleshooting a power supply.
- Describe the basic procedures for preliminary checks and power-off visual inspection and fuse tests.
- Describe the basic procedures for power-on tests and output tests.
- Explain how to perform section tests and part tests.

Amplifiers

Course 253: Amplifiers

Covers the effects of gain, bandwidth, and distortion on performance. Compares linear and nonlinear amplifiers. Explains using transistor curves to analyze amplifier operation by region, load line, operating (Q) points, and biasing. Discusses impedance matching, comparing capacitive, transformer, and direct-coupled amplifiers. Provides methods for troubleshooting common amplifier problems.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Introduction to Amplifiers

Topics

Amplifying Circuits; Amplifier Characteristics; Transistor Amplifiers; Transistor Characteristic Curves; Effects of Temperature; Operational Amplifiers; Switching Amplifiers

Objectives

- Explain how gain, bandwidth, and distortion relate to amplifier operation.
- Compare bipolar transistor amplifiers and FET amplifiers.
- Explain how to use characteristic curves to predict transistor performance.
- Explain how to use an input/output curve to determine transistor gain.
- Discuss the effect of ambient temperature on amplifier performance.
- Discuss the uses of operational amplifiers and switching amplifiers.

Lesson 2: Single-Stage Amplifiers

Topics

Operating Region; Biasing Circuits; Operating Points and Load Lines; Biasing Common-Emitter Amplifiers; Biasing Common-Collector and Common-Base Amplifiers; Biasing Field-Effect Transistor Amplifiers; Amplifier Classifications; Push-Pull Amplifiers

Objectives

- Discuss the transistor characteristics that define operating region limits.
- Explain how to draw an amplifier load line.
- Explain how to find the operating point of an amplifier.
- Discuss biasing as a means of establishing a stable operating point in an amplifier circuit.
- Discuss five ways that amplifiers can be classified and compare Class A, AB, B, and C amplifiers.

Lesson 3: Amplifier Performance and Multistage Amplifiers

Topics

Amplifier Performance; Power Gain and Amplifier Efficiency; Current Gain; Voltage Gain; Distortion; Impedance Matching; Multistage Amplifiers; Multistage Amplifier Gain; Multistage Amplifier Bandwidth; Amplifier Coupling; Capacitive Coupling; Transformer Coupling; Direct-Coupled Amplifiers

Objectives

- Explain how to calculate amplifier power gain, efficiency, current gain, and voltage gain.
- Explain how nonlinearity and clipping cause amplifier distortion.
- Discuss the importance of impedance matching in interconnecting circuits.
- Explain how to calculate multistage amplifier gain and bandwidth.
- Compare the advantages and disadvantages of capacitive-coupled, transformer-coupled, and direct-coupled amplifiers.

Lesson 4: Op Amps

Topics

Differential Amplifiers; Typical Op Amp; Inverting Amplifiers; Summing Amplifiers; Noninverting Amplifiers; Op Amp Frequency Effects; Nonlinear Op Amp Circuits; Integrators; Comparators; Squaring Circuits

Objectives

- Describe the operation of differential amplifiers.
- Compare the properties of an ideal op amp and a typical actual op amp.
- Describe the operation of inverting amplifiers in terms of virtual ground.
- Compare the advantages of inverting amplifiers and noninverting amplifiers.
- Explain how integrators and comparators work.
- Explain how zener diodes are used in squaring circuits.

Lesson 5: Troubleshooting Amplifiers

Topics

Troubleshooting Single-Stage Amplifiers; Troubleshooting by DC Analysis; Troubleshooting by AC Analysis; Troubleshooting Three-Stage Amplifiers; Troubleshooting Trees; Troubleshooting Procedures; Measuring Gain; Measuring Power Supply Performance; Troubleshooting Components; Troubleshooting Operational Amplifiers

Objectives

- Describe basic procedures for troubleshooting single-stage and multistage amplifiers.
- Explain how dc analysis, ac analysis, and troubleshooting trees are used in amplifier maintenance.
- Explain how to measure amplifier gain and power supply performance.
- Describe the procedures for troubleshooting resistors, capacitors, and op amps.

Oscillators

Course 254: Oscillators

Covers how oscillation is started and maintained. Compares sine-wave oscillators and square-wave switching circuits. Discusses monostable, astable, and bistable flip-flop operation;Schmitt trigger circuits, frequency dividers, ripple counters, propagation delays, and glitches. Describes operation of low-, high-, and band-pass filters; and, how to troubleshooting oscillator components and circuits.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Introduction to Oscillators

Topics

Oscillation; Oscillators and Amplifiers; Classes of Oscillators; LC (Tuned) Circuits; RC (Phase-Shift) Oscillators; Crystal Oscillators; Comparison of Oscillators; Common Oscillator Circuits

Objectives

- Describe the conditions needed to start and to sustain oscillation.
- Explain how positive feedback affects oscillation.
- Name three kinds of feedback networks used in oscillators.
- Discuss the advantages and disadvantages of tuned circuits, phase-shift oscillators, and crystal oscillators.
- Describe several common oscillator circuits.

Lesson 2: Flip-Flops

Topics

Square Waves; Switching Circuit; Kinds of Flip-Flops; One-Shots; Integrated Circuit (IC) One-Shots; Astable Flip-Flops (Multivibrators); Frequency of Multivibrators; IC Astable Circuit from One-Shots; Bistable Flip-Flops; IC Bistable Flip-Flops

Objectives

- Discuss the differences between sine wave oscillators and square wave switching circuits.
- Explain how rise time and the time constant affect flip-flop circuits.
- Compare the operation of discrete transistor one-shots and IC one-shots.
- Explain how IC pairs of one-shots or IC op amps form an astable multivibrator.
- Describe the operation of bistable flip-flops.

Lesson 3: Logic Clocks

Topics

Combinational Logic; Synchronous Logic; Logic Clock Generation; Negative Resistance Oscillator; Integrated Circuit (IC) Oscillator; Clock Conditioning; Schmitt Trigger Circuit; Frequency Dividers; Multiphase Clocks; Real-World Logic Clocks

Objectives

- Compare combinational logic, synchronous logic, and sequential logic.
- Explain how logic clocks are generated.
- Explain how negative resistance enables the UJT relaxation oscillator to be used as a logic clock.
- Discuss the effect of hysteresis on logic clock operation and describe the operation of the Schmitt trigger circuit.
- Describe the operation of ripple counters and other frequency dividers.
- Discuss problems caused by real-world (nonideal) logic clocks.

Lesson 4: Filters and Waveforms

Topics

Filters in Wave Shaping; Simple Filters; RC Low-Pass Filters; RL Low-Pass Filters; High-Pass Filters; Band-Pass Filters; Band-Reject Filters; Active Filters; Time Constants; Universal Time Constant Chart; Differentiators and Integrators; Function Generators

Objectives

- Discuss the composition of waveforms and explain how filters change the shapes of waveforms.
- Compare the frequency characteristics of low-pass and high-pass filters and of band-pass and band-reject filters.
- Discuss the calculation of time constants in timing circuits.
- Describe methods of creating and shaping complex waveforms, including the differentiator and integrator circuits.
- Explain briefly how digital waveforms are generated with a microprocessor.

Lesson 5: Troubleshooting Oscillators

Topics

Test Equipment; Troubleshooting Components; Troubleshooting Circuits; Troubleshooting Oscillators; Tracing Oscillator Operation; Troubleshooting Multivibrators; Troubleshooting One-Shots; Troubleshooting Bistable Flip-Flops; Troubleshooting Sequential Logic Circuits; Troubleshooting Clocks; Troubleshooting Frequency Dividers; Troubleshooting Filters

Objectives

- Discuss the basic requirements of four kinds of equipment used to test oscillators.
- Describe good general practices in troubleshooting oscillator components and circuits.
- Describe the steps in tracing oscillator circuit operation and selecting test points for monitoring waveforms.
- Discuss the steps in troubleshooting multivibrators, one-shots, and flip-flops.
- Discuss troubleshooting methods for sequential logic circuits, including clocks.
- Discuss troubleshooting methods for frequency dividers and filters.

Digital Logic Systems

Course 291: Digital Logic Systems

Compares analog and digital switching circuits. Explains Boolean logic functions. Describes TTL and CMOS logic, and IC logic devices. Explains how flip-flops, clock circuits, counters, multiplexers, and memory circuits work. Describes sections and interfaces in functional logic systems, including microprocessors. Describes proper methods for detection and correction of common fault potentials.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Digital Logic Fundamentals

Topics

Digital Logic; Boolean Algebra; Logical AND Function; Logical OR Function; Logical NOT Function; Digital Applications; Solid-State Switches; Positive and Negative Logic; NAND Logic; Combining Logic Circuits; TTL Logic; Integrated Circuit (IC) Logic Devices; 7400 Series TTL Logic; CMOS Logic

Objectives

- Explain the difference between digital and analog circuits.
- Describe AND, NOT, and OR logic functions.
- Explain how solid-state switches can perform logic functions.
- Compare equivalent NAND and NOR gates using positive and negative logic.
- Discuss the importance of TTL and CMOS circuits.

Lesson 2: Logic Building Blocks

Topics

Sequential Logic; Flip-Flops; Clocked Flip-Flops; Clock Circuits; Schmitt Triggers; Frequency Dividers; Pulse Counters; Decimal and Binary Number Systems; Other Number Systems

Objectives

- Describe the function of a logic clock.
- Explain the operation of a flip-flop.
- Discuss the differences among clocked R-S flip-flops, D-latches, and J-K master-slave flip-flops.
- Explain how to convert between the decimal and binary number systems.
- Discuss the use of BCD and the octal and hexadecimal number systems.

Lesson 3: Medium- and Large-Scale ICs

Topics

Integrated Circuits Defined by Size; Counters; Serial vs Parallel Data Transmission; Registers; Multiplexers; Decoders/Demultiplexers; Arithmetic Circuits; LSI Memories

Objectives

- Explain the operation of each of the following counters: ripple, BCD, synchronous, and up/down.
- Describe the operation of a shift register.
- Discuss the difference between multiplexers and decoders/demultiplexers.
- Define the terms read, write, serial access, and random access as they apply to memories.
- Discuss the purposes of RAM and ROM devices.

Lesson 4: Functional Logic Systems

Topics

Logic System Basics; Logic Subsystems; ROM Logic Subsystems; Microprocessors; Input/Output (I/O) Subsystems; Noncontact Switches; Multiple-Bit I/O Devices; Data Codes; Data Displays; Data Transfer

Objectives

- Describe the sections of a basic logic system.
- Compare a ROM, a PROM, and a PLA.
- Name the basic parts of a microprocessor.
- Describe common kinds of I/O interfaces and data displays.

Lesson 5: Troubleshooting Logic Systems

Topics

Reliability of Solid-State Components; External Faults; General Troubleshooting Practices; Gathering Information; Isolating the Problem to a Major Subsystem; Localizing the Trouble; Interpreting Logic Diagrams; Timing Waveforms; Locating Faulty Components; Test Equipment

Objectives

- Describe seven external faults that can affect solid-state circuits.
- List the major steps in efficient troubleshooting.
- Name information sources for identifying system malfunctions.
- Explain how to trace a faulty component by using a troubleshooting tree.
- Explain how to use various kinds of test equipment to pinpoint system faults.

ENERGY CONSERVATION

The Energy Conservation Series explains how to recognize where energy losses occur so that maintenance employees can take proper corrective measures to stop the losses. Trainees will learn about energy conservation in heating, ventilating, and air conditioning systems as well as in the building structure itself - walls, ceilings, and floors. In addition, the program demonstrates how to conduct an energy audit so trainees can quantify the options available and determine the payback period for each option.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
376: Energy Conservation Basics		✓		✓	132
377: Energy Losses in Buildings		✓		✓	133
378: Heating/Cooling System Efficiency		✓		✓	134
379: Mechanical Energy Conservation	✓	✓		✓	135
380: Electrical Energy Conservation	✓	✓		✓	136

Energy Conservation Basics

Course 376: Energy Conservation Basics

Covers energy sources and the history of energy usage. Examines alternative energy sources and their feasibility. Identifies current energy usage patterns and places where energy can be conserved. Explains how to recognize energy waste, and includes sample corrective actions. Explains how to conduct an energy survey.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Energy and its Sources

Topics

What is Energy?; How Fossil Fuels Developed; Mining and Drilling Methods; Putting Fossil Fuels to Work; Nuclear Power; Nuclear Reactors; Solar Energy; Converting Solar to Electrical Energy; Wind as an Energy Source; Hydroelectric Power; Evaluating Energy Sources; Measuring Energy

Objectives

- Define energy and list several potential energy sources
- Explain how fossil fuels developed and how they are extracted from the earth.
- Explain, in simple terms, how uranium produces energy.
- List at least one advantage and one disadvantage of each of the following: oil, natural gas, coal, solar power, wind energy, and hydroelectric power.
- Tell how heat and temperature are measured (what units).

Lesson 2: Why the Energy Crisis?

Topics

History of Energy Use; The Fossil Fuel Age Begins; America Strikes Oil; Other Traditional Sources; How Much Energy is Enough?; WWII and After; The End of Cheap Oil; World's Energy Record; Fossil Fuel Reserves; Increase in Coal Use; Fossil Fuels Produce More Than Energy; Alternative and Synthetic Fuels; Gas and Oil from Coal; Nuclear Fuels; Nuclear Fusion; Geothermal Energy Sources; Biomass

Objectives

- Define the fossil fuel age and list the energy sources that made it possible.
- Name some of the factors that contributed to the greatly increased use of fossil fuels in the past century.
- Describe the outlook for fossil fuel availability in the next century.
- Give examples of current efforts to develop alternative sources of oil and gas.
- Identify potential sources of future energy and describe their present limitations.

Lesson 3: Energy Consumption and Loss

Topics

Using Fuels to Generate Electricity; Fuels Most Often Used; Energy Losses in Consumer Areas; Effects of Climate on Energy Use; Degree-Days; Cooling Degree-Days; Using Degree-Day Figures; Where Can Energy Be Conserved?; More Savings; The Cost of Saving Energy; ROI and Payback Period; Establishing Priorities

Objectives

- Tell why generating electricity is an inefficient use of energy and what characteristics of electricity justifies this inefficiency.
- Compare energy use in the three categories of energy consumers.
- Explain degree-days and how they are used?
- State why a building's HVAC system is a good place to start looking for potential energy savings.
- Tell how to calculate the payback period of an energy conservation plan.

Lesson 4: Practical Conservation Measures

Topics

Recognizing Energy Waste in Building Structures; Correcting Energy Waste in Building Structures; Energy Loss in Heating and Cooling; Sample Heating/Cooling Corrective Measures; Energy Waste in Mechanical Systems; Some Energy Savers for Mechanical Systems; Recognizing Electrical Energy Waste; Electrical Conservation Examples; Electric Utility Charges; Computer Monitoring and Control

Objectives

- Recognize energy waste conditions in building structures.
- Name at least three factors that affect boiler and furnace efficiency.
- Give examples of energy waste in a building's mechanical system and how it might be eliminated.
- Explain peak demand and why it is important in electricity costs.
- Tell how computer monitoring and control can be used to save energy and lower utility costs.
- Tell how computer monitoring and control can be used to save energy and lower utility costs.

Lesson 5: Conducting an Energy Audit

Topics

What Is an Energy Audit?; Mini-Audits; Tools Required for the Energy Survey; Sample Energy Audit; Fuel Usage Information; Building and Equipment Data; Conservation Opportunities; Priorities

Objectives

- Name and describe the six segments of a detailed energy audit.
- Define a mini-audit and tell when it might be used.
- List the tools required for an energy survey of any building.
- Record the data necessary to make up an energy audit.
- Explain the procedure for assigning priorities to energy-saving projects.

Energy Losses in Buildings

Course 377: Energy Losses in Buildings

Covers physical laws of heat transfer and how they apply to building heat losses. Discusses effects of sun, wind, and shade on energy consumption in buildings. Examines different types of walls, roofs, windows, and flooring. Demonstrates how different forms of insulation can improve thermal resistance. Gives sample applications of energy conservation measures, illustrating how to determine cost and payback period.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Heat Flow Principles

Topics

Methods of Heat Transfer; Heat Flow in Structures; Detecting Heat Loss; Defining Heat Flow Terms; History of Insulation; Early Forms of Insulation; Industrial Insulation; The Building Envelope; Effect of Insulation; Environmental Considerations; Windbreaks, Foundation Plantings; Building Orientation

Objectives

- Distinguish between heat transfer by conduction, convection, and radiation.
- Explain the importance of infiltration in a building's heat loss/gain.
- Define thermal conductance, overall coefficient of heat transmission, and thermal resistance and how they relate to each other.
- Explain the concept of the building envelope
- Tell how environmental factors can affect the loss of gain of heat in a building.

Lesson 2: Heat Loss/Gain Through Roofs

Topics

Roof Construction; Insulating Characteristics of Roofs; Vapor Barriers; Ventilation; Types of Insulation and Applications; Checking Heat Leaks; Infrared Scanner; Payback Periods; Sample Calculations

Objectives

- Demonstrate how to arrive at the R value of a roof section.
- List the principal types of roof and ceiling insulation and the applications for which each is best suited.
- Name the two most effective precautions to take against moisture damage and give examples of their proper installation.
- Explain how and under what circumstances heat leaks can be detected in roof structures.
- Identify the facts needed for payback calculations and tell how to use them to determine payback periods.

Lesson 3: Minimizing Heat Flow Through Walls

Topics

Wall Construction; Totaling R Values; Construction Considerations for Insulating Materials; Eliminating Condensation; Vapor Barriers; Cold-Side Venting; Convective Looping; Insulating Foundations; Metal Walls; Insulating Metal Walls; U Values; Payback; Sample Calculation

Objectives

- Evaluate the merits of the common forms of insulation as applied to wall construction.
- Identify at least two types of vapor barrier and tell when each would be used.
- Explain convective looping and how to prevent it.
- Tell why metal buildings have special insulation needs and describe the techniques developed for them.
- Use payback calculations to determine which of two alternatives conservation measures is the more profitable.

Lesson 4: Heat Loss/Gain Through Windows and Doors

Topics

Infiltration; Window Heat Loss by Conduction; Corrective Measures; Caulking; Weatherstripping; Air Locks; Reducing Conductive Heat; Loss/Gain Through Windows; Hermetically Sealed Windows; Removable Storm Windows; Draperies; Solar Heat Gain; Preventing Heat Gain; Shading; Payback Calculations

Objectives

- Identify two forms of infiltration.
- Explain the valves of an air lock and describe a typical installation.
- Name at least three means of reducing conductive heat loss through windows.
- Tell why the angle of the sun is important in efforts to increase or minimize solar heat gain.
- State the reason for the lengthy payback period on most window retrofits.

Lesson 5: Controlling Losses Through Floors

Topics

Above-Grade Floors; Vapor Barrier for Above-Grade Floors; Ground Cover; Crawl Space Flooding; Crawl Space Ventilation; Below-Grade Floors; On-Grade Floors; Correct Surface Drainage; Effects of Floor Covering; Pipes and Duct Work; Payback Calculations; Slab-Foundation Retrofit; Wooden Overlay Retrofit

Objectives

- Describe the principal methods of insulating existing above-ground floors.
- Tell how to test for capillary rise in a crawl space.
- Point out the value of a ground-cover vapor barrier.
- List two ways to insulate on-grade or below-grade floors.
- Explain the special problems involved in calculating heat losses and payback periods for on-grade and below-grade floors.

Heating/Cooling System Efficiency

Course 378: Heating/Cooling System Efficiency

Covers the measurement of various environmental factors and their effect on human comfort. Introduces the concept of zones. Covers ventilation requirements and savings possible by reducing airflow. Examines energy waste vs. conservation measures relating to furnaces, boilers, air conditioners, and refrigeration equipment.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Conditioning the Air

Topics

Human Comfort; Environmental Factors Affecting Human Comfort; Heat Generated Within a Building; Thermal Zones; The Basic All-Air HVAC System; Types of All-Air HVAC Systems; Single-path Systems; Multiple-Path Systems; General Energy Conservation; Guidelines for HVAC

Objectives

- Explain the various environmental factors affecting human comfort.
- Interpret the ASHRAE comfort chart.
- Differentiate between sensible and latent heat.
- Explain the operation of the components in a basic al-air HVAC system.
- Name the different kinds of single-path and multiple-path HVAC systems, tell how each operates, and list ways to conserve energy in each type.

Lesson 2: Managing Airflow in HVAC Systems

Topics

Measuring Air Velocity and Volume Flow Rate; Air Pressure Within a Duct System; The Pitot Tube; Other Airflow Measuring Devices; Building Ventilation Requirements; Determining Ventilation Requirements; The Cost of Using Outside Air; Heat Recovery Systems; Exhaust Systems; Conserving Energy in Exhaust Systems; Maintaining System Components

Objectives

- Compare and contrast static pressure, velocity pressure, and total pressure.
- Define ventilation air and tell how to determine ventilation air requirements.
- Calculate the amount of energy needed to heat or cool outside air.
- Name four types of heat recovery systems and explain how each works.
- Explain where and why exhaust systems are used and how they may be installed.

Lesson 3: Conserving Energy in Heating Systems

Topics

Heating Units; Warm Air Furnaces; Boilers; Furnace and Boiler Maintenance; Energy Conservation in Furnaces and Boilers; Stack Gas Analysis; Purchased Steam and Hot Water; Metering Steam and Hot Water; Steam Traps; Steam Trap Maintenance; Humidifiers; Heating Controls Maintenance; Domestic Hot Water

Objectives

- Explain why good furnaces and boiler maintenance is an important part of an energy conservation program.
- Detail the types of maintenance required on various types of furnaces.
- Tell how to locate and correct energy waste in steam and hot water distribution systems.
- Explain the importance of steam traps and describe their operation and maintenance.
- List ways energy may be saved in humidification systems.

Lesson 4: Conserving Energy in Cooling Systems

Topics

Types of Refrigeration Equipment; Mechanical Compression Systems; The Vapor-Compression Cycle; Absorption Refrigeration Systems; The Absorption Refrigeration Cycle; External Refrigeration Controls; Internal Controls—Checking System Operation; Evaporator Temperatures; Condenser Temperatures; Equipment for Cooling Condensers; Cooling Towers; Evaporative Condensers; Air-Cooled Condensers; Water-Cooled Condensers; Self-Contained Air Conditioning Units; Heat Pumps; The Direct Use of Evaporative Cooling Systems; Refrigerators and Freezers

Objectives

- Compare and contrast the operation of a mechanical compression system and an absorption system.
- Define external and internal controls for refrigeration and give examples of each.
- Explain how evaporator and condenser temperatures influence energy consumption.
- Name several different methods for cooling condensers.
- Describe the basic operation of a heat pump and tell how it differs from other air conditioning systems.

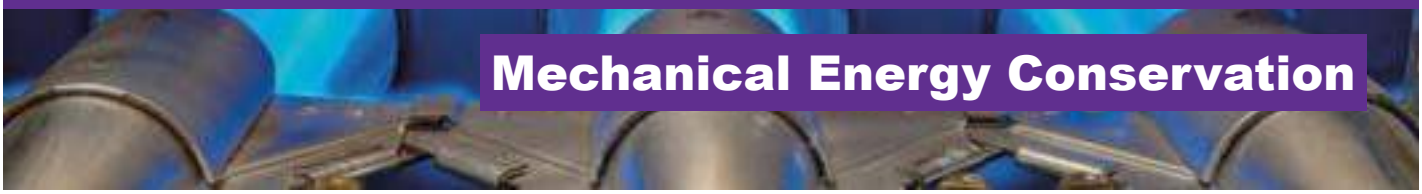
Lesson 5: Reducing Losses in Distribution Systems

Topics

The Nature of Fluid Flow; Reducing Distribution System Losses; Reducing Resistance to Air Movement; Fans; Insulating Air Ducting; Fluid Flow in Piping Systems; Balancing Hydronic Systems; Insulating Piping Systems; Centrifugal Pumps; Maintaining Centrifugal Pumps; Strainers in Hydronic Systems; Control Valves; Three-Way Control Valves; Maintaining Control Valves

Objectives

- Define the term fluid and discuss the importance of reducing a fluid's resistance to flow.
- List several ways to reduce flow resistance in air distribution systems.
- Discuss the purpose of insulating air ducting and tell how insulation is applied.
- Explain how flow resistance can be reduced in piping systems.
- Name several types of control valves, tell where each is used, and explain the importance of good valve maintenance.



Mechanical Energy Conservation

Course 379: Mechanical Energy Conservation

Covers causes and effects of friction and the importance of lubrication. Includes a discussion of efficient operation of materials handling systems, elevators, and escalators. Examines ways to conserve energy by reducing vibration. Explains importance of good maintenance of pumps, blowers, and compressors. Discusses vehicle efficiency, emphasizing tuneups, lubrication, and other energy-saving practices.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Reducing Friction

Topics

Mechanical Systems; Prime Movers; Mechanical Power Transmission; Mechanical Efficiency; Friction; Coefficient of Friction; Reducing Friction; Lubrication; Gear and Bearing Oils; Greases; Seals; Manual Lubricating Devices; Natural Oil Lubrication Systems; Pressurized Oil Lubrication; Automatic Oil Lubricating Devices; Automatic Grease Lubrication Systems; Lubrication Precautions

Objectives

- Name the three basic parts of a mechanical system
- Explain the concept of mechanical efficiency.
- Give examples of the three basic kinds of friction encountered in mechanical systems.
- List at least four purposes of lubrication.
- Define viscosity, viscosity index, and pour point.
- Tell why oil and grease seals are used.

Lesson 2: Cutting Transmission Losses

Topics

Belt Drives; Chain Drives; Gear Drives; Bearings; Clutches and Brakes; Drive Couplings; Vibration; Balancing Machinery; Vibration Isolation; Vibration Switches

Objectives

- Explain why proper bearing lubrication is important.
- Name the drive component responsible for the most power loss.
- List three functions of couplings.
- Show how to check coupling alignment.
- Define vibration and explain why vibration control is important.
- Compare and contrast static unbalance and dynamic unbalance.

Lesson 3: Pumps, Fans, and Compressors

Topics

Pump Installation and Piping; Priming; Bearing Lubrication; Seals and Packing; Centrifugal Pumps; Vertical Turbine Pumps; Rotary Pumps; Reciprocating Pumps; Problems With Fans and Blowers; Improving Fan Performance; PM for Fans; Compressor Operation; Compressor Maintenance

Objectives

- Tell why proper pump installation is important to energy conservation.
- Describe the problems that can occur if pump bearing lubrication is neglected.
- Demonstrate the proper method of replacing pump packing.
- List the three major maintenance items related to centrifugal pumps.
- Identify several places where energy losses can occur in a fan system.
- Explain how to determine whether a fan is suited to the system in which it is operating.
- Name several maintenance procedures important to efficient compressor operation.

Lesson 4: Elevators and Conveyor Systems

Topics

Drive Packages; Conveyor Operation; Overhead Conveyors; Belt Conveyors; Roller Conveyors; Escalators; Elevators; Elevator Maintenance; Elevator Safety; Loading Docks

Objectives

- List at least two energy-saving tips to keep in mind when dealing with conveyor operation.
- Explain the purpose of a take-up in a conveyor system.
- Differentiate between unit-handling belt conveyors and bulk-handling belt conveyors.
- Tell how lagging can reduce energy waste.
- Name one type of conveyor that is not capable of wasting energy and explain some of its uses and limitations.
- List the three basic methods used to drive elevators.
- Identify common causes of energy waste at loading docks.

Lesson 5: Improving Vehicle Efficiency

Topics

Opportunities for Improvement; Vehicle Selection; Tires; Internal Combustion Engine or Electric?; Gasoline or Diesel?; Vehicle Operation; Maintenance and Repairs; The PM Program; Vehicle Maintenance—General; IC Engine Maintenance; Electric Vehicle Maintenance

Objectives

- Name the three basic areas offering energy conservation opportunities in vehicles.
- Explain why it is important to use the correct conservation opportunities in vehicles.
- Compare and contrast the applications of IC engine and electric vehicles.
- List as least ten tips for fuel-conscious vehicle operations.
- Describe what a PM program involves and tell why it is important.
- Tell why air cleaner care is important to an energy conservation program.
- Explain the importance of battery maintenance in an electric vehicle.

Electrical Energy Conservation

Course 380: Electrical Energy Conservation

Covers electrical energy consumers in typical commercial and industrial facilities. Investigates utility rate structures and relates cost to load management. Examines power factors, including how they are calculated and how they affect energy usage. Shows methods of conducting lighting surveys and how lighting fixture and lamp selection can impact electricity costs.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Surveying Electrical Consumption

Topics

Identifying Electricity Consumers; Determining System Efficiency; Using Electrical Metering; Justification for Metering; Meters; Meter Selection; Determining Consumption; Evaluating Examples Using Meters

Objectives

- Conduct an electrical energy audit.
- Determine the efficiency of an electrical system.
- Give three reasons for metering electric energy use.
- Name the three basic types of meters used in energy conservation work and explain how each is used.
- Differentiate between indicating and recording meters.

Lesson 2: Using Load Management Techniques

Topics

Electrical Quantities; Load Factor; Electric Bill Audit; Graphic Record of Demands; Equipment Audit; Target Demand; Methods of Control; Manual Control; Automatic Control; Demand Controllers; Electric Rates; Calculating the Cost of Electricity

Objectives

- Name the two metered quantities that determine the major part of an electric bill.
- Define power factor and load factor and explain why each is important.
- Show how to use meters to identify usage patterns ad peak usage periods.
- Compare and contrast manual and automatic demand control and give an example of each.
- Name several types of demand controllers and tell how each operates.
- Describe the way in which electric bills are calculated.

Lesson 3: Improving Electrical Equipment Efficiency

Topics

Energy, Watts, and the Electric Circuit; Electrical Quantities; Capacitors; Induction Motors; Motor Operation; Motor Efficiency; Determining Motor Loading; Variable-Speed Drives; Transformers; Energy-Saving Devices

Objectives

- Name the two familiar forms energy may take.
- List three elements of impedance in an ac system.
- Explain how power factor is calculated in a single-phase and a three-phase circuit.
- Tell why capacitors are important from an energy conservation standpoint and name three sources of capacitance in an electrical system.
- Explain the information found on a motor nameplate and tell how it relates to energy on a electrical system.
- Calculate load losses and no-load losses of motors, speed controls, and transformers.
- Evaluate the value of energy-saving devices.

Lesson 4: Conducting a Lighting Survey

Topics

The Importance of Lighting; Lighting Levels; Measuring Lighting Levels; A Lighting Survey; Improve Switching; Remove Existing Lighting; Replace Existing Lighting; Reduce Lamp Size; Improve Lighting Controls; Modify Work Stations; Provide Task Lighting; Use Natural Light

Objectives

- Explain the importance of a good lighting system.
- Define uniform lighting and selective task lighting and tell how they affect energy consumption.
- Determine recommended and actual lighting levels
- Distinguish between lumens and footcandles as measures of light.
- Give examples of ways in which switching modifications can be used to reduce energy consumption.
- Describe several ways to use natural lighting more efficiently.

Lesson 5: Evaluating Lamps and Fixtures

Topics

Lighting Fixtures and Their Maintenance; Incandescent Lamps; Fluorescent Lamps; Scheduling Lamp Replacement; Comparing Fluorescent and Incandescent Lamps; High Intensity Discharge Lamps; Mercury Lamps; Metal-Halide Lamps; High-Pressure Sodium Lamps; Low-Pressure Sodium Lamps; HID Lamp Maintenance and Replacement

Objectives

- Tell why cleaning lamps and fixtures is important.
- Compare and contrast incandescent and fluorescent lamps.
- Differentiate between R lamps and ER lamps.
- Name six types of lighting in order of efficacy.
- List advantages and disadvantages of each of the following types of high intensity discharge lighting: mercury, metal halide, HPS, and LPS.

FOUNDATIONS OF TECHNOLOGY

The Foundations of Technology Series provides job enrichment for those who would like to go beyond what is required on the job. It is intended for individuals who could benefit from a stronger understanding of basic science. The course presents some of the most fundamental concepts in physics, which support all of modern technology.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
391: Force and Motion					138

Force and Motion

Course 391: Force and Motion

Covers fundamentals of force and motion, showing how an engineer thinks about these concepts. Demonstrates how mathematical and graphical representations can help clarify our thinking about mechanical force and motion.

TPC Training is accredited by IACET to offer **0.8 CEU** for this program.

Lesson 1: Scalars and Vectors

Topics

Introduction to Physical Quantities; Locating Points on a Map; Vectoring a Trip on the Map; Properties of Vectors; Components of Vectors; Vector Sum; A Rule for Adding Vectors; Subtraction of Vectors; Vector Multiplication and Division

Objectives

- Explain the difference between scalars and vectors, and list examples of each.
- Draw a vector, given a verbal description.
- Describe a vector verbally, given its graphic symbol, a frame of reference, and an appropriate scale.
- Define resolution, resultant, and commutative.
- Demonstrate how to resolve a vector into its rectangular components.
- Demonstrate how to add and subtract vector quantities in one-dimensional and two-dimensional frames of reference.
- Multiply and divide a vector by a scalar.

Lesson 2: Motion Along a Straight Line

Topics

Speed; Velocity; Velocity and Slope; The Difference Between Speed and Velocity; Changing Velocity; Instantaneous Velocity; Constructing a Velocity-Versus-Time Graph; Finding Displacement; Using a Curved Graph

Objectives

- Explain the difference between speed and velocity.
- Define the terms instantaneous velocity, average velocity, and slope.
- Identify the delta notation, and explain how to use it in a calculation.
- Demonstrate how to determine displacement and velocity from a position-versus-time graph.
- Demonstrate how to determine displacement by calculating the area under a velocity-versus-time graph.

Lesson 3: Acceleration

Topics

Introduction to Acceleration; Directional Acceleration; Equations of Motion; Acceleration Due to Gravity; Upward and Lateral Motion During Free Fall

Objectives

- Define acceleration.
- Demonstrate how to determine the magnitude of an acceleration from a velocity-verses-time graph.
- Demonstrate the difference between average acceleration and instantaneous acceleration.
- Solve simple problems for average acceleration, displacement, and final velocity.
- Explain why the velocity-verses-time graph for all objects in free fall are parallel (when drawn on the same coordinate system).

Lesson 4: How to Describe Force

Topics

The How's and Why's of Motion; Definition of Force; Representation of Force; The Basic Forces of Nature; Action-Reaction Pairs; Newton's Third Law of Motion; Unbalanced Forces; Resolution of Forces

Objectives

- Define force.
- Name the four basic types of forces in nature.
- State Newton's Universal Law of Gravitation.
- Explain how and why vectors are used to represent forces.
- Explain Newton's Third Law of Motion.
- Give examples which demonstrate that forces always occur in action-reaction pairs.
- Demonstrate how to add force vectors.
- Describe how to resolve a force vector into its components.

Lesson 5: Force and Acceleration

Topics

Friction; Newton's First Law of Motion; "Resistance" to Acceleration; Newton's Second Law of Motion; Units of Force; Applications of Newton's Second Law; Conservation of Momentum; The Effect of Weightlessness

Objectives

- State Newton's First Law of Motion.
- Define inertia, and describe how it is measured.
- Explain why a force must be applied continuously to objects on earth in order to maintain their motion.
- Explain what happens when a net applied force is greater than the friction force.
- State Newton's Second Law of Motion.
- Solve problems using the equation F=ma.

Lesson 6: Equilibrium

Topics

Forces on Bodies; Particles in Static Equilibrium; Equilibrium of a Rigid Body; Center of Mass

Objectives

- State the two conditions of equilibrium, and distinguish between static and dynamic equilibrium.
- Explain the difference between particles and rigid bodies.
- Define torque.
- Solve problems involving torque and rotational equilibrium.

Force and Motion

Lesson 7: Rotational and Circular Motion

Topics

Centripetal Force; Rotational Motion; Angular Displacement and Radian Measure; Angular Velocity; Angular Acceleration; Tangential Acceleration; Moments of Inertia; Centrifugal Force; Conservation of Angular Momentum

Objectives

- Describe centripetal force.
- Differentiate between centripetal acceleration, angular acceleration, and tangential acceleration, and state the formula for each.
- Demonstrate how to convert degree measurements to radian measurements.
- Define the terms uniform circular motion, period angular velocity, angular impulse, angular momentum, and moment of inertia.
- Explain why moment of inertia is calculated differently for different objects.
- State Newton's Second Law in terms of rotational motion.
- Identify examples of the Law of Conservation of Angular Momentum.

Lesson 8: Simple Harmonic Motion

Topics

Periodic Motion; Projections of Circular Motion; Terminology of Simple Harmonic Motion; Causes of Harmonic Motion; Hooke's Law; Equations of Harmony; Resonance

Objectives

- Describe the relationship between simple harmonic motion and uniform circular motion.
- Define the terms cycle, amplitude, frequency, period, and Hertz.
- State Hooke's Law.
- Describe how acceleration and restoring force vectors change as an object moves in simple harmonic motion.
- Use equations to determine the period and frequency of both a mass-spring system and a pendulum.
- Give examples of resonance.

INDUSTRIAL HAZARD CONTROL

The Industrial Hazard Control Series covers OSHA's Hazard Communication Standard, detailing specific responsibilities for employers whose employees work with or around potentially hazardous materials. The course provides training materials to help comply with the standard. The materials are organized into a Program Manager's Guide and an Employee Training Manual.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
151: Chemical Hazards - OSHA's Hazard Communication Standard					141

Chemical Hazards

Course 151: Chemical Hazards

Covers OSHA'S Hazard Communication Standard. Discusses the physical and health hazards presented by dangerous chemicals. Explains the information contained in a Material Safety Data Sheet (MSDS).

TPC Training is accredited by IACET to offer **0.3 CEU** for this program.

Lesson 1: What the Standard Requires

Topics

The OSHA Standard; Goals of the Standard; What the Standard Requires; Identifying and Evaluating Chemical Hazards; Providing an MSDS; Labeling Hazardous Chemicals; Listing All Chemical Hazards; Informing and Training Employees; Exchanging Information with Contractors; Writing a Hazard Communication Program

Objectives

- Identify the goals of the Hazard Communication standard and the agency responsible for writing and enforcing the standard.
- Lost the eight fundamental actions required by the OSHA Hazard Communication standard and state the purpose of each.
- Explain the key requirements for carrying out each fundamental action.

Lesson 2: Types of Chemical Hazards

Topics

What Is a Chemical Hazard?; Physical Hazards; Health Hazards; Forms of Chemical Hazards; Exposure Routes; Key Factors That Affect the Degree of Hazard; Controlling Chemical Hazards; Detecting Exposure Hazards

Objectives

- Define chemical hazards covered by the Hazard Communication standard and the two categories into which they are divided.
- Identify the common physical forms of chemical hazards and the industrial operations that produce or release vapors, mists, dusts, and fumes.
- Name the three basic routes of exposure to health hazards.
- Explain the key factors that affect the degree of hazard.
- Discuss common methods of controlling chemical hazards.
- Explain how to detect exposure hazards and symptoms.

Lesson 3: Material Safety Data Sheets

Topics

What Is an MSDS?; Chemical Identification; Physical Data; Health Hazard Information; Physical Hazard Information; Fire and Explosion Hazards; Reactive Hazards; Special Protection Information; Special Precautions and Procedures

Objectives

- Explain the purpose, availability, preparation, and basic content of MSDSs.
- Give examples of the health hazard information contained in MSDSs and how it is used.
- Give examples of the physical hazard information contained in the MSDSs and how it is used.
- Describe typical MSDS instructions on special precautions and procedures.

MACHINE SHOP PRACTICES

Machine Shop Practices begins with an explanation of the types of tools, then proceeds immediately to step-by-step setup directions for turning and shaping operation. In-depth text materials are well-illustrated to make every point as clear as possible - all reinforced with the latest programmed learning techniques.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
315: Machine Shop Practice					143
316: Machine Shop Turning Operations					145
317: Machine Shop Shaping Operations					146
323: Machine Shop Job Analysis					147
324: Lathe - Turning Work Between Centers					148
325: Lathe - Machining Work in a Chuck					149
326: Basic Milling Procedures					150
327: Indexed Milling Procedures					151
328: Multiple-Machine Procedures					152

Machine Shop Practice

Course 315: Machine Shop Practice

Covers the principles of machining, measurement, tool grinding, and machine shop safety. Discusses the properties of metals, how to lay out and set up a job, how to use measuring devices such as the micrometer and vernier caliper, and how to read working drawings. Explains how to grind single-and multi-point tools.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Principles of Machining

Topics

The Need for Machine Tools; Modern Machine Tools; Metal Cutting Tools; Metals Machined in the Shop; How to Identify Steels; Properties of Metals; Changing the Hardness of a Metal; Case Hardening Cutting Metal; Cutting Fluids; Cutting Speeds and Feeds; Changing SFPM to RPM; Determining Feed Rates; Chip Color and Shape; Disposing of Chips

Objectives

- Name the two main classes of machine tools.
- Tell how to identify ferrous and nonferrous metals.
- Explain methods of identifying steels.
- Define the following terms: tensile strength, compressive strength, ductility; and malleability.
- Explain various heat treating processes used with metals.
- List the functions of a cutting fluid.
- Explain how to change sfpm to rpm.
- Describe the information you can gather from chip color and shape.

Lesson 2: Layout Work and Shop Safety

Topics

Using Shop Drawings; Scribing Lines on Metal; Outside and Inside Calipers; The Square; Measuring Angles; Surface Plates; The Surface Gauge; Aids to Layout Work; Making a Layout; Laying Out Boltholes in Flanges; Four-Bolt Flange Layout; Six-Bolt Flange Layout; Eight-Bolt Flange Layout; Shop Safety

Objectives

- Describe the tools commonly used for layout work in the machine shop.
- Explain the function of a surface plate.
- Define the terms bolt circle, pitch chord, and centerline.
- List the steps involved in laying out flange holes.
- Explain shop safety practices relating to eye protection, chip removal, and tool handling.

Lesson 3: Setup Tools

Topics

Holding Devices for Lathe Operations; Holding Work between Centers; Driving Work Mounted between Centers; Holding Lathe Work in a Chuck; Mounting a Chuck on a Lathe; Removing a Chuck from a Lathe; Practical Chuck Sizes; Holding Oddly Shaped Workpieces; Supporting the Workpiece; Collet Chucks; Steady Rests and Follower Rests; Holding Work on a Machine Table; T-Slot Bolts and T-Slot Clamps; Step Blocks; V-Blocks; C-Clamps, Angle Plates, and Planer Jacks; Parallels and Hold-Downs; Drill Press Vise; Milling and Planing Vises; Swivel Vises; Air/Hydraulic Vises; Magnetic Chucks; Safety Precautions for Setup Tools

Objectives

- Explain how to hold and drive work held between centers on a lathe.
- Explain how to hold lathe work in a chuck, and how to mount and remove a chuck from a lathe.
- Define the term swing as it relates to a lathe.
- Tell how to hold oddly shaped workpieces on a lathe
- Explain when each of the following is used: collet chuck, steady rest, and follower rest.
- Explain how each of the following is used to hold work on a machine table: T-slot bolts and clamps, step blocks, V-blocks, C-clamps, angle plates, and planer jacks.
- Tell when and how to use a vise to hold a workpiece.
- List safety precautions for setup tools.

Lesson 4: Setup Measurement

Topics

The Working Drawing; Sectional View on a Drawing; Dimensions and Their Values; Precision and Tolerance; Using the Steel Rule and the Scale; How to Hold a Micrometer; Reading a Micrometer; Reading a Vernier Micrometer; Reading a Metric Micrometer; Using a Vernier Caliper; The Sine-bar and Its Use; Gauge Blocks and Their Use

Objectives

- Explain the importance of having a working drawing when machining a part.
- Define the terms section and sectional view.
- Name the three systems of dimensioning.
- Define the terms precision and tolerance.
- Define the term fit, and compare actual fit, clearance fit, interference fit, and transition fit.
- Name the simplest measuring tool in the shop.
- Explain how to hold and read a micrometer.
- Tell how to use a vernier caliper, sine-bar, and gauge blocks.

Machine Shop Practice

Lesson 5: How to Grind Single-Point Tools

Topics

Materials for Tools; Basic Single-Point Tools; Parts of a Single-Point Tool; Direction of Cutting; Specifying a Tool Size; Relief Angles; Grinders for Single-Point Tools; Grinding Wheel Marking Code; Diamond Grinding Wheels; Grinding a Single-Point Tool Bit; Grinding Finishing Tools; Grinding Grooving Tools; Grinding Threading Tools; Grinding Carbide-Tipped Tools; Using a Silicon Carbide Wheel; Using a Diamond Grinding Wheel

Objectives

- Describe the various materials used for tools.
- Identify the parts of a single-point tool.
- List important specifications for single-point cutting tools.
- Name the two basic types of grinders and explain how they are used to sharpen single-point tools.
- Explain the standard marking system for grinding wheels.
- Describe the best way to grind carbide-tipped tools.

Lesson 6: How to Grind Multi-Point Tools

Topics

Construction of a Twist Drill; Wearing Parts of a Drill; Grinding a Drill by Hand; Checking the Drill Lips and Relief Angles; Thinning the Drill Web; Types of Milling Cutters; Grinding Milling Cutters; Grinding the Cutter Relief and Clearance; Grinding End Mills; Grinding Counterbores and Countersinks; Grinding Reamers

Objectives

- Describe the construction of a twist drill, including identification of its parts.
- Explain how to perform the following operations when grinding: check the drill lips, check the relief angles, and thin the drill web.
- List the three categories of milling cutters based on the way they are mounted on a milling machine.
- Name the most common type of milling cutter for maintenance work.
- Explain how to grind end mills, counterbores, and reamers.

Machine Shop Turning Operations

Course 316: Machine Shop Turning Operations

Covers the major types of lathes and their attachments, safety, maintenance, job preparation, and basic lathe operations. Discusses all facets of drilling and boring, types of drills and drill presses, milling machines, and job bores. Explains reaming and reamer terms. Covers threads and threading.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Lathes and Attachments

Topics

Engine Lathes; Principal Parts of a Lathe; Lathe Capacity; Lathe Gearing; Lathe Drive Systems; Holding Work in a Lathe; Steady Rest; Follower Rest; Using a Lathe

Objectives

- Explain the function of each of the following lathe parts: lathe bed, ways, headstock, tailstock, carriage, compound rest, and spindle.
- Name the two dimensions usually used to describe lathe capacity.
- List and describe several methods of holding work in a lathe.
- Explain the function of a steady rest and follower rest.

Lesson 2: Basic Lathe Operations

Topics

Setting Up a Lathe Job; Preparing the Stock; Centering the Stock; Aligning the Lathe Centers; Using the Steady and Follower Rests; Cutting Speeds; Feed Rates; Cutting Tools for Lathes; Turning Operations; Facing Operations; Boring Operations; Drilling and Reaming Operations; Milling Operations; Cutting Fluids and Coolants

Objectives

- Describe the factors to consider when selecting and preparing a piece of stock for a lathe job.
- Explain how to mount eccentric or irregularly shaped workpieces.
- Define the terms cutting speed and feed rate and list factors that affect each.
- Name two factors that affect the smoothness of a finishing operation.
- Explain the function of cutting fluid in lathe work.

Lesson 3: Drilling and Boring

Topics

Types of Drill Press; Types of Drills; Drill Numbering and Sizing; Setting Up Work on a Drill Press; Drill Speed Variation; Drill Feed Variation; Cutting Speeds and Feeds; Drilling Compounds; Drilling Holes; Drill Press Safety; Boring; Boring on Engine and Turret Lathes; Milling Machines and Jig Borers; Boring Blocks; Clamp the Workpiece Tight

Objectives

- Identify the main parts of a twist drill.
- Explain the step-by-step procedure for drilling a hole.
- Demonstrate how to convert speed in surface feet per minute to inches per minute.
- Describe safety precautions to observe when working with a drill press.
- Describe the boring procedure and tell when it is used.

Lesson 4: Reaming

Topics

Description of Reaming; Reamer Terms; Stock Allowances for Reaming; Machines for Reaming; Chucking or Machine Reamers; Shell Reamers; Hand Reamers; Adjustable Reamers; Expansion Reamers; Taper Reamers; High-Speed Steel Reamers; Carbide-Tipped Reamers; A Reamer for an Emergency; Selecting the Right Reamer; Reaming Speeds; Reaming Feeds; Using Reaming Fixtures; Cutting Fluids for Reaming; How to Avoid Chatter When Reaming; Reamer Troubleshooting; Counterboring; Countersinking; Spotfacing

Objectives

- Identify the main parts of a reamer.
- Tell what reaming method is best to use when a very accurate hole is required.
- Describe the benefits and uses of the following reamers: shell, hand, adjustable, expansion, taper, high speed steel, and carbide tipped.
- Explain how to remove burrs from the cutting edges or teeth of a reamer.
- Define counterboring, countersinking, and spotfacing.

Lesson 5: Threads and Threading

Topics

Threads and Fasteners; Common Thread Series; National or Unified National Threads; Thread Identification; Square Threads; Acme Threads; Buttress Threads; Multiple Threads; Pipe Threads; Repair or Replace Damaged Threads?; The Tapping Operation; Machine Tapping vs Hand Tapping; Suggestions for Tapping; Solid Tap Sets; Special Solid Taps; Pipe Taps; Selecting the Right Tap; Drilling a Hole to be Tapped; Tapping Blind Holes; Tapping Pipe Threads; Speeds and Feeds for Tapping; Cutting Fluids for Tapping; Tips on Tapping; Threading with Dies; Measuring Threads

Objectives

- Describe and state the uses of the following threads: National, square, Acme, and Buttress.
- Explain how the sizing of pipe threads differs from the sizing of other threads.
- Explain when to use each of the following taps: plug, taper, bottoming, spiral-pointed, spiral-fluted, and fluteless.
- Tell why cutting fields are used in tapping operations.
- Explain how to deal with long chips when tapping.

Machine Shop Shaping Operations

Course 317: Machine Shop Shaping Operations

Covers types of milling machines and milling operations. Covers spindles, arbors, feed rates, and safety precautions. Discusses shaper and planer operations—setup, maintenance, and safety procedures. Also introduces grinding, power sawing, and gear cutting operations.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Milling Operations

Topics

Types of Milling; Types of Milling Machines; Holding the Workpiece; Spindles; Arbors, Styles A and B; Arbors, Style C; End Mill Holders and Collets; Locating the Cutter; Determining Spindle Speed; Determining Feed Rates; Determining Direction of Feed; Cutting Fluids; Indexing; Safety Precautions for Milling Machine Operation

Objectives

- Explain the difference between peripheral milling and face milling.
- List the four types of knee-and-column milling machines.
- Explain how each of the knee-and-column machines works.
- Explain how a workpiece is held on a milling machine.
- Name and describe the three basic styles of arbor.
- Explain how the speed of a milling cutter is measured.
- Define indexing.

Lesson 2: Shaping and Planing

Topics

Introduction; Description of Shaping; Types of Shapers; Shaper Tooling; Cutting Fluids for Shaping Work; Cutting Speeds for Shapers; Setup Procedures for Shaper Operations; Typical Shaper Jobs; Angular and Internal Shaping; Description of Planing; Planer Construction; Planing Tools; Cutting Fluids for Planer Work; Planer Cutting Speeds and Feeds; Setup Procedures for Planer Operations; Safety Precautions for Shaping and Planing Operations

Objectives

- Compare and contrast shapers and planers.
- Explain the processes of shaping and planing.
- Explain how to select a shaper cutting fluid.
- Explain how shaper cutting speed is expressed.
- Explain how to check alignment of the shaper vise and ram.
- Explain how cutting fluids are applied to planer work.

Lesson 3: Grinding Operations

Topics

The Grinding Process; Types of Grinding Machines; Manual Grinding Operations; Grinding Wheels; Mounting a Grinding Wheel; Dressing and Truing a Grinding Wheel; Grinding Speeds and Feeds; Cutting Fluids and Their Use; Grinding Machine Construction and Features; Holding the Workpiece; Using the Surface Grinder; Grinding Faults; Cylindrical Grinding; Safety in Grinding

Objectives

- Define grinding.
- Name the five categories of grinding.
- Explain how to read the marking code on a grinding wheel.
- Explain how to mount a grinding wheel.
- Define the terms dressing and truing as related to grinding wheels.
- Explain how cutting fluids id grinding operations.
- List the steps involved in surface grinding.

Lesson 4: Gear Cutting

Topics

Purpose of Gears; Types of Gears; Gear Terms and Definitions; Diametral Pitch; Spur Gear Tooth Calculations; Cutting Spur Gear Teeth; Repairing a Gear by Pinning; Cutting an Involute Rack; Straight Bevel Gears; Bevel Gear Tooth Calculations; Cutting Bevel Gear Teeth; Cutting Other Gears

Objectives

- Name the most common and easiest-to-make gear.
- Name the most widely used types of gears in plant machinery.
- Define the following terms: pitch diameter, circular pitch, diametrial pitch, working depth, and face width.
- Explain how to check the first full tooth of a spur gear after cutting.
- Describe the pitch line of an involute rack.
- Explain how the teeth of straight bevel gears are cut.

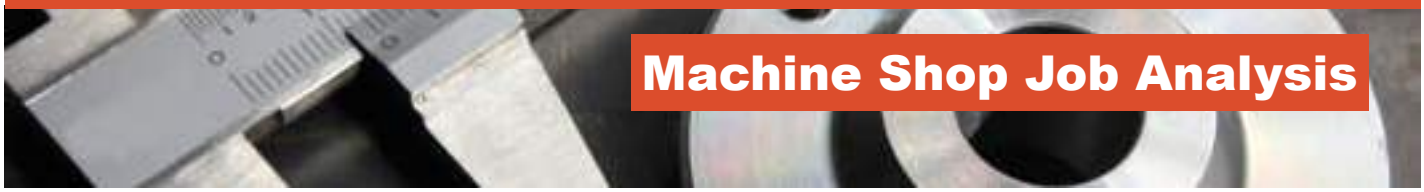
Lesson 5: Power Sawing

Topics

Power Hacksaws; Power Hacksaw Blade Selection; Inspecting and Installing a Power Hacksaw Blade; Operating a Power Hacksaw; Rules for Good Hacksawing; Horizontal Band Saws; Vertical Band Saw; Band Saw Blades; Features of Band Saw Blades; Types of Blade Set; Selecting the Right Blade; Blade Installation; Operating a Band Saw; Cutting Fluids for Sawing; Straight Sawing Using a Band Saw; Contour Sawing; Friction Sawing; Other Band Saw Operations; Safety in Power Sawing; Cutting Fluids for Hacksawing and Band Sawing

Objectives

- Explain when and why cutting fluid is required when using a power hacksaw.
- Explain how to select a power hacksaw blade.
- List at least three rules for good hacksawing.
- Contrast the operation of a hacksaw and a band saw.
- List the three factors involved in selecting the right band saw blade.
- Explain the important points of power sawing safety.



Machine Shop Job Analysis

Course 323: Machine Shop Job Analysis

Covers types of jobs likely to be encountered by the maintenance machinist, and describes how the machinist decides which machine(s) to use for particular operations. Shows how to analyze the entire job before selecting the most efficient sequence of machining operations. Builds on Courses 315, 316, 317, and is a prerequisite for the “hands-on” projects in the courses that follow.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Machining Cylindrical Shapes

Topics

Turning; Shoulder Facing; Machining Fillets; Turning Relief Notches; Turning Tapered Profiles; Knurling; Filing on a Lathe; Facing; Boring and Counterboring; Boring Tapered Holes; Thread Cutting; Thread Forms; Job Analysis

Objectives

- Explain the procedures for turning single and multiple diameters, including shoulders, fillets, and relief notches.
- Compute tapers, including the use of the setover method, compound rest method, and taper attachment method.
- Show how to use the cutting tools and machines for knurling, filing, and polishing.
- List the procedures for facing chucked work and work mounted between centers on the lathe.
- Describe the procedures for boring and counterboring in a lathe and boring mill.

Lesson 2: Drilling, Reaming, and Honing

Topics

Drilling in a Lathe; Workpiece Stationary/Drill Rotating; Workpiece Rotating/Drill Stationary; Drill Press Jobs; Radial Drill Presses; Spot Facing Tools; Boring Bars; Drill Bushings and Jigs; Drilling Jigs; Reaming; Honing

Objectives

- Describe the basic drilling process.
- List drilling procedures for work mounted in a lathe.
- List drilling procedures for work mounted in a drill press.
- Explain the use of reaming in a lathe and a drill press.
- Explain the use of honing and the type of equipment used.

Lesson 3: Machining Flat Surfaces

Topics

Milling Flat Surfaces; Profile Milling; Face Milling; Machining Irregular Shapes; Slotting; Shaping; Slotters; Broaching; Broaching Machines; Surface Grinding; Surface Grinding Machines; Grinding Special Shapes

Objectives

- Describe the basic milling process, cutter types, and their application.
- List slotting procedures in a milling machine.
- Define shaping, its tooling, and its relationship to planing and milling.
- Define broaching, its application, and the machines used.
- Define surface grinding, its application, and the machines used.

Lesson 4: Determining Tolerances and Finishes

Topics

Physical Dimensional Factors; Linear Dimensions; Tolerances; Limits; Tolerance Stackup; Rough Cuts; Allowances for Finishing; Finish Cuts; Factors that Affect Surface Finish; Definition of Surface Texture; Examples of Surface Finish Requirements

Objectives

- Define dimensional factors, including linear and angular dimensions.
- Compute tolerances and tolerance stackup.
- Describe allowance for finishing, including procedures for finish cuts.
- Compute surface texture in terms of an average used for final machining.
- Analyze surface finish requirements as specified for the job.

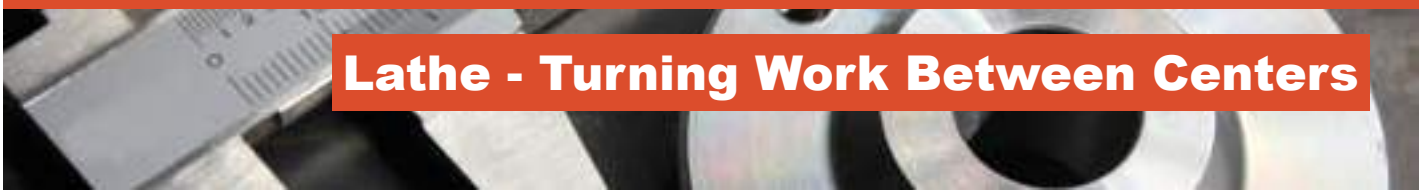
Lesson 5: Variables Affecting Job Efficiency

Topics

Machinability of Workpiece Stock; Machining Variables; Workpiece Variables; Chip Formation; Machinability Ratings; Selection and Application of Cutting Fluids; Solid Lubricants; Application of Cutting Fluids; Machining Efficiency; Keeping Workpiece Movements to a Minimum; Standard Versus Special Tooling and Fixtures; Selecting the Correct Machine; Cutter and Tool Selection

Objectives

- Define machinability of workpiece stock, including machining variables, and workpiece variables.
- Explain machinability ratings.
- Select cutting fluids, cutting lubricants, and solid lubricants.
- Describe machining efficiency, including minimal workpiece setups and standard versus special tooling and fixtures.
- Identify the correct machine and cutting tool for a given job.



Lathe - Turning Work Between Centers

Course 324: Lathe—Turning Work Between Centers

Takes the trainee through a series of operations on the lathe to make a student project (a plug gauge). Covers lathe setup, rough turning procedures, finish turning, and chamfering. Next covers shouldering, knurling, and notching operations. Finishes with external thread cutting and maker tapers.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Lathe Setup and Workpiece Preparation

Topics

Checking the Lathe; The Workpiece; Selecting the Work Mounting Method; Setting Up the Lathe; Installing the Faceplate; Installing the Lathe Dog; Live and Dead Centers; Alternate Methods for Holding the Workpiece; Facing the Workpiece Ends; Test Running; Tool Selection; Mounting the Facing Tool; Speed and Feed Selection; Facing the End; Facing the Opposite End

Objectives

- Describe how to select a work mounting method.
- Install a faceplate and lathe dog in a lathe.
- Select and mount a cutting tool for facing the ends of a workpiece.
- Explain how the optimum speed and feed are selected.
- Face the ends of the workpiece.

Lesson 2: Rough and Finish Turning

Topics

Rough Turning Between Centers; Selecting the Cutting Tool; Aligning the Cutting Tool With the Work; Spindle Speed Selection; Selecting the Feed; Taking Trial Cuts; Setting Final Feed; Rough Turning; Finish Turning; Selecting the Finishing Cutter; Taking a Trial Finishing Cut; Setting Final Controls; Taking the Finishing Cut; Chamfering

Objectives

- Align the cutting tool with the workpiece.
- Take a trial cut on the workpiece.
- Rough turn the workpiece.
- Finish turn the workpiece.
- Chamfer edges of the workpiece.

Lesson 3: Shouldering, Knurling, and Notching

Topics

Laying Off Shoulders; Caliper Method; Scriber Method; Parting Tool Method; Setting the Parting Tool; Laying Off With the Parting Tool; Turning Filleted Shoulders; Turning Larger Fillets; Turning Square Shoulders; Turning With a Shouldering Tool; Turning With a Parting Tool and Round-Nosed Cutter; Notching; Knurling; Knurling Tools; Polishing Between Centers; Filing Between Centers

Objectives

- Describe how to lay off shoulders using the caliper, scriber, and parting tool methods.
- Turn a filleted shoulder on the workpiece.
- Explain how to notch a workpiece with a parting tool.
- Knurl the workpiece.
- Perform a polishing and filing operation between centers.

Lesson 4: Cutting External Threads

Topics

Project Description; Preparing and Mounting the Workpiece; Lathe Thread Cutting Parts; Lead Screw; Split Nuts; Screw Thread Features; Thread Cutting Tools; Setting the Compound Rest; Thread Cutting Stop; Using the Thread Dial Indicator; Cutting the Thread; Setting Thread Cutting Speed; Determining Total Depth of Cut; The Trial Cut

Objectives

- Prepare and mount the workpiece.
- Describe screw thread features.
- Explain in detail how threads are cut on a lathe.
- Set the thread cutting speed and use the thread dial indicator.
- Determine the total depth of cut and take a trial and finish cut on the workpiece.

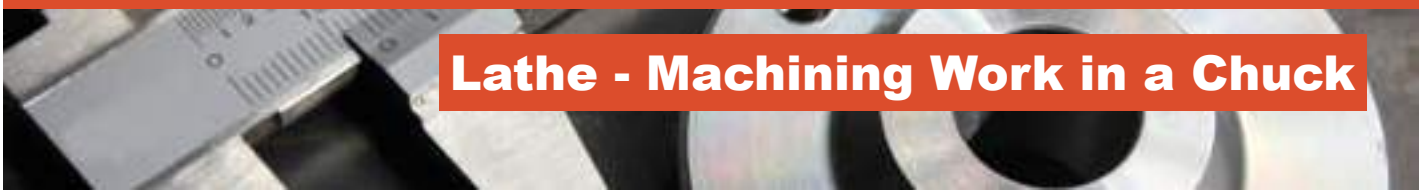
Lesson 5: Turning Tapers Between Centers

Topics

Standard Tapers; Taper Calculation; Laying Off the Workpiece; Tailstock Setover Method; Taper Attachment Method; Taper Turning Using the Compound Rest; Machining the Tapers; Turning the Short Taper Using the Dial Test; Indicator and Vernier Bevel Protractor; Making the Taper

Objectives

- Designate standard types of tapers as well as calculate special tapers.
- Explain how to turn a taper using the tailstock setover method.
- Describe how to turn a taper using a taper attachment.
- Turn a taper using the compound rest method.
- Tell how to use the dial test indicator and vernier bevel protractor for close tolerances.



Lathe - Machining Work in a Chuck

Course 325: Lathe—Machining Work in a Chuck

A sequential follow-up to Course 324 on lathe operation, covers chuck installation, boring and counterboring operations, thread cutting, and taper boring. Continues into special lathe operations that use faceplates, angle plates, and boring bars. Provides several real "hands-on" projects.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Lathe Setup and Workpiece Preparation

Topics

Checking the Lathe; Basic Holding Methods; Chuck Size Selection; Installing a Chuck; Installing Work in a Chuck; Correcting Misalignment; Centering Odd Shapes in a Chuck; Using a Three-Jaw Universal Chuck; Using a Collet Chuck; Using Mandrels; Workpiece Description; Planning the Work Sequence; Using a Four-Jaw Independent Chuck; Removing a Chuck

Objectives

- Select and install a chuck.
- Install and center work in a chuck.
- Use a 3-jaw and 4-jaw chuck.
- Use a collet chuck.
- Use a mandrel.

Lesson 2: Rough Turning and Finish Turning

Topics

Facing the Workpiece; Tool Selection and Installation for Facing; Tool Alignment for Facing; Setting the Speed and Feed for Facing; Rough Turning the Workpiece; Speed and Feed for Rough Turning; Use of Cutting Fluids; Setting the Longitudinal Feed; Completing Rough Turning; Finish Turning the Workpiece; Facing the Shoulder

Objectives

- Select, install, and align both a facing tool and a turning tool.
- Set the correct speed and feed for facing and turning.
- Rough turn a workpiece.
- Finish turn a workpiece.
- Face a shoulder

Lesson 3: Boring and Counterboring

Topics

Boring Tool Design; Boring Tool Bit Selection; Boring the Workpiece; Installing the Boring Bar and Bit; Adjusting the Cross Feed; Rough Boring; Depth of Cut for Rough Boring; Rough Trial Cut; Speed and Feed for Rough Boring; Use of Coolants; Completing the Rough Boring; Finish Boring; Finish Boring Tool Selection and Installation; Speed and Feed for Finish Boring; Counterboring

Objectives

- Select and install a boring bar and bit.
- Select the speed and feed for boring and counterboring.
- Make a trial cut.
- Rough bore and finish bore a workpiece.
- Counterbore a workpiece.

Lesson 4: Cutting Internal Threads and Boring Tapers

Topics

Cutting Internal Threads; Thread-Cutting Tool Selection; Installing and Aligning the Tool; Threading the Workpiece; Checking Finished Threads; Boring Tapers; Using the Compound-Rest Method for Boring Tapers; Cutting Tool Selection and Installation; Aligning the Tool with the Workpiece; Boring the Taper; Using the Taper-Attachment Method; Workpiece Mounting and Tool Selection; Aligning the Tool with the Workpiece

Objectives

- Select, install, and align a thread-cutting tool.
- Machine internal threads in a workpiece.
- Check finished threads.
- Bore a taper using the compound-rest method.
- Bore a taper using the taper-attachment method.

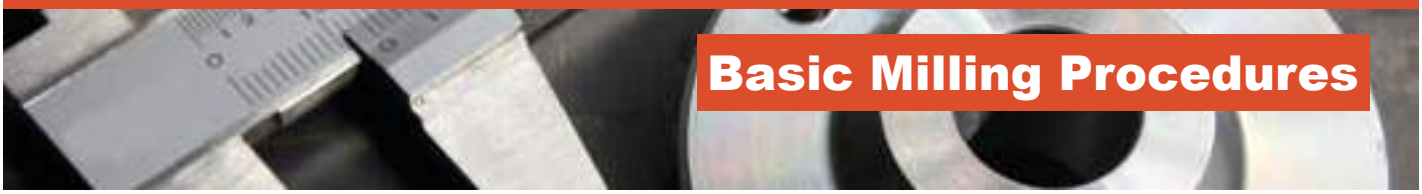
Lesson 5: Holding Irregular and Oversize Workpieces

Topics

Special Lathe Operations; Mounting the Workpiece on a Faceplate; Truing a Faceplate; Holding Work on a Faceplate; Using Faceplate Jaws; Using Faceplate Clamps; Using Angle Plates; Installing and Aligning an Angle Plate; Mounting Work on an Angle Plate; Aligning Work on an Angle Plate; Using V-Block Angle Plates; Facing Large Diameters; Mounting the Workpiece; Using a Specialized Mandrel; Boring Work on the Lathe Carriage

Objectives

- Mount and true a faceplate.
- Use faceplate clamps and jaws.
- Hold work on an angle plate.
- Mount work on the lathe carriage for boring.



Basic Milling Procedures

Course 326: Basic Milling Procedures

Covers the setup and use of the horizontal milling machine, and describes the functions of basic cutters and attachments. Uses "hands-on" projects so trainees actually gain experience on the milling machine. Includes a work-holding fixture project that can have practical value in the shop when finished.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Using the Horizontal Milling Machine

Topics

Milling Machine Parts and Their Functions; Vertical Milling Attachment; Machine Orientation; Milling Speed Selection; Milling Feed Selection; Depth of Cut; Lubricants and Coolants; Mounting the Workpiece; Using V-Blocks; The Milling Machine Vise; Aligning the Vise on the Table; Installing Work in a Vise

Objectives

- Identify the major parts of a universal horizontal milling machine and their functions.
- Define the use of a vertical milling attachment.
- Compute the milling spindle speed and the machine table feed rate.
- Install and align a workpiece in a V-block.
- Install and align a workpiece in a milling machine vise.

Lesson 2: Slab Milling Procedures

Topics

Special Work-Holding Fixture; Slab Milling the Workpiece; Slab Milling Cutters; Checking the Machine; Installing the Arbor and Cutter; Speed and Feed Selection; Depth of Cut; Cutter Alignment; The Trial Cut; Rough Milling the Workpiece; Taking the Finish Milling Cut; Breaking Down the Setup

Topics

- Select and install a slab milling cutter on a Style B arbor.
- Install a Style B arbor with cutter, spacers, key, and bearing sleeve into a horizontal milling machine.
- Complete a rough slab milling cut on a workpiece.
- Complete a finish slab milling cut on a workpiece.

Lesson 3: Milling Slots and Angles

Topics

Slotting on a Horizontal Milling Machine; Aligning the Cutter and Workpiece; Milling the Slot; Completing the T-Slot; Angle Milling the Workpiece; Making the Cut; Slotting with a Vertical Milling Attachment; Installing the Cutter; Workpiece and Cutter Alignment; Making the Cut; Milling the T-Slot with a Vertical Milling Attachment; Angular Milling with a Vertical Milling Attachment; Milling a Female Dovetail; Milling the Dovetail

Topics

- Mill a slot with the cutter in a horizontal and a vertical spindle position.
- Use a T-slot cutter in both a horizontal and vertical spindle position.
- Angle mill a bevel from both a horizontal and vertical spindle position.
- Use adapters for shank-type cutters.
- Cut a female dovetail in a workpiece using a dovetail cutter.

Lesson 4: Straddle, Side, and Face Milling

Topics

Straddle Milling; Selecting and Mounting the Cutters; Aligning the Cutters and Workpiece; Straddle Milling the Workpiece; Side Milling on a Horizontal Milling Machine; Selecting the Cutter; Setting Up the Machine; Making the First Angle Cut; Using Trig Functions for the Final Cut; Face Milling; Face Milling on a Horizontal Milling Machine; Selecting and Installing the Cutter; Aligning the Cutter and Workpiece; Milling the Workpiece; Vertical Face Milling; Aligning the Cutter and Workpiece

Topics

- Select, set up, and align straddle milling cutters on a Style B arbor.
- Straddle mill a workpiece.
- Cut an angular step using a side milling cutter.
- Face the side of a workpiece with a shell end mill.
- Face a broad workpiece surface using a face mill.

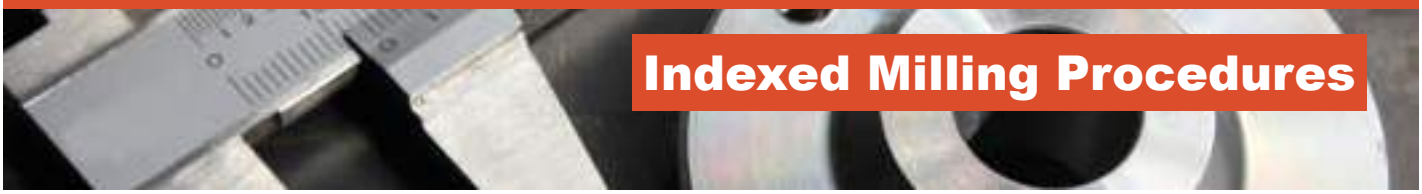
Lesson 5: Milling Keyseats, Squares, and Flats

Topics

Analyzing the Workpiece; Keyseats for Square Keys; Keyseats for Woodruff Keys; Mounting Fixtures; Milling Keyseats for Square Keys; Selecting the Cutter; Installing the Cutter; Laying Off the Keyseat Lengths; Setting Depth of Cut; Speeds and Feeds; Milling the Open-End Keyseat; Milling the Closed-End Keyseat; Installing the Woodruff Keyseat Cutter; Centering the Woodruff Cutter; Cutting the Woodruff Keyseat; Use of Automatic Feed Controls; Milling Squares on Round Work; Mounting the Workpiece; Milling the Square End; Milling Tangs and Flats

Topics

- Select and install a standard Woodruff keyseat cutter.
- Mill a keyseat with rounded ends (for a square key) and a Woodruff keyseat (for a Woodruff key) in a workpiece.
- Make a plunge cut with a two-fluted end mill.
- Mill a square on the end of a shaft.
- Mill a tang and a flat on a cylindrical workpiece.



Indexed Milling Procedures

Course 327: Indexed Milling Procedures

Covers the use of the dividing head. Covers plain, differential, and angular indexing. Explains the use of the dividing head for milling hexagons. Proceeds to the cutting of spur gears, helical gears, and cams.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Using the Dividing Head

Topics

Indexing; The Dividing Head; Direct Indexing; Simple Indexing; Indexing Fractions of a Turn; Using Sector Arms; Selecting an Index Plate; Angular Indexing; Indexing Parts of a Degree; Compound Indexing; Differential Indexing

Objectives

- Describe indexing and its uses.
- Identify the parts of a dividing head.
- List the four types of indexing you can do with a dividing head.
- Explain how to use sector arms to index fractions of a turn.
- Select the right index plate for the job.

Lesson 2: Dividing Head Setup

Topics

Mounting the Dividing Head; Holding Work on the Dividing Head; The Dividing Head Center; The Dividing Head Driver; The Dividing Head Chuck; Milling Hexagons; Side Milling the Hexagon; Depth of Cut; Setting Up the Dividing Head; Straddle Milling a Hexagon; Milling Hexagonal Bars; Indexing the Workpiece; Using Indexing for Drilling Holes

Objectives

- Mount a dividing head on a milling machine table.
- Mount work between a dividing head and footstock.
- Mount work in a dividing head chuck.
- Index and side mill or straddle mill a hexagonal workpiece.
- Use the dividing head to index a series of holes in a circle.

Lesson 3: Milling Spur Gears

Topics

Milling Spur Gear Teeth; Preparing the Workpiece; Checking Concentricity; Selecting the Cutter; Installing the Cutter; Aligning the Workpiece and Cutter; Setting Up the Dividing Head; Milling Large-Diameter Spur Gears; Indexing With a Rotary Table; Inspecting Finished Gears; Using a Gear Tooth Caliper; Measuring Sample Gears; Helical Milling; Helical Forms and Terminology; Helix Angle; Helix Pitch

Objectives

- Index spur gear teeth on a gear blank.
- Use formulas to compute gear tooth dimensions.
- Select the correct cutter for specific spur gear tooth dimensions.
- Explain how to use a rotary table.
- Use the measuring over pins technique to check the dimensions of gears.
- Define the terms helix, helix lead, helix angle, and helix pitch.

Lesson 4: Helical Milling

Topics

Computing Change Gearing; Using Idler Gears; Milling Helical Flutes; Indexing Setup; Swiveling the Table; Selecting the Cutter; Aligning the Cutter; Setting Depth of Cut; Milling the Helix; Helical Gears; Milling a Helical Gear; Cutter Selection; Milling the Teeth

Objectives

- Use change gears to vary the lead of the milling machine.
- Describe the purpose of idler gears.
- Compute the lead of a helix.
- Index and mill helical teeth on a cutter.
- Index and mill helical gears

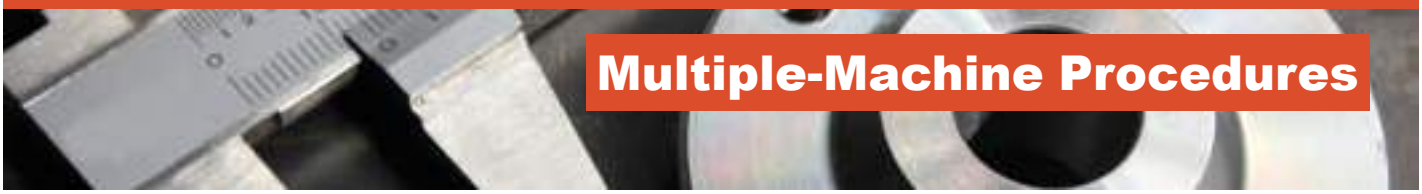
Lesson 5: Milling Cams

Topics

Cam Functions; Nonpositive Cam Systems; Positive-Type Cam Systems; Uniform Motion Systems; Harmonic Cam Systems; Radial Cam Definitions; Milling a Uniform-Rise Cam; Milling Short-Lead Cams; Milling Multilobe Cams; Nonuniform-Rise Cams; Incremental-Cut Method

Objectives

- Describe positive and nonpositive cam systems.
- Define radial cam terms such as cam lobe, uniform rise, cam rise, and cam lead.
- Mill a uniform-rise cam.
- Mill a short-lead cam.
- Mill a multilobe cam.
- Explain how to use the incremental-cut method to mill a nonuniform rise cam.



Multiple-Machine Procedures

Course 328: Multiple-Machine Procedures

Previous courses have dealt largely with the operation of two major machine tools, the lathe and the milling machine. This course picks up some of the other machines found in a machine shop, some of which may be used infrequently, but which nevertheless require specific skills to operate. In most cases, simple projects are described to give trainees experience working with these machines.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Power Sawing

Topics

Power Saw Functions; The Power Hacksaw; Using the Power Hacksaw; The Horizontal Bandsaw; Band Installation; Setting Up the Horizontal Bandsaw; Making the Cut; The Vertical Bandsaw; Using the Vertical Bandsaw; Setting the Blade; Vertical Bandsaw Safety; Sawing the Wheel-Puller Body; Filing the Workpiece; Internal Cutting with a Vertical Bandsaw; Welding the Band

Objectives

- List the three main types of power saws commonly used in maintenance machine shops and describe their appropriate uses.
- Explain the primary difference between a hacksaw and a bandsaw.
- Demonstrate how to install the band on a horizontal bandsaw.
- Demonstrate how to set up a workpiece and make a cut on a horizontal bandsaw.
- Describe the safety precautions to be taken when working with a vertical bandsaw.
- Explain how to make an internal cut using the vertical bandsaw.
- Demonstrate how to reweld the band of a vertical bandsaw.

Lesson 2: Drilling Operations

Topics

Types of Drill Presses and Major Components; A Drill-Press Project; Preparing the Material; Step 1: The Corner Holes; Step 2: The Mounting Holes; Step 3: The Dowel Holes; Step 4: Sawing Out the Center

Objectives

- Name three types of drilling machines in common machine shop use.
- List the main features of a sensitive drill press.
- Describe the factors used to select the best drill for a given job.
- Describe correct, safe practices for changing drill bits.
- Explain how to achieve the most efficient order of drill press operations.
- Demonstrate how to set a workpiece perfectly level on a drill press table.
- Demonstrate how to select the correct speeds and feed rates for a drill press.

Lesson 3: Operating a Horizontal Shaper

Topics

Varieties of Shaping Machines; Shaper Tables; The Tool Head and Clapper Box; Cutting Tools; Work-Holding Devices; Prestartup Checklist; Indicating-in the Worktable and Visa; A Beginner's Project; Mounting the Workpiece; Positioning the Ram, Table, and Tool Holder; Calculating the Number of Strokes Per Minute; Making the Cut; Shaping Slants and Slots

Objectives

- List four specific uses for a horizontal shaper.
- Describe the safety precautions to be taken when working with or around a shaper.
- Demonstrate how to mount a block-shaped workpiece in a shaper vise.
- Explain how to calculate and set the proper stroke rate on a shaper.
- Demonstrate how to set length of stroke and correctly position the ram over the workpiece.
- Demonstrate how to indicate-in on a horizontal shaper.

Lesson 4: Grinding Operations

Topics

Introducing the Surface Grinder; Preparation for Grinding Your Workpiece; Grinding the Basic Flat Surface; Grinding Parallel Surfaces; Grinding Sides Square with the Basic Flat Surface; Grinding Sides Square and Parallel; Grinding Ends Square and Parallel; Grinding the 90°Angles; The Cylindrical Grinder; Preparing the Cylindrical Grinder; Grinding Parallel Diameters and Square Shoulders; Grinding the Tapered Diameter

Objectives

- Explain the purpose of a surface grinder
- Demonstrate how to dress and true a grinding wheel.
- Demonstrate how to set up a workpiece on a surface grinder, and grind its surfaces to specified dimensions.
- Explain the purpose of a cylindrical grinder.
- Demonstrate how to set up a workpiece between centers on a cylindrical grinder.
- Describe the processes of traverse grinding, plunge grinding, and bumping the shoulder.
- Calculate the rpm settings for the wheel of a cylindrical grinder and for the workpiece, given the sfpm.
- Describe safety procedures for both types of grinders.

Multiple-Machine Procedures

Lesson 5: Boring Mill Operations

Topics

Types of Horizontal Boring Mills; Table-Type Horizontal Boring Mills; Table-Type Mills with Rotary Tables; Floor-Type Horizontal Boring Mills; Planer-Type Horizontal Boring Mills; Boring Mills; Boring Cutters; Planning the Setup; Measuring Alignment on Finished Surfaces; Aligning with One Finished Surface; Holding the Workpiece; Taking a Trial Cut; Boring Mill Operations

Objectives

- Describe three different types of horizontal boring mills.
- Explain the purpose of a rotary table, a line boring bar, slot blocks, a drawbolt, and a continuous-feed (cross-slide) head.
- Explain how a boring bar is aligned on center of an existing hole in the workpiece.
- Describe how a facing operation works on a horizontal boring mill.

MACHINE TOOL WORKBOOKS

TPC's Machine Tool Series will get your machine shop trainees off to a perfect start. They will learn how to use basic hand tools, how best to plan and set up machine work, and how to use layouts. They'll also acquire the skills needed for true machine shop craftsmanship. The workbooks in the series present instruction in a slightly different format. All areas of instruction are divided into major sections, each beginning with a list of objectives the trainee will have achieved upon successful completion of that section. Numbered exercises appear in each section; almost every exercise presents a learning task that requires some response from the trainee. Six books make up the complete series.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
161: Measurements (**Workbook**)					155
162: Basic Hand Tools (**Workbook**)					156
163: Work Planning and Setup (**Workbook**)					157
164: Metal Cutting Fundamentals (**Workbook**)					158
165: Cutting Tools I (**Workbook**)					159
166: Cutting Tools II (**Workbook**)					160

Measurements

Course 161: Measurements

Working with fractions; Using calipers and the rule depth gauge; Micrometer and vernier measurement; Developing a sense of touch; Working with decimals in reading a micrometer; Using the vernier caliper and micrometer; Other measuring instruments with vernier scales; Using the dial indicator.

Lesson 1: Linear Measurement

Topics

Linear Measurement; Converting Fractions; Improper Fractions; Adding Fractions; Subtracting Fractions; Measuring within Tolerance, The Outside Caliper; The Inside Caliper, The Slide Caliper, The Rule Depth Gauge

Lesson 2: Micrometer Measurement

Topics

The Outside Micrometer; Developing a Sense of Touch; Decimals; Reading Decimals; Adding Decimals; Subtracting Decimals; Tolerance; Multiplying Decimals; Dividing Decimals; Reading a Micrometer; The Scales; Converting Fractions to Decimals; Taking a Zero Reading; Measuring Flat Stock; Reading Inside Caliper and Depth Gauge Micrometers; The Inside Micrometer; The Small Hole Gauge; The Telescoping Gauge

Lesson 3: Vernier Measurement

Topics

The Vernier Micrometer; The Vernier Caliper; How to Read the 25-Division Vernier Caliper; How to Read the 50-Division Vernier Caliper; Measuring Objects with a Vernier Caliper; Outside Measurements; Inside Measurements; Other Measuring Instruments with a Vernier Scale; Vernier Depth Gauge; Vernier Height Gauge; The Dial Indicator; How the Dial Indicator Works; How to Read the Dial Indicator

Basic Hand Tools

Course 162: Basic Hand Tools

Machinist's bench vise, files, ball-peen hammers, chisels, wrenches, screwdrivers, pliers, etc.; Reamers; Thread and taps, types and usage.

Lesson 1: Basic Hand Tools

Topics

Machinist's Bench Vise Files; The Parts of a File; Single-Cut and Double-Cut Files; The Ball-Peen Hammer; Chisels; Wrenches; The Adjustable Wrench; The Allen Wrench; Open-End Wrenches; Screwdrivers; Pliers; The Hacksaw

Lesson 2: Reamers, Counterbores, and Countersinks

Topics

Reamers; Types of Reamers—Straight and Spiral Fluted Reamers; Tapered Reamers; Rose Reamers; Shell Reamers; Carbide Tipped Reamers; Inserted Blade Reamers; Reamer Selection Guide; Other Machining Operations; Countersinking; Spotfacing and Counterboring

Lesson 3: Threads and Taps in the Shop

Topics

Types of Threads; American National and Unified National Threads; Course, Fine, and Extra Fine Threads; Types of Taps

Work Planning and Setup

Course 163: Work Planning and Setup

Using clamps, blocks, jacks, and rods; Vises and their uses; Production jig; Holding work with chucks, between centers, and on face plates; Basic layout: lines, angles, shapes, circles, and three-dimensional shapes.

Lesson 1: Holding Work on Slotted Tables

Topics

Work Holding Setups; V-Blocks; C-Clamps; Planer Jacks; Parallels; Soft Metal Rods; Hold-Downs; Types of Vises; Flanged Vise; Swivel Vise; Universal Vise;
The Production Jig; Magnetic Chucks; Electromagnetic Chuck; Permanent Magnetic Chuck

Lesson 2: Lathe Workholding Devices

Topics

Holding Work in Lathes; Holding Work in Chucks; The 3-Jaw Universal Chuck; The 4-Jae Independent Chuck; The Collet Chuck; Holding Work Between Centers; Holding Work on Faceplates

Lesson 3: Basic Layout

Topics

Lines, Angles, and Shapes; Right Angles; Straight Angles; Parallel and Perpendicular Lines; Layout Work; Triangles; Squares and Rectangles; Circles; The Parts of a Circle; Concentric and Eccentric; 3-Dimensional Shapes

Metal Cutting Fundamentals

Course 164: Metal Cutting Fundamentals

Ferrous and nonferrous metals; Identifying types of steel; Characteristics of metals and cutting techniques; Harig Speed and Feed Calculator.

Lesson 1: Metal Cutting Fundamentals

Topics

Ferrous and Nonferrous Metals; Identifying Steels; The SAE and AISI Coding Systems; Color Coding; Spark Test; Characteristics of Metals; Changing the Hardness of a Metal; Testing for Hardness; Heat Treatment of Metals; Cutting Tools; Machinability of the Metal; Type of Tool Material; Cutting Fluids; How to Apply Cutting Fluids; Speeds and Feeds; How to Use the Harig Speed and Feed Calculator; Finding Speeds; Finding Feeds; Depth of Cut

Cutting Tools I

Course 165: Cutting Tools I

Use, mounting, and types of milling cutters; Form and special cutters; Climb vs conventional milling; Lathe cutting tools; Lathe use; Making a tool bit and grinding a lathe bit.

Lesson 1: Milling Cutters

Topics

Milling Cutters; Cutters and How They are Mounted; Milling Operations and Cutters; Paling Milling Cutters; Side Milling Cutters; Form Cutters; Climb vs. Conventional Milling; Special Cutters; End Mills; T-Slot, Woodruff Keyway and Dovetail Cutters

Lesson 2: Lathe Cutting Tools

Topics

Lathe Principles; Lathe Shaping Devices; Lathe Holding Devices; The Surfaces of a Cutting Tool; Right-Hand and Left-Hand Cutting Tools; Round Nose Tools; Roughing Tools; Finishing Tools; Boring Tools; Making a Tool Bit Out of Clay; Grinding a Lathe Bit; The Tool Holder

Cutting Tools II

Course 166: Cutting Tools II

Use and abuse of twist drills; Sharpening twist drill bits; Using a grinding chart; Grinding wheels—how they work, their construction, and their markings; Mounting a grinding wheel; Proper dressing and conditions that prevent free cutting.

Lesson 1: The Use and Abuse of Twist Drills

Topics

The Uses of Drills; The Parts of a Drill; Drill-Holders; Drill Sizes; The Core Drill; Cutting Angles on Drill

Lesson 2: Sharpening Twist Drills

Topics

Sharpening a Drill Bit; The Drill Point and Clearance Angles; Grinding the Drill by Hand; The Drill Grinding Machine; Drill Grinding Chart

Lesson 3: Grinding Wheels

Topics

Grinding Machines; How a Grinder Works; Grinding Wheel Construction; Grinding Wheel Marking; How to Mount a Grinding Wheel; Dressing a Grinding Wheel; Condition Which Prevent a Wheel from Cutting Freely

MATERIAL HANDLING SYSTEMS

From hand trucks to fully automated installations, Material-Handling Systems are critical in most industries. This course offers a solid grounding in the components and operating principles of different conveyor systems, along with troubleshooting pointers.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
331: Bulk-Handling Conveyors					162

Bulk-Handling Conveyors

Course 331: Bulk-Handling Conveyors

Covers belt conveyors that carry coal, sand, gravel, grain and other loose materials. Acquaints the trainee with the terminology, basic structure, and operation of these systems. Includes detailed coverage of belts, belt cleaners, idlers, and feed/discharge devices, as well as an explanation of how to install, maintain, replace, and troubleshoot these components.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Conveyor Components

Topics

Conveyor Profiles; Conveyor Pulleys; Conveyor Idlers; Bulk-Handling Conveyor Belts; Conveyor Drive Packages; Support Components

Objectives

- Describe the basic operation of a bulk-handling belt conveyor and identify its major components.
- Name and explain the function of the different pulleys used in belt conveyors.
- Describe four popular conveyor drive-package arrangements.
- Explain the purpose and the operation of at least four of the support components of a bulk-handling belt conveyor.

Lesson 2: Bulk-Conveyor Belting

Topics

Conveyor-Belt Components; Belt Plies; Storing Conveyor Belts; Handling the Belt; Installation; Squaring Belt Ends and Cutting; Belt Fasteners; Vulcanized Splicing; Tensioning the Belt; Test Run; Retensioning; Preventive Maintenance; Replacing a Belt; Repairing Damaged Sections; Troubleshooting Conveyor Belts

Objectives

- Describe the composition and structure of the three components of a bulk-handling conveyor belt.
- State correct storage and handling procedures for bulk conveyor belts.
- Detail the installation of a belt in a bulk conveyor system, including splicing and tensioning.
- Name the five points that require special attention in a preventive maintenance program for a belt conveyor system.

Lesson 3: Belt Cleaners and Idlers

Topics

The Need for Belt Cleaners; Blade Belt Cleaners; Brush Belt Cleaners; Plow-Type Belt Cleaners; Belt Cleaning by Rollover; Using Deck Plates; Self-Cleaning Return Idlers; Wing Pulleys; Installing Belt Cleaners; Testing; Preventive Maintenance; Inspection and Maintenance; Troubleshooting Belt-Cleaning Devices

Objectives

- Describe the design and placement of blade, brush, and plow belt cleaners and the applications for which each one would be used.
- Name and describe the different types of blade belt cleaners.
- Describe the process of belt cleaning by rollover.
- Explain how devices such as wing pulleys, self-cleaning return idlers, and deck plates function as parts of a belt cleaning system.
- Describe the appropriate safety precautions to take when installing or maintaining belt cleaners.
- List the essential features of preventive maintenance and inspection for a belt cleaning system.

Lesson 4: Feed and Discharge Devices

Topics

General Considerations; Factors in Loading; Discharge Factors; Using Skirting Devices; Skirtboard Heights; Skirtboard Edgings; Intermediate Skirting; Hoppers; Hopper Accessories; Chutes at Loading Points; Chutes at Discharge Points; Spouting;Inspection and Preventive Maintenance; Troubleshooting

Objectives

- Explain two important factors in efficient conveyor loading and how they are affected by the two ways (directions) in which belt conveyors are loaded.
- Describe the construction and the purpose of skirtboards.
- Differentiate between a deadbed and a bed of fines and detail the use of both in chute loading of conveyors.
- Name and explain the operation of three special types of discharge spouts.

Lesson 5: Safety and Troubleshooting

Topics

Conveyor Characteristics; Conveyor Identification; Conveyor System Profiles; Loading and Discharge Points; Emergency Controls; Working Near Running Conveyor Systems; Preparing for Conveyor Maintenance; The Belt; Idlers; Pulleys; Conveyor Drive Systems; Cleaning Up After Maintenance; Test Running; Common Problems and Possible Remedies

Objectives

- Differentiate between a conveyor profile and a system profile.
- Point out the special hazards for workers at conveyor loading and discharge points.
- Explain the function and operation of the following emergency controls: electrical interlocks, backstops, level switches, pull-cords, and conveyor belt alignment switches.
- Name at least five safety measures employees should take to protect themselves when working on or near bulk-handling conveyors.
- Describe the three-step procedure for preventing accidental startup of a conveyor during maintenance work.
- Name at least one specific chore or safety caution required in maintenance work on each of the following: belts, idlers, pulleys, and drive systems.
- Identify common problems (and their probable causes) found in troubleshooting idlers, pulleys, takeup bearings, and conveyor drives.

MECHANICAL MAINTENANCE APPLICATIONS

Mechanical Maintenance Applications builds on the ten courses of the Mechanical Systems Series, these additional seven courses concentrate on practical procedures for installation, maintenance, and replacement. Many troubleshooting guides are included.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
341: Mechanical Drive Maintenance					166
342: Mechanical and Fluid Drive Systems					166
343: Bearing and Shaft Seal Maintenance					168
344: Pump Installation and Maintenance					170
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Mechanical Drive Maintenance

Course 341: Mechanical Drive Maintenance

Covers alignment, particularly coupling alignment. Includes installation and maintenance of mechanical drives, from chain drives to enclosed gear drives.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Chain Drives

Topics

Types of Chain Drive; Installing and Aligning Shafts; Mounting the Drive Sprockets; Mounting the Drive Chain; Test Running with No Load; Lubrication Recommendations; Lubrication Methods or Types; Test Running with Full Load; Preventive Maintenance of Chain; Care of Stored Chain; Troubleshooting Chain Drives; Chain Drives and Safety

Objectives

- List four types of chain drives.
- Describe the procedure for aligning the driving and driven shafts.
- Distinguish between bored sprockets and bushed sprockets and tell how each is mounted.
- Tell how a drive chain is mounted on the sprockets.
- List four methods of lubrication for chain drives.
- Explain both no-load and full-load test running procedures.
- Describe the causes of fatigue breaks, tensile breaks, rapid chain wear, roller wear, and side plate spreading.

Lesson 2: Belt Drives

Topics

Types of Belt Drive; Installing and Aligning Drives; Mounting Sheaves and Pulleys; Installation of V-belts; Adjusting the Sheave Centers; Use of Idler Sheaves; Adjusting V-belt Tension; Test-Running and Initial Run-in; Flat Belt Drives; Positive Belt Drives; Preventive Maintenance of Belts; Operating Environment for Belts; Troubleshooting Belt Drives; Belt Drives and Safety

Objectives

- List the three general types of belt drive and explain how they work.
- Tell how sheaves and pulleys are mounted and aligned on their shafts.
- Explain why all the belts in a multi-belt drive must be replaced at the same time.
- Describe two ways of taking up slack in a stretched V-belt.
- List three ways of splicing the ends of a flat belt together.
- Differentiate between the way positive-drive belts and other types of belt transmit power.

Lesson 3: Open Gear Drives

Topics

Makeup of a Gear Train; Terminology of Gearing; Aligning the Shafts; Handling the Gears; Preparing the Shafts; Mounting the Gears; Checking the Gear Alignment; Lubricating Open Gearing; Preventive Maintenance of Gearing; Troubleshooting Open Gear Drives; Open Gearing and Safety

Objectives

- Explain why open gearing requires special provisions for feeding lubricating oil to its parts.
- Describe how to align parallel shafts, intersecting right-angle shafts, and nonintersecting right-angle shafts.
- Describe the procedure for aligning worm gearing.
- List some of the problems a visual inspection of gearing can uncover.
- Describe the appearance and causes of wear, abrasion, corrosion, scoring, pitting, spalling, cold flowing, fatigue breaks, and cracked rims and webs.

Lesson 4: Enclosed Gear Drives

Topics

Installation of Enclosed Drives; Preparing the Drive Foundation; Installing the Gear Drive and Accessories; Lubricating; Test Running; Run-in; One-Week Check; Thirty-Day Check; Storage; Preventive Maintenance; Troubleshooting Enclosed Gear Drives

Objectives

- Tell how an enclosed gear drive should be mounted on the floor.
- Tell how an enclosed gear drive should be mounted on the framework of a driven machine.
- Describe the two methods of lubrication used in enclosed gear drives.
- Explain what should be done during the initial run-in, the one-week check, and the thirty-day check.
- List four steps you should take to protect an enclosed gear drive that is to be put into storage.
- Identify typical nameplate data.

Mechanical Drive Maintenance

Lesson 5: Drive Couplings

Topics

Introduction to Couplings; Installing Standard Shaft Couplings; Aligning Shaft Couplings; Precision Coupling Alignment; Coupling Expansion Allowance; Lubrication of Couplings; No-Load Testing; Installing Spacer Couplings; Installing Floating Shaft Couplings; Installing Universal Joints; Preventive Maintenance of Couplings; Drive Couplings and Safety

Objectives

- List three purposes of a coupling.
- List the three basic types of coupling.
- Explain how to check both the angular and the parallel alignment of shafts.
- Tell how a dial indicator is used in precision coupling alignment.
- Calculate shim thickness required to align couplings in an angular plane.
- Distinguish between couplings that need lubrication and those that do not.
- Describe how shaft couplings, spacer couplings, floating shaft couplings, and universal joints are installed.

Mechanical and Fluid Drive Systems

Course 342: Mechanical and Fluid Drive Systems

Covers further details of drive maintenance, including brakes, clutches, and adjustable-speed drives. Also covers maintenance and troubleshooting of fluid drives and package drive systems.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Mechanical Brakes and Clutches

Topics

Basic Types of Mechanical Clutch; Installing a Mechanical Clutch; Preparing the Shafting; Installing the Clutch Body; Initial Lubrication of Clutch; Providing the Power Supply; Making Initial Adjustments; Test Running with No Load; Making Final Adjustments; Test Running with Full Load; Installing a Mechanical Brake; Preventive Maintenance; Operating Environment; Troubleshooting Brakes and Clutches; Brakes, Clutches, and Safety

Objectives

- Explain how friction-type and jaw-type clutches differ in construction.
- Name the precautions that should be taken when mounting body on a shaft.
- Explain how to test-run a mechanical clutch with no load.
- Explain how to install a mechanical brake.
- Describe the results of improper alignment between driving and driven shafts.
- Identify the problems that may be indicated by chatter and excessive noise.

Lesson 2: Electric Brakes and Clutches

Topics

Types of Brakes and Clutches; Single-Disc Friction Clutch; Multiple-Disc Friction Clutch; Tooth-Type Clutch; Hysteresis Clutch; Eddy-Current Clutch; Magnetic Particle Clutch; Clutch Operation; Clutch Torque; Heat Dissipation; Response Time; Preventive Maintenance; Wiring Brakes and Clutches; Troubleshooting Brakes and Clutches; Brakes, Clutches, and Safety

Objectives

- Describe how single-disc and multiple-disc friction clutches operate.
- Explain how the principle of hysteresis is applied in electric clutches.
- List the three basic components of magnetic particle clutch.
- Differentiate between the static torque, pickup torque, and average torque of a clutch.
- Identify the problems that may arise in a clutch if its heat is not dissipated.
- Define decay time, pull-in time, and response time.

Lesson 3: Adjustable-Speed Drives

Topics

Principles of Adjustable-Speed Drives; Two Basic Designs; Open-Type Adjustable-Speed Drive; Environment for Open-Type Drive; Enclosed-Type Adjustable-Speed Drive; Storage of Enclosed Drives; Protection of Enclosed Drives; Handling an Enclosed Drive; Preparing the Drive Shafting; Leveling an Enclosed Drive; Eliminating Vibration in Drives; Initial Lubrication of Drive; Test-Running; Preventive Maintenance of Drives; Troubleshooting Adjustable-Speed Drives; Adjustable-Speed Drives and Safety

Objectives

- List the precautions necessary to provide extra protection for open-type drives.
- Describe how to install an enclosed-type drive on a concrete floor.
- Explain how to prepare the shafting when installing a new enclosed drive.
- Describe the initial lubrication of new adjustable-speed drives.
- Describe how to test-run an adjustable-speed drive under no load and full load conditions.
- Name some of the safety rules for working on an adjustable drive.

Lesson 4: Fluid Drives

Topics

Principle of Fluid Drives; Operation of Fluid Coupling; Constant-Speed Couplings; Variable-Speed Couplings; Operation of Torque Converter; Torque Converter Modifications; Coupling Drive Arrangements; Installing Fluid Couplings; Installing Large Fluid Couplings; Installing Torque Converters; Preventive Maintenance of Couplings; Fluid Couplings and Safety

Objectives

- Explain how a fluid drive works.
- Describe how constant-speed couplings differ from variable-speed couplings.
- Trace the fluid path through a torque converter using either a drawing or a cutaway.
- Describe the various ways of mounting a fluid coupling.
- Explain how to cool the fluid in large couplings.
- Discuss preventive maintenance procedures for couplings.

Mechanical and Fluid Drive Systems

Lesson 5: Complete Drive Systems

Topics

Introduction; Drive with Coupling and Roller Chain; Drive with Two Flexible Couplings; Drive with Right-Angle Drive Shafts; Drive with Adjustable-Speed Belt; Shaft-Mounted Drive; Installing a Drive System; Protection of Drives; Test Running a Drive; Preventive Maintenance of Drives; Troubleshooting a Drive System; Packaged Drives and Safety

Objectives

- List the components used in a typical drive system.
- Name the part of a drive system in which most of the speed reduction occurs.
- Describe the construction and operation of a shaft-mounted drive.
- List the protective devices for a drive.
- Explain the proper maintenance procedures for a drive system.
- Describe the steps to be taken when troubleshooting a drive system.

Bearing and Shaft Seal Maintenance

Course 343: Bearing and Shaft Seal Maintenance

Covers plain bearings, their parts, dimensions, functions, and relining techniques. Continues with installation and replacement of antifriction bearings. Also covers linear motion bearings and shaft seals.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Plain Bearings

Topics

Plain Bearings; Measuring Plain Bearing Dimensions; Measuring Clearances; Plain-Bearing Linings; Bearing- and Lining-Material Characteristics; Prefabricated Bearing Liners; Poured Bearing Liners; Pouring the Babbitt; Cleaning the Bearing; Measuring and Inspecting the Shaft Journal; Installing Split-Housing Bearings; Deformation; Lubrication of Plain Bearings; Oils as Lubricants; Greases as Lubricants; Initial Run-in; Scheduling Inspections; Removing Faulty Bearings; Signs of Overheating; Troubleshooting

Objectives

- Name the important dimensions of a plain bearing.
- State the source for learning the proper running clearance in a plain-bearing installation and describe how to measure running clearance.
- State the characteristics of bearing and liner material and explain how they influence the choice of bearing for a given application.
- Discuss the steps involved in fabricating a poured babbitt bearing liner and obtaining the correct finished-bore dimensions.
- State the purpose and general principles of plain-bearing installation.
- List important factors to consider when selecting the correct lubricant for a given plain-bearing installation.
- Identify the symptoms of bearing trouble and describe how to remedy each situation.

Lesson 2: Installing Antifriction Bearings

Topics

Preparatory Cleanup; Inspecting the Bearing; Inspecting the Shaft Bearing Seat; Bearing Seating Methods; Cold Mount Techniques; Cold Mount Using Split Tapered Adapter; Temperature Mount; Mounted Internal Clearance Adjustment; Lubrication; Inspection and Maintenance

Objectives

- Describe proper procedures in handling, storing, cleaning, and inspecting antifriction bearings.
- Explain how to measure, inspect, and condition a shaft bearing seat prior to installing a new bearing.
- Tell where pressure should be applied to force a ball bearing onto a shaft.
- Name the two dimensions that are important in mounting a tapered-bore bearing on a shaft.
- Describe the steps involved in correctly seating an antifriction bearing.
- Discuss how an adapter is used to mount a bearing on a shaft.
- Describe the steps to take when using a hot-oil bath to heat a bearing for mounting.
- Name the three major signals of bearing failure in antifriction bearings.

Lesson 3: Removing and Replacing Antifriction Bearings

Topics

Preparation; Removing Retainers and Seals; Press or Impact Bearing Removal; Bearing Removal with Mechanical Pullers; Using Heat to Remove Bearings; Cleaning Used Bearings; Inspecting Used Bearings; Storing Bearings During Machine Overhauls; Replacing the Bearing; Conditioning Shaft and Housing Bore Surfaces; Replacement of Auxiliary Parts; Safety Measures

Objectives

- Describe the correct procedures for removing bearing seals and retaining devices from a bearing assembly.
- Describe the impact bearing removal technique.
- Explain how to use an aluminum heating ring to mount and dismount the inner ring of a cylindrical roller bearing.
- Discuss the steps involved in inspecting and cleaning used bearings.
- Describe the procedures for remounting sound used bearings.
- Explain how to replace a shaft seal.
- List the safety precautions that are essential to working with bearings.

Lesson 4: Mounted Antifriction Bearings

Topics

Bearing Types and Applications; Seals; Housings; Bearing Inserts and Mounting Devices; Shaft Misalignment; Installing Mounted Bearings; Pillow Block Lubrication; Regular Maintenance

Objectives

- Name the three major types of housings or mounts for bearings.
- Name the major components of a mounted antifriction bearing.
- Describe the two basic types of bearing seal and name the advantages of each.
- List the different methods of securing insert bearings to the shaft and describe the mounting methods involved.
- Discuss shaft alignment and describe bearing design factors that compensate for misalignment.
- Explain why most bearing/shaft assemblies have one free and one fixed bearing.
- List factors to consider when selecting bearing lubricants for pillow blocks.

Bearing and Shaft Seal Maintenance

Lesson 5: Linear Motion Bearings and Shaft Seals

Topics

Linear Motion Bearings; Ball Bearing Screw Operation; Ball Bearing Screw Design and Performance; Ball Bearing Screw Support; Preparing for installation; Installing the Ball Bearing Screw; Ball Bearing Screw Lubrication; Shaft Seals; Shaft Seal Operation; Shaft Seal Selection; Effects of Temperature; Effects of Speed; Shaft and Housing Design; Shaft Seal Installation; Shaft Seal Removal; Troubleshooting Shaft Seals

Objectives

- Name the major components of a ball bearing screw.
- Describe the major differences between a ball bearing screw and an acme screw.
- Describe the main purpose of a ball bearing screw and give an example of a typical application.
- Describe the installation procedures for a ball bearing screw.
- Name the differences between contact and labyrinth seals and explain what creates the sealing action in each.
- List the factors that determine the choice of shaft seal.
- Describe how to install a lip seal on a shaft, including shaft preparation.
- Name the major problem that arises with lip seals and list at least four conditions that can cause it.

Pump Installation and Maintenance

Course 344: Pump Installation and Maintenance

Covers basic pumping concepts. Describes required maintenance of packing and seals. Covers maintenance and overhaul of centrifugal pumps. Concludes with maintenance of rotary pumps.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Basic Pumping Concepts

Topics

Force; Work; Power; Horsepower; Energy; Velocity and Acceleration; Static Suction Lift; Pressure Losses; Available NPSH; Required NPSH; Checking Pump Capacity; Pumping Hot Water; Computing Pump Power Requirements; Effects of Operational Factors; Priming a Pump

Objectives

- Compute the amount of work done when given values for force and distance.
- Name the two types of energy.
- Check pump capacity by determining NPSHA of the system.
- Compute the brake horsepower required to drive a pump under given conditions.
- Explain how to prime a fluid-handling pump.

Lesson 2: Maintaining Packing and Seals

Topics

Uses of Packing and Seals; Two Types of Seals; Packing; Selecting Packing Material; Removing Old Packing; Installing New Packing; Packing Precautions; Mechanical Seals; Mechanical Seals Versus Packing; Types of Mechanical Seals; Installing Mechanical Seals; Maintaining Packing and Seals; Troubleshooting Packing and Seals

Objectives

- Identify the two major functions of packing and seals.
- Explain selection and installation of packing rings on a pump shaft.
- Identify the components of typical mechanical seals.
- Name at least three advantages of mechanical seals over packing.
- Describe how to install a mechanical seal on a pump shaft.
- Discuss the care and maintenance of packing and seals.

Lesson 3: Maintaining Centrifugal Pumps

Topics

Installing the Pump; Preparing the Foundation; Fabricated Steel Baseplates; Leveling the Baseplate; Checking Shaft Alignment; Grouting the Baseplate; Mounting Pump and Motor Separately; Compensating for Heat; Installing Auxiliary Pump Drives; Maintaining Centrifugal Pumps; Inspecting Packing and Seals; Inspecting Bearings; Motor and Drive; Avoiding Common Pump Problems; Cavitation; Ring Seizure; Overheating; Pump Operation; Scheduling Maintenance; Troubleshooting

Objectives

- Explain how to align and level a pump on its base.
- Explain the needs for and uses of auxiliary pump drives.
- Identify the major symptom of faulty packing.
- Identify the major symptom of cavitation on a pump impeller.
- Describe the causes and remedies of common centrifugal pump problems.
- Tell how to conduct a periodic inspection of the major pump components.

Lesson 4: Overhauling Centrifugal Pumps

Topics

Preparation; Work Areas and Rigging; Moving a Pump; Disassembling a Pump; Inspecting Pump Parts; Checking Clearances; Reassembling a Pump; Reinstalling a Pump

Objectives

- Describe the procedures involved in disassembling, inspecting, reassembling, and reinstalling a centrifugal pump.
- Explain how to check the runout of a pump shaft.
- Explain how to check the clearances between stationary rings and the impeller or rotating rings.
- Describe how to make a new housing gasket.

Lesson 5: Maintaining Rotary Pumps

Topics

Types of Rotary Pumps; Gear-Type Rotary Pumps; Vane-Type Rotary Pumps; Axial Flow Pumps; Installing Rotary Pumps; Aligning Pump and Piping; Direction of Rotation; Pump Start-Up; Maintaining Rotary Pumps; Scheduling Inspections and Maintenance; Troubleshooting Rotary Pumps

Objectives

- Identify the differences between the different types of rotary pumps.
- Trace the path of fluid through a rotary pump.
- Identify the major problem areas in a rotary pump.
- Explain how to troubleshoot some of the common problems of rotary pumps.
- Create a maintenance schedule for inspections and a record-keeping log.

Maintenance Pipefitting

Course 345: Maintenance Pipefitting

Covers components and terminology used in piping systems. Also covers terminology, measurement, and maintenance of threaded, welded, and plastic piping systems. Explains the use of pipefitting accessories—supports, traps, filters and strainers, and expansion joints.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Piping Dimensions and Terminology

Topics

Piping Standards; Basic Pipe Dimensions; Piping System Symbols; Pipe Fittings; Flanges; Flange Facings and Finishes; Using Dimensional Tables; Calculating Lengths from Existing Pipes; Straight Offsets; Rolling Offsets

Objectives

- State whether ID or OD identifies a given nominal pipe size.
- Given a nominal pipe size and a copy of the American Standard Code for Pressure Piping, find the wall thickness of a pipe of a given schedule number.
- Name at least four kinds of pipe fittings.
- Given a schematic drawing of a piping system, identify all fittings used in the system.
- Given a drawing showing three lengths of pipe with and without fittings installed, correctly name the application dimension for measuring the pipe length.
- Given a schematic drawing showing two parallel horizontal pipe runs with a 45° run connection, identify the travel, set, and face-to-face length.

Lesson 2: Threaded Piping Systems

Topics

Threads; Thread Terminology; Measuring Pipe Threads; Threaded Pipe Fittings; Measuring Pipe for Installation; Cutting Pipe; Threader and Dies; Threading Pipe; Finishing the Pipe; Inspecting Old Threads; Applying Sealants; Assembly of Components; Testing the System; Troubleshooting/ Emergency Repairs; Replacement

Objectives

- Given a descriptive number, identify the pipe size, thread type, and number of threads per inch on a threaded pipe.
- Given a length of unthreaded pipe and required thread specifications, thread one end of the pipe to meet the specifications.
- Given a length of threaded pipe and two threaded fittings, prepare the parts, apply the proper compound, and assemble the components.
- State the important parts of a pipe thread.
- Given actual dimensions for travel and set of a threaded pipe and fitting assembly, use established dimensional tables to compute the total length of replacement pipe needed.

Lesson 3: Welded Piping Systems

Topics

Welds Based on Type of Connection; Fittings for Welded Pipe Systems; Welding Rings; System Alignment; Squareness; Aligning Fittings; Hole Positioning; Measurements; Preparing the Work; Squaring the Flange; Weld Cracks; Inspection; Repairs

Objectives

- Explain what steps to take to prepare lengths of pipe for butt and fillet welding.
- Name the welding ring material used with stainless steel or nickel alloy piping.
- Explain squareness and its importance in a welded piping system.
- Name the major assembly considerations when fabricating flanged connections for a rolling offset installation.
- Given a schematic drawing of this installation, compute the hole compensation angle to be used when positioning the flange for welding.
- Name at least one accessory used to help align two sections of pipe for welding.
- Given a length of pipe and a slip-on flange with a raised face, align and weld the pipe and flange.

Lesson 4: Plastic Piping Systems

Topics

Thermoplastic Pipe Materials; Advantages of Thermoplastic Materials; Disadvantages of Thermoplastic Materials; Standards for Thermoplastic Pipe; Thermosetting Pipe Materials; Fluids Carried by Thermosetting Pipe; Advantages of Thermosetting Materials; Disadvantages of Thermosetting Materials; Standards for Thermosetting Pipe; Installing Thermoplastic Pipe; Installing Thermosetting Pipe; Troubleshooting Plastic Piping Systems

Objectives

- Name the materials used for plastic pipes and fittings.
- Name at least one advantage of plastic piping.
- Name the two most common materials used to make thermosetting plastic pipe.
- Given two lengths of thermosetting plastic pipe, demonstrate how to join then with a bell and spigot joint.
- Name at least one limitation of plastic piping.
- Demonstrate how to align and install fittings on a length of plastic pipe.

Maintenance Pipefitting

Lesson 5: Pipefitting Accessories

Topics

Hangers and Supports; Special Mountings; Steam Traps; Types of Traps; Steam Trap Installation; Trap Cleaning; Filters, Strainers, and Separators; Installation; Cleaning; Expansion Joints and Fittings; Expansion Joint Applications; Expansion Joint Selection and Installation; Maintenance

Objectives

- Name the three classes of piping supports and hangers.
- Explain which two types of pipe hangers are most often used to reduce line vibration and shock.
- Explain the factors to be considered when installing pipe hangers for different applications.
- Name the piping system components used to compensate for pipe length changes due to temperature changes.
- Explain the factors to be considered when locating (spacing) pipe hangers in a system.
- Name two types of steam traps and identify the major consideration in locating them.
- Explain the purpose of a line filter.

Tubing and Hose System Maintenance

Course 346: Tubing and Hose System Maintenance

Covers tubing specifications, materials, and fittings. Explains procedures used for handling, bending, cutting, and installing tubing. Gives basics of tubing in a hydraulic system. Describes hose systems and their functions. Concludes with gaskets, sealants, and adhesives.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Tubing Fundamentals

Topics

Tubing or Pipe?; Tubing Specifications; Copper Water Tubing; Other Tubing Materials; Fittings; Handling Tubing; Cutting Tubing; Sawing Tubing; Filing and Deburring Tubing; Calculating Tubing Length; Bending Tubing

Objectives

- Compare and contrast tubing and pipe.
- List factors to be considered when selecting tubing for a specific application.
- State a common application of various tubing materials.
- Describe various fittings and tell how to select the proper fitting for a given tube.
- Tell why is it sometimes necessary to anneal tubing.
- List the steps to follow when cutting, sawing, and deburring tubing.
- Explain how to calculate tubing length accurately.
- List the steps involved in bending a given length of tubing.

Lesson 2: Installing Tubing

Topics

Selecting Tubing Material; Determining Tubing Size; Soldered Fittings; Brazed Fittings; Flared Fittings; Flaring Tubing; Using Flaring Tools; Installing Flared Fittings; Flareless Fittings; Installing Flareless Compression Fittings; Tubing Supports and Clamps; Tubing Maintenance and Troubleshooting

Objectives

- Define the service conditions that must be taken into account when selecting tubing.
- List the properties and typical uses of various types of fittings.
- Explain the procedures involved in soldering and brazing.
- Name several types of flaring tools and explain how they are used.
- Explain how to install flared and flareless fittings.
- Tell how and why tubing systems should be well supported.
- List common causes of tubing system problems and their solutions.

Lesson 3: Hydraulic Tubing Systems

Topics

Force and Pressure; Hydraulic Fluids; Basic Hydraulic Circuitry; Hydraulic Line Components; Control Devices; Selecting Tubing and Fittings; Tubing Sizes; Fittings; Installing Hydraulic Tubing Systems; Maintaining Hydraulic Tubing Systems; Troubleshooting Hydraulic Tubing Systems

Objectives

- Explain the principles of force, pressure, and area as applied to hydraulics.
- Discuss hydraulic fluids, hydraulic circuits, and hydraulic line components.
- Explain how to select the proper tubing and fittings for hydraulic systems.
- Describe maintenance and troubleshooting procedures for hydraulic tubing systems.

Lesson 4: Hose Systems

Topics

Hose Selection Factors; Hydraulic Hose; General Applications; Hose Construction; Hose Fittings; General Fitting Classifications; Measuring Assembly Length; Calculating Hose Length for Bends; Installing Hose Systems; Testing and Inspecting Hose; Maintenance and Troubleshooting

Objectives

- Discuss the three most common applications for hoses in industry.
- Describe hose fitting classifications and installation techniques.
- Explain how to calculate hose lengths for bends.
- Describe the methods of testing, inspection, and maintaining hose.

Lesson 5: Gaskets, Sealants, and Adhesives

Topics

Gaskets; Gasket Materials; Critical Dimensions; Preparing to Install a Gasket; Making a Gasket; Preparing the Contact Surfaces; Cleaning Flange Surfaces; Coatings; Installing the Gasket; Tightening the Joint; Replacing Old Gaskets; Gasket Ropes, Tapes, and Strips; Sealants and Adhesives

Objectives

- Identify the types and uses of gasket materials.
- Name the critical dimensions of a flanged pipe joint gasket.
- List and explain the three characteristics of contact surfaces that must be considered prior to the installation of a gasket.
- Explain the uses of gasket coatings, tapes, and strips.
- Describe the application of sealants and adhesives in gasket joints.

Valve Maintenance and Piping System Protection

Course 347: Valve Maintenance and Piping System Protection

Covers maintenance and operation of gate, globe, ball, plug, check, and special-purpose valves. Details actuators and various accessories. Explains valve selection based on application. Describes methods of protecting piping systems.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Valve Maintenance

Topics

Valve Materials; Threaded Connections; Welded and Brazed Connections; Flanged Connections; Valve Installation; Repairing Gate Valves; Repairing Globe and Angle Valves; Repairing Ball Valves; Maintaining Plug Valves; Maintaining Check Valves; General Maintenance

Objectives

- Discuss the factors that affect the selection of valve materials.
- Describe the various methods of connecting valves to piping.
- Identify the various types of common valves and the operating characteristics of each.
- Explain general maintenance and repair procedures for different types of valves.

Lesson 2: Special Valves

Topics

Special Valves; Butterfly Valves; Butterfly Valve Installation; Butterfly Valve Repair; Diaphragm Valves; Diaphragm Valve Installation; Diaphragm Valve Repair; Pop Safety Valves; Pop Safety Valve Installation; Pop Safety Valve Repair; Relief Valves; Safety Relief Valves; Safety Relief Valve Installation; Safety Relief Valve Repair; Pressure-Reducing and Regulating Valves; Installation and Repair; Quick-Opening Valves

Objectives

- Identify several types of special valves and the operating characteristics of each.
- Discuss the installation, maintenance, and repair of special valves.

Lesson 3: Actuators and Accessories

Topics

Valve Actuators; Diaphragm Actuators; Piston Actuators; Electric Actuators; Actuator Installation; Actuator Maintenance and Repair; Bourdon Tube; Bimetallic Gauge; Bellows Gauge; Flowmeters; Rotating Unions; Accumulators; Air Receivers

Objectives

- Explain the function and operation of a valve actuator.
- Identify various types of valve actuators and describe the installation. maintenance, and repair of each.
- Discuss the operating characteristics of various accessories, including gauges, meters, accumulators, and air receivers.

Lesson 4: Valve Selection

Topics

Application Considerations; Studying the Total System; Valve Applications; Valve Materials; Valve Identification; Soldered Valve Connections; Threaded Valve Connections; Flanged Valve Connections; Tool Selection; Valve Location; Positioning the Valve

Objectives

- Name the five major uses of valves in piping systems and identify the types of valves best suited for each.
- Identify and explain the factors that determine the selection of a valve for a given application.
- Identify various valve markings and symbols.
- Describe several types of valve-to-pipe connections.
- Discuss the selection and proper use of tools in valve installations.
- Explain the importance of the correct installation of valves in well-chosen locations.

Lesson 5: Piping System Protection

Topics

Protecting Hot Pipelines; Heat Conduction; Heat Convection; Heat Radiation; Installing Insulation; Maintaining Insulation; Tracing; Installing Steam Tracers; Electric Tracing; Tracing Valves and Fittings; Protection from Freezing; Protection from Corrosives; Active Protection; Passive Protection; Inspection of Piping Protection; Hangers and Supports

Objectives

- Describe the methods by which heat transfer occurs.
- Discuss the methods of tracing process lines.
- Explain the various methods of protecting piping systems from heat, cold, and corrosion.
- Discuss the installation, inspection, and maintenance of insulation and other forms of piping system protection.

PACKAGING MACHINERY

Maintaining packaging machinery is a demanding job that requires basic skills in electrical and mechanical techniques, plus specialized knowledge of the complex equipment unique to packaging operations. The Packaging Machinery Series addresses these specialized skills.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
311: Introduction to Packaging					176
312: Packaging Machinery					178
313: Casing Machinery					180

Introduction to Packaging

Course 311: Introduction to Packaging

Covers the job of packaging mechanic. Provides detail on major types of packaging machinery. Covers various mechanical drives, couplings, motors, brakes, variable speed drives, clutches, electrical controls, motor starters, event sequencing controls, time delays, and relays. Includes packaging specifics: types of materials, methods of filling, methods of sealing, weights, and volumetric measurements.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: The Packaging Mechanic

Topics

What is Packaging?; Packaging Operations; Packaging Machinery Maintenance; Planned Maintenance; Lubrication

Objectives

- Describe types of machines for packing and filling.
- Describe packaging machinery breakdown maintenance procedures.
- List specific requirements for planned packaging machinery maintenance.
- Explain packaging machinery lubrication selection, scheduling, and correct application.

Lesson 2: Actuating Mechanisms

Topics

Actuating Mechanisms; Cranks; Cams; Intermittent Motion Mechanisms; Geneva Wheels; Reciprocating Drives; Angle-Doubling Drives; Toggle Links; Detents; Overload Protection Drives

Objectives

- Explain the operation of the lever and crank.
- Describe the differences among types of cams.
- Explain how ratchet wheels and Geneva wheels produce intermittent motion.
- Describe reciprocating and oscillating drive mechanisms.

Lesson 3: Problem Solving Principles

Topics

Solving Problems; Elements of Measurement; Measurement Tolerances; Types of Packaging Machines; Basic Machine Elements; Troubleshooting a Packaging Machine; Determining Causes of Trouble

Objectives

- Describe the differences between intermittent-motion and continuous-motion packaging machines.
- Explain how to time a packaging machine with a timing dial.
- Define the four basic machine elements—timing, position, stroke, and alignment.
- List correct packaging machine troubleshooting steps.

Lesson 4: Mechanical Drives

Topics

Drive Mechanisms; Couplings; Coupling Construction; Coupling Installation; Belt Drives; Chain Drives; Speed Reducers; Gearing

Objectives

- List the functions of couplings.
- Explain the differences among the more common types of couplings.
- Describe how to check coupling alignment and how to correct a misalignment.
- Compare the different types of belt and chain drives.
- Describe the different types of speed reducers and gearing.

Lesson 5: Motors and Brakes

Topics

Primary Drive Components; AC Motors; Fractional-Horsepower Motors; Three-Phase Motors; Motor Construction Classification; Special Motors; Mechanical/Electrical Speed Drives; Electric Clutches; Hydraulic Clutches; Mechanical Clutches; Brakes; Friction Shoe Brakes; Friction Disk Brakes; Maintenance

Objectives

- Describe the basic features of ac motors.
- Compare the different types of fractional-horsepower motors and three-phase motors.
- List the features of common and special types of motors.
- Explain how variable-speed units work.
- Describe the operation and use of electric, hydraulic, and mechanical clutches.

Lesson 6: Electrical Controls

Topics

Machine Identification; Start-Up Sequence; Motor Starters; Running Sequence; Machine Control; Time-Delay Relays; Product Control; Adhesive Application; Product Detectors

Objectives

- Describe the elements of a packaging machine's start-up sequence.
- Explain how thermal overload and melting alloy starters work.
- Explain the use of detectors and time delays in packaging machine control.
- Describe how adhesive is applied.
- Explain the differences in operation among types of product detectors.

Introduction to Packaging

Lesson 7: Packaging Materials

Topics

Materials; Films; Shrink Films; Nonshrinkable Films; Combination Films; Water-Soluble Films; Plain and Coated Papers; Chipboard Cartons; Glass Bottles and Jars; Plastic Bottles and Jars

Objectives

- List the characteristics of film.
- Compare the different types of shrink film.
- Name the different types of combination films.
- Describe the uses of water-soluble film, kraft paper, and chipboard.
- List the advantages and disadvantages of glass and plastic bottles and jars.

Lesson 8: Methods of Filling

Topics

A Definition of Filling; Flexible Packaging; Vertical-Fill Machines; Horizontal-Fill Machines; Pouch Filling; Weigh Filling; Carton Filling; Liquid Filling; Filling by Count

Objectives

- Describe the operation of vertical and horizontal flexible film packaging machines.
- Explain how volumetric pouch filters work.
- Explain how carton-filling and liquid-filling machines work.
- Describe methods of filling by count.

Lesson 9: Methods of Sealing

Topics

What Is Sealing?; Tube Sealing; Film Sealing; High-Frequency Sealing; Capping; Seaming; Tying; Sewing; Gluing; Stapling or Stitching; Strapping

Objectives

- Describe how plastic and metal tubes are sealed.
- Explain the operation of different types of film sealers.
- Describe how high-frequency sealers work.
- Explain the basics of cappers and seamers.
- Describe correct procedures for using hot and cold glues.

Lesson 10: Weighing and Measuring

Topics

Units of Weight; Measuring Devices on Packaging Machines; Volumetric Measuring; Weighing Devices; Scale Components and Installation; Net Weighers; Controls; Check Weighers; Troubleshooting and Maintenance; Installation Suggestions

Objectives

- Explain the uses of gross, net, and check weighers.
- Compare the mechanisms of counterbalances and force balance systems.
- List the components in a scale system.
- Explain how typical check weighers work.
- Describe proper troubleshooting, maintenance, and installation techniques for scales.

Packaging Machinery

Course 312: Packaging Machinery

Covers operating and servicing various types of packaging machinery. Describes different types of liquid filling machines. Covers positive displacement fillers, filling, and sealing machines, as well as volumetric filling machines and blister packaging machines.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Gravity and Vacuum Filling

Topics

Gravity Filling; Vacuum Pumps; Vane Pump Construction; Piston Pump Construction; Vacuum Pump Installation; Vacuum Filling; Gravity/Vacuum Filling; Balanced Vacuum Filling; Submerged Vacuum Filling; Fill Height Control; Container Control

Objectives

- List the main advantage and disadvantages of gravity filling and vacuum filling methods.
- Tell what kinds of vacuum pumps are commonly used in filling applications.
- Describe the construction and operation of vane and piston pumps.
- Compare and contrast vacuum filling, gravity/vacuum filling, balanced vacuum filling, and submerged vacuum filling.
- Explain various methods of fill height and container control.

Lesson 2: Bottle Filling and Capping

Topics

Bottle Filling Considerations; Volumetric Filling; Piston-Type Filling Machines; Piston-Type Volumetric Filling Machines; Auger Feed Pumps; Volumetric-Displacement Machines; Constant-Level Filling Machines; Other Constant-Level Fillers; Counterpressure Filling; Capping and Sealing; Screw Cappers; Bottle Filling Machine Maintenance

Objectives

- List some of the factors considered when selecting a bottle filling machine.
- Explain the operation of, piston-type, auger, volumetric-displacement, and constant-level filling machines.
- Describe the various kinds of bottle capping and sealing.
- List the major maintenance requirements of liquid filling machines.

Lesson 3: Pressure Liquid Filling

Topics

Pressure Filling Principles; Pressure Filling Techniques; General Construction; Indexing Pressure Fillers; Indexing Container Filling; Machine Control; Indexing Container Control; Continuous Motion Pressure Fillers; Rotary Pressure Fillers; Continuous Container Control; Continuous Container Filling; Filling Nozzle Construction; Direct Pressure Filling Machines; Filling Control

Objectives

- Name the most important advantage of using positive displacement pumps on pressure filling machines.
- Name the two classifications of pressure fillers.
- List possible causes of filling inaccuracies.
- Explain the importance of proper fluid velocity in filling machine operation.

Lesson 4: Aerosol Fillers

Topics

Aerosol Filling; Aerosol Containers; Metal Container Construction; Aerosol Valves; Aerosol Propellants; Container Filling; Cold Filling; Pressure Filling; Individual Station Operation; Safety Testing; Drying; Capping; Additional Accessory Equipment

Objectives

- Explain the concept of aerosol filling.
- Describe metal container and aerosol valve construction.
- Name and describe the two methods of aerosol container filling.
- Explain the operation of the individual stations in a filling line.
- Describe the process by which aerosol containers are safety tested.

Lesson 5: Bag Forming and Filling

Topics

Machine Classification; Bag Materials; Bag Construction; Classifying Bags; Bag Forming; Additional Bag Forming Operations; Other Bag Forming Machines; Film Extrusion; Bag Filling Machines; Filling Machine Modifications; Bag Machinery Maintenance

Objectives

- List commonly used bag materials and their typical applications.
- Explain the various bag constructions and related terminology.
- Describe the film extrusion method of bag forming.
- Explain the operation of bag filling machines.
- List the major maintenance requirements of bagging machinery.

Lesson 6: Pouch Filling

Topics

Pouch Filling Machine Classification; Pouch Materials and Control; Vertical Filling Machines; Vertical Pouch Filling; Vertical Pouch Filling Modifications; Horizontal Pouch Filling; Continuous Motion Horizontal Fillers

Objectives

- Tell how pouch filling machines are classified.
- Name the three types of vertical seals made on vertical form, fill, and seal machines, and tell when each is used.
- Explain the vertical filling machine operating sequence.
- Name the two methods of classifying pouch filling machines that handle the film horizontally, and give advantages of each.

Packaging Machinery

Lesson 7: Volumetric Filling Machines

Topics

Types of Volumetric Filling Machines; Balance Point Measuring; Measuring by Volume; High Speed Measuring by Volume; Intermittent Motion Fillers; High Speed Measuring by Volume; Continuous Vacuum Draw Filling; Measuring by Weight; Liquid Volumetric Filling; Volumetric Piston Filling Machines; Volumetric Filling Machine Maintenance

Objectives

- Give examples of products that can be handled by volumetric fillers.
- Explain how volumetric filling machines are identified.
- Describe the operation of volumetric filling machines.
- Describe the various methods of measuring products packaged on volumetric filling machines.
- Explain how liquid volumetric filling is controlled.

Lesson 8: Filling by Count

Topics

Why Count Filling is Used; Machine Selection Factors; Filling by Count Machines; Flat Plate and Disc Sorters; Column Measuring; Modified Column Counting Machines; Electronic Counting; Strip Packaging Machines; Blister Strip Packaging Machines; Cottoning Devices

Objectives

- Give examples of products that are commonly packaged by count.
- Describe three methods of counting product in a fill by count machine.
- Define the term strip packaging, name its two classifications.
- Give an example of a product packaged by each of the two strip packaging methods.

Lesson 9: Positive Displacement Filling

Topics

Principles of Filling; Controlling the Fill; Filling Machines; Manual Fillers; Automatic Filling Machines; Timing Control; Continuous Motion Filling Machines; Rotary Filling Methods; Machine Maintenance

Objectives

- Trace the positive displacement filling cycle.
- Name the kinds of pumps used to fill containers on positive displacement filling machines.
- Describe the controls associated with positive displacement filling systems.
- List important points in the maintenance of positive displacement filling machines.

Lesson 10: Blister Packing

Topics

Blister Packaging; Blister Films; Blister Cards; Blister Card Board Construction; Blister Card Problems; Reducing Blister Failures; Preliminary Test Procedures; Conducting the Tests; Seal Examination and Evaluation; Product Compatibility; Blister Forming Machines; Blister Packaging and Sealing Machines

Objectives

- Define the term thermoforming.
- Describe the film and card materials commonly used in blister packing.
- Give several examples of problems that can cause blister failures.
- Describe the tests and evaluations performed on blister package seals.
- Tell what kind of film is most often used with inline blister forming machines.

Casing Machinery

Course 313: Casing Machinery

Covers operating characteristics and service techniques of accessory or auxiliary machines used with packaging lines. Describes general operating characteristics of labeling equipment, uncasing, unscrambling, and cleaning machines, gluing equipment and adhesives, wrapping machines, tying, strapping, and stitching machines, and shrink wrapping devices.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Uncasing and Unscrambling

Topics

How Containers are Received; Manual Uncasing; Low-Volume Uncasing; Low-Volume Unscrambling; Unscrambling with Wire-Mesh Conveyors; Unscrambling with Parallel Conveyors; Automatic Uncasing; Combined Automatic Operations; Unscrambling Plastic Bottles; Unscrambling Plastics Bottles by Gravity; Unscrambling with an Inclined Hopper; Conveyor Chain and Its Care

Objectives

- List the steps that must occur before an empty container can be processed.
- Tell which types of conveyors are typically used for unscrambling.
- Explain how the pickup head of an automatic uncaser grips different container shapes.
- List important steps in the periodic care and maintenance of roller chain.

Lesson 2: Cleaning and Washing

Topics

Why Clean Containers Are Necessary; Container Cleaning Methods; Semiautomatic Air Cleaning; Fully Automatic Air Cleaning; Inverter Air Cleaners; Manual Washing with Water; Combination Bottle Washer and Rinser; Metal Washers; High-Production Washing; Container Warming; Why Pasteurization is Necessary; The Pasteurizer; The Pasteurizing Process; Lubricating a Pasteurizer; Pasteurizer Maintenance

Objectives

- Name the two methods by which containers are usually cleaned.
- Describe the automatic air cleaning operation.
- Describe the operation of an automatic bottle washer and rinser.
- Describe the operation of a high-production bottle washer.
- Explain why pasteurization is important.

Lesson 3: Gathering Machines

Topics

Types of Gathering Machines; Multipacking Machines; Infeed Supply Machinery for Multipacking; Continuous Run Multipacking; Skip-Carton Detector; Continuous Run Accumulator; Stacking Sequence for Continuous Runs; Cycle-Style Multipacking; Cycling Operations; Case Packing Machines; Bundling Machines; Gathering Machine Maintenance

Objectives

- Name the three types of gathering machines currently in use.
- Describe the operation of a bundling machine.
- Describe the infeed supply operation and cycle of a multipacker.
- Name the two functions of a typical case packer.
- Explain your most important responsibility in gathering machine maintenance.

Lesson 4: Cartoning Machines

Topics

Cartons and Their Application; Basic Steps in Carton Making; Common Types of Cartons; Glue-End Cartons; Types of Cartoning Machines; Methods of Carton Feeding; Expanding Draw Feeding; Rotary Feeding; Product Infeed; Horizontal Carton Loading; Cartoning Machine Attachments; Closing Cartons; Gluing Cartons; Cartoning Machine Maintenance

Objectives

- Define the following terms: reverse tuck, arthur lock, and crash fold.
- Explain why butt flaps are rarely used.
- Describe the operation of cartoning machines and related carton feeding methods.
- Explain how cartons are typically closed and glued.
- List steps involved in cartoning machine maintenance.

Lesson 5: Casing Machines

Topics

Casing Machine Types; Case Forming Machines; Horizontal Casing Machines; Vertical Casing Machines; Top Filling Machines; Side Filling Machines; Bottom Filling Machines; Case Taping Machines; Casing Long Narrow Products; Heat Shrink Sealing; Machine Maintenance

Objectives

- Tell how the manner in which cases are filled is determined.
- Explain the function of a compression unit.
- Contrast top filling and side filling machines.
- Explain the purpose and operation of electrical interlocks in an automatic casing machine.
- Identify the source of heat control problems in a shrink film machine.

Lesson 6: Wrapping Machines

Topics

Machine Drive; Wrapping Materials; Parts Lists and Changeover Parts; Scale and Dial Settings and Controls; Paper Feed; Adjusting the Paper Feed; Adjusting the Paper Reel; Paper Corrugating Wires; Paper Rollers; Paper Cutoff Change Gears; Paper Cutoff Knife; Paper Feed Belts; Paper Stops and Guides; Starting the Machine; Machine Adjustments; Heat Controls; Glues and Their Application; Package Discharge; Lubrication

Objectives

- Explain the function of registration dots on the continuous roll paper used on wrapping machines.
- Explain the functions of the paper corrugating wires in a wrapping machine.
- Trace the operation of a typical wrapping machine, including timing elements.
- Tell how to clear a jam in a wrapping machine.
- Describe various kinds of glue used in wrapping machines and their application.

Casing Machinery

Lesson 7: Strapping and Stitching

Topics

Strapping Materials; Tensioner and Sealers; Combination Tools; Combination Tool Maintenance; Strapping Machines; Operation of Strapping Head; Strapping Head Maintenance; Strapping Systems; Stitching Machines; Buckled Stitch Legs; Variance in Stitch Leg Length; Keeping the Wire Straight; Leg Too Short or Too Long; Distorted, Broken Corners; Other Stitch Defects; Adjusting Defective Stitching Machines

Objectives

- Explain why a tensioner and sealer are sometimes combined into a single assembly.
- Describe the maintenance required by strapping heads.
- Explain the operation of a stitching machine.
- List common stitching machine problems and stitch defects and tell their probably causes.

Lesson 8: Adhesives and their Application

Topics

Adhesives in Packaging; Properties of Adhesives; Types of Adhesives; Hot Melts; Advantages of Hot Melts; Hot Melt Application Systems; Hot Melt Troubleshooting; Maintaining Hot Melt Equipment; Cleaning Hot Melt Equipment; Other Synthetic Adhesives; Natural Adhesives; Applying Natural Adhesives; Maintaining Application Equipment; Storing and Handling Liquid Adhesives

Objectives

- Define the terms penetration, tackiness, and viscosity as they relate to adhesives.
- Name the most likely source of trouble in hot melt application machinery.
- List steps involved in servicing a hot melt dispensing head.
- Explain common maintenance items related to application equipment.
- Describe the storing and handling requirements for liquid adhesives.

Lesson 9: Labeling and Coding

Topics

Purpose of Labeling; Label Forms; Manual Labeling; Semiautomatic Labeling; Automatic Labeling; Continuous Roll Feeding; Indirect Label Feeding; Pressure-Sensitive Labeling; Pressure-Sensitive Labeling Heads; Labeling Head Setup, Maintenance; Automatic Pressure-Sensitive Labeling; Daily and Monthly Maintenance; Coding Attachments; Bottom Coding of Containers; Flexograph Imprinting; Flexograph Imprinter Maintenance

Objectives

- Name common problems in labeling operations and give their solutions.
- Describe the process of continuous roll feeding.
- Explain the periodic maintenance required of labeling heads.
- Explain the operation of a friction-driven coder and a flexographic imprinter.

Lesson 10: Maintenance and Safety

Topics

Planned Maintenance; Spare Parts; Lubrication Schedules; Mechanical Maintenance; Electrical Maintenance; Fluid Components Maintenance; Maintenance Safety; Safe Clothing; Using Tools Correctly; Hand Tool Safety; Machine Guards; Material Handling

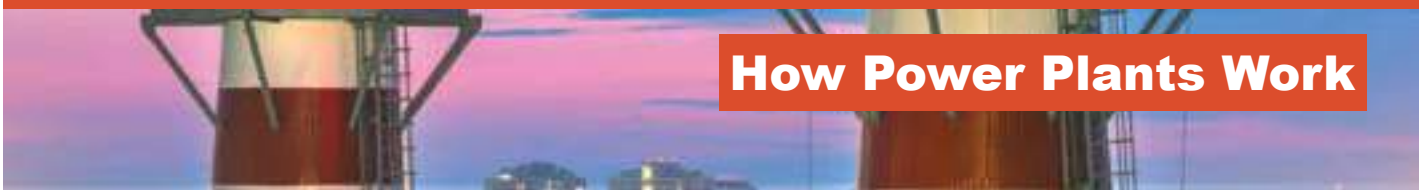
Objectives

- Identify the key to good planned maintenance.
- Name the two most important factors in drive belt wear on a packaging machine.
- List items to consider when replacing a motor?
- Explain the purpose of recommended color codes for plant equipment.
- Name the leading causes of industrial injuries.

POWER PLANT OPERATIONS

Steam generation is still the most important source of electrical power for utilities and industrial plants. The Power Plant Series addresses the need of the power plant worker to understand basic principles of power generation and the safe, efficient operation and maintenance of the power plant itself. It also introduces waste-to-waste energy conversion, including fuel, furnace design, and plant operations. This series provides a foundation for learning more of the technical aspects of power plant operations and maintenance.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
111: How Power Plants Work					183
112: Generating Steam in the Power Plant					184
113: Using Steam in the Power Plant					186
114: Waste-to-Energy Fundamentals					188



How Power Plants Work

Course 111: How Power Plants Work

Covers the basic steam generation system, how thermal energy is converted into electrical energy, components of the system, and design features for gaining thermal efficiency. Includes handling of water, fuel, and wastes, and the operating features of a power plant.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Steam—The Primary Force

Topics

Energy for Power Plants; Converting Energy to Electricity; The Importance of Air in Combustion; Removing Ashes and Flue Gases; Heating the Air; Boiler Design; Controlling the Water Level; Feedwater Heater; The Economizer

Objectives

- Describe the basic concepts involved in converting energy to electricity through a steam power plant.
- Explain why air is important in combustion and describe how air is heated.
- Describe the basic design of a boiler.
- List the methods commonly used to create efficiency in a boiler.

Lesson 2: How Heat is Converted to Power

Topics

The Turbine; The Generator; Using Exhausted Steam; Producing a Vacuum; Using the Condensate; Improved Coal Handling; Boiler Efficiency

Objectives

- Describe the components of an elementary turbine.
- List the uses of exhaust steam.
- Explain how a vacuum is produced in a boiler system.
- Describe how condensate is formed in a boiler system and how it can be used to create a closed cycle system.
- Explain how boiler efficiency is related to steam temperature and pressure.
- Calculate absolute temperature values using Fahrenheit and Celsius readings.

Lesson 3: Power Plant Efficiency

Topics

Thermodynamic Efficiency; Pumps; Feedwater Heating; Air Heating; The Superheater; Circulation Problems in High-Pressure Boilers; Minimum Temperatures in the System; Minor Refinements; Condenser Performance

Objectives

- List the kinds of pumps used in a boiler system and explain the function of each.
- Describe common processes by which boiler feedwater can be heated, and explain these increase boiler efficiency.
- Explain the process by which air is heated in a boiler system.
- Explain the purpose of a superheater.

Lesson 4: Handling Water, Fuel, and Wastes

Topics

Water Requirements; Physical Properties of Water; Chemical Properties of Water; Water Softening and Purification; Cooling Water; Water Disposal Problems; Air Cooling; Fossil Fuel Handling and Wastes; Flue Gases; Particle Removal; Problem Transfer; Looking to the Future

Objectives

- List the two main uses for water in a power plant.
- Describe the physical and chemical properties of water.
- Explain the past and present methods used to purify water for use in a power plant.
- Explain the common handling procedures for flue gases and solid wastes, and describe the problems involved in disposing of these wastes.
- List some of the ways in which power plant waste problems might be resolved in the future.

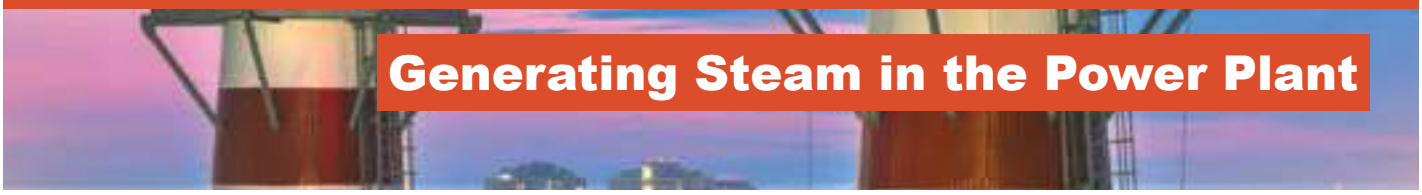
Lesson 5: Power Plant Operation and Control

Topics

Operating Features of a Power Plant; Power Plant Controls; Temperature Measurement; Pressure Measurement; Special Measurements; Other Power Sources; Nuclear Power

Objectives

- Give a detailed description of the arrangement of a modern steam generating plant and explain the progression of the steam cycle from one end to the other.
- Compare and contrast the common instruments for measuring temperature.
- Compare and contrast the common instruments for measuring pressure.
- List some of the special measurement devices that are important in a steam generating plant.
- List the alternate power sources described in the lesson.
- Explain the concept of nuclear power and describe the operation of a nuclear power plant.



Generating Steam in the Power Plant

Course 112: Generating Steam in the Power Plant

Covers energy principles and boiler maintenance. Explains coal, oil, and natural gas combustion, and how to conserve energy through improved combustion control.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Transforming Energy into Work

Topics

Energy and Matter; Fuels; Combustion; Temperature Measurement; Pressure Measurement; Quantity of Heat; Heat Transfer; Conduction; Radiation; Convection; Sensible and Latent Heat; Vaporization; Boiling Point; Enthalpy; Heat and Work; Basic Steam Generation

Objectives

- Define energy and describe the main forms of energy encountered in a power plant.
- Explain the process of combustion and list the three elements necessary for combustion to occur.
- Explain the principles of temperature and pressure measurement and describe the four scales on which temperature is measured.
- Describe the methods of heat transfer and the types of effects heat transfer can have on a material.
- Summarize the interrelationship of temperature, volume, and pressure in a gas.

Lesson 2: Boiler Operation

Topics

Types of Boilers; Boiler Characteristics; Water Treatment for Boiler Use; Boiler and Cooling Tower Blowdown; Wastewater Disposal; Efficiency in the Power Plant; Thermodynamic Efficiency; Conserving Energy in the Power Plant

Objectives

- Compare the two basic types of boilers.
- Describe the characteristics by which boilers are classified.
- Explain the different processes by which water is treated for use in a boiler.
- Define blowdown and explain its importance in boiler operation.
- List the problems associated with wastewater disposal and describe how these problems are overcome.
- Describe the factors that affect boiler efficiency, as well as auxiliary equipment efficiency.
- Calculate thermodynamic efficiency.
- List practices that aid in energy conservation in all areas of the power plant.

Lesson 3: Boiler Maintenance

Topics

Soot Removal; Scale Removal; Corrosion; Casing Corrosion; Refractory; Control Systems; Calibration and Cleaning; Compressed Air Systems; Maintaining Boiler Auxiliaries; Maintaining Stacks and Cyclones; Maintenance Schedules and Reports

Objectives

- Explain how the two types of sootblowers remove soot and slag from heat exchange surfaces.
- Describe how scale forms on boiler surfaces and list the three common removal methods.
- Explain why both hot-end and cold-end corrosion occur in a boiler, and tell what practices help prevent corrosion.
- Describe how refractory should be maintained and list the problems that can occur if it is not properly maintained.
- List the primary functions of boiler control systems and describe the three common types.
- Explain how to calibrate and clean boiler control systems and maintain compressed air systems.
- Summarize maintenance procedures for boiler auxiliaries such as pumps, valves, motors and electric circuits.

Lesson 4: Combustion and How It Works

Topics

Coal Ranks; Coal Analyses; Coal Sizes; Coal Storage; Oil Properties; Natural Gas; Chemistry of Combustion; Oil Burners; Gas Burners; Flame Color; Flame Adjustment for Oil and Gas; Coal Firing Systems; Pulverized Coal Burners; Overfeed Stokers; Underfeed Stokers; Ash Analysis for Carbon; Combustion Efficiency; Handling Unburned Solids

Objectives

- Identify the different ranks of coal and describe how the makeup of coal affects its heating value.
- List the properties that are tested in a coal analysis.
- Summarize the properties of oil and natural gas fuels.
- Explain the combustion process in detail.
- Describe how to interpret and adjust a flame's characteristics in coal, oil, and gas burners.
- Describe the three types of coal firing systems.
- List the ways in which combustion efficiency is measured.

Generating Steam in the Power Plant

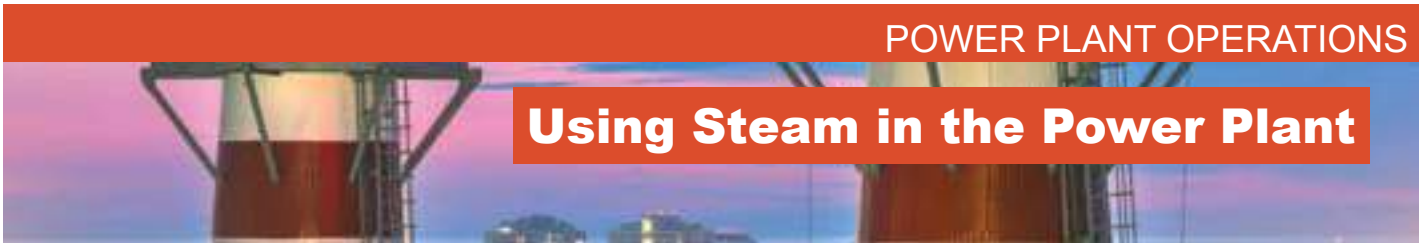
Lesson 5: Steam Generation

Topics

The Steam Generation Process; Temperature and Pressure Relationship; Superheating Steam and Steam Quality; Volume and Pressure Relationship; Steam Tables for Saturated Steam; How to Use Steam Tables; Circulation of Boiler Water; Steam Circulation and Tube Temperature; Steam Drum Design; Operating a High-Pressure Boiler at Low Pressure; The Complete Steam Generation System; Conserving Energy; Blowdown; Makeup Water

Objectives

- Trace the flow of water and steam through the boiler system.
- Explain the relationship between temperature and pressure and explain why superheated steam has a higher quality than saturated steam.
- Read a steam table properly and apply its information to a boiler system.
- Compare natural circulation boilers with forced circulation boilers, and explain how pressure and temperature affect the type of boiler used.
- Describe the process of operating a high-pressure boiler at low pressure.
- Describe how proper maintenance of steam traps, valves, packing, flanges, and insulation improve the energy conservation rate in a boiler system.



Using Steam in the Power Plant

Course 113: Using Steam in the Power Plant

Covers how to conserve energy in turbines, auxiliaries, electric power generation, and air conditioning systems.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Turbines

Topics

What is a Turbine?; Operating Principles; Turbine Classification; Gas Turbines; Condensers; Heat Rejection and Thermal Pollution; Boiler-Turbine-Generator Efficiency; Operating Data on Turbine-Generator Performance; Maintaining a Turbine-Generator System; Condenser Cooling Water Requirements; Cooling Water Systems

Objectives

- Name the five main parts of a steam turbine system and explain the function of each.
- Contrast the operating principle of an impulse turbine and a reaction turbine.
- Define the terms tandem compound and cross compound.
- Explain how a condenser improves turbine efficiency.
- Explain how an overspeed trip is activated.
- List three causes of turbine rotor vibration.
- Name the main cause of bearing failure in a turbine.

Lesson 2: Boiler Instrumentation, Controls, and Safety

Topics

Boiler Instrumentation; Pressure Measurement; Bourdon Tube Gauges; Manometers; Diaphragm and Bellows Gauges; Flowmeters; Temperature Gauges; Gauge Glasses; Combustion Control; Feedwater Control; Safety Devices

Objectives

- Define the term variable.
- Describe the three main classes of boiler instruments.
- List the four variables on which boiler instrumentation usually provides data.
- Name the four common types of pressure gauges, and describe the characteristics and uses of each.
- Name and describe the three types of flowmeters commonly used in power plants.
- Name and describe the four types of temperature gauges commonly used in power plants.
- Describe the uses for gauge glass assemblies in power plant instrumentation.
- Explain the purpose of combustion control systems and describe the three basic kinds.
- Describe the three kinds of feedwater regulators.
- Explain the importance of safety valves and flame safety devices in power plants.

Lesson 3: Electrical Power Fundamentals

Topics

Fundamentals of Electricity; Ohm's Law for DC Circuits; Power in DC Circuits; Theories of Magnetism; Circuit Components; Circuit Types; Generators; Phase Difference; Power Factor; Three-Phase Systems; Transformers; Metering Principles; Instrument Transformers; Electric Distribution Systems and Equipment; Protective Equipment; Distribution Wiring; Substations

Objectives

- Explain the basic principles of electricity and electric power, including the significance of Ohm's Law.
- Identify the parts of an electrical circuit and describe the function of each part.
- Contrast series and parallel circuits.
- Explain the difference between the two main groups of generators and further describe each group in terms of its sources of mechanical power.
- Define phase difference and power factor, and describe a three-phase system.
- Explain the function of a transformer.
- Describe the variety of metering instruments used to measure the value of electric energy.
- Explain the purpose of an electric distribution system, and list the three main kinds.
- Name four kinds of protective equipment used in power systems.

Lesson 4: Electrical Systems Analysis

Topics

Line Diagrams; Electrical Power Billing; Electrical Demand Considerations; Determining Load Factor; Demand Analysis; Manual and Automatic Control; Demand Costs; Power Systems Analysis; Low Power Factor Costs; Causes of Low Power Factor; Power Factor Correction; Capacitors; Synchronous Motors; Transformer Losses; System Voltage Variation and Losses; Maintaining Protective Devices; Maintaining Cable Systems; Maintaining Generators and Motors; Conservation

Objectives

- Explain the purpose of a line diagram.
- List the four kinds of charges normally found on a power bill.
- Define peak demand.
- Calculate a plant's load factor.
- Describe the steps involved in performing demand analysis.
- Calculate demand cost and explain the effect of short demand peaks on billing.
- Define power factor and explain how it is calculated, what causes it to be low, and how it can be improved.
- List the types of power losses that occur in transformers and describe the cause of each.
- Explain how to maintain protective devices, cable systems, and generators and motors.
- Explain the importance of energy conservation in power plants.

Using Steam in the Power Plant

Lesson 5: Air-Conditioning Systems

Topics

Temperature and Humidity; Basic Air-Conditioning Cycle; Air-Conditioning Compressors; Condensers; Evaporators; Metering Devices; Accessories; Controls; Absorption Systems; Air-Handling Systems; Maintenance Practices to Improve Efficiency; Air-Handling System Maintenance

Objectives

- Define relative humidity and explain how it is measured.
- Define the terms refrigeration ton and refrigeration effect.
- Name and describe the three common kinds of compressors used in air-conditioning systems.
- Name and describe the three kinds of condensers used in air-conditioning systems.
- List the metering devices used in an air-conditioning system and explain their uses.
- List the accessories and controls that are found in an air-conditioning system and state their purposes.
- Describe the air-handling system and its components.
- Explain how to measure velocity pressure and static pressure.
- Explain several maintenance practices that will improve the efficiency of an air-conditioning system.

Waste-to-Energy Fundamentals

Course 114: Waste-to-Energy Fundamentals

Covers fundamentals of waste combustion - characteristics and handling of MSW fuel, furnace designs, waste combustion, and plant operations.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Introduction to Waste Combustion

Topics

History of Waste Management; Benefits of Converting Waste to Energy; Environmental Regulations; The Clean Air Act; Current Guidelines; Permit Program; Reporting Procedures

Objectives

- Summarize the history of waste handling.
- List some problems associated with landfills and the benefits of waste-to-energy conversion.
- Name the federal regulations that apply to MWCs.
- Explain how NSPS regulations affect the operation of MWCs.
- Explain the permitting program.

Lesson 2: Characteristics of MSW Fuel

Topics

MSW Definitions; MSW Classification and Composition; MSW Handling Safety; MSW and Refuse-Derived Fuel; MSW Compared to Fossil Fuels

Objectives

- State the definition of MSW and list some kinds of waste excluded from MSW.
- Explain the various methods of classifying MSW.
- Discuss safety concerns related to the handling of MSW.
- Explain the differences between mass-burn MSW and RDF.
- Compare and contrast MSW and fossil fuels.

Lesson 3: MSW Handling

Topics

Solid Materials Flow Path; Weight Scale Operation; Tipping Floor and Refuse Pit; Receiving and Feeding Equipment; Front-End Conveyor Systems; Feed Systems; Ash Removal

Objectives

- Describe the MSW flow in a mass-burn and an RDF facility.
- Explain the responsibilities of the weight scale operator.
- Describe the tipping floor and refuse pit.
- Explain how odors are managed is an MSW facility.
- List typical receiving and feeding equipment and explain its functions.
- Describe how conveyors are used in a typical RDF facility.

Lesson 4: Furnace Designs

Topics

History of MWCs; MWC Designs; Mass-Burn Designs; Rotary Combustors; RDF Designs

Objectives

- Explain the impact of corrosion on MWC design.
- Describe mass-burn and RDF feed systems.
- Explain the operation of the following types of stokers: reciprocating grate, reversed reciprocating grate, oscillating grate, roller grate, and traveling grate.
- Define and contrast overfire air and underfire air and explain why the control of combustion air is important.
- Explain the advantages and disadvantages of a rotary combustor.

Lesson 5: Municipal Waste Combustion

Topics

The Combustion Process; Municipal Solid Waste as Fuel; Theoretical Air and Excess Air; Heating Value; Charging Rate; MSW Combustor Capacity; Combustion Temperatures; Reaction Rates; Air Pollution Control Equipment; Slag and Soot

Objectives

- Explain the combustion process as it occurs in a municipal waste combustor.
- Name the two main factors that determine feed rate.
- Define the terms theoretical air and excess air and tell why they are important.
- Explain the use of common air pollution control equipment and processes.
- Tell how soot and slag are formed and how they are removed.

Lesson 6: Ash Handling and Material Recovery

Topics

Characteristics of MSW Ash; Ash Safety and Handling Requirements; Ash Treatment and Testing Programs; Ash Transport and Loading Systems; Material Recovery

Objectives

- Describe the characteristics of MSW ash.
- Explain the safety considerations when handling MSW ash.
- List the major ash handling equipment.
- Describe the ash treatment and testing program.
- List the materials recovered from ash.
- List some potential uses for ash.

Waste-to-Energy Fundamentals

Lesson 7: Integrated Plant Operations

Topics

Principles of Plant Operation; Operator Training; Upset Conditions; Operating Procedures; Troubleshooting Concepts; Basic Plant Economics

Objectives

- State the main responsibilities of an MWC operator.
- Define the terms turnover, parameter, and walkdown as they relate to MSW operations.
- Explain the importance of operator training.
- Describe the three upset conditions in an MWC that can be dangerous to personnel and property.
- List the causes and symptoms of common MWC process problems.
- List the three sources of profit in a typical MWC.

PROCESS CONTROL INSTRUMENTATION

The Process Control Instrumentation Series describes the safe operation and maintenance of sensors, transducers, controllers, final control elements, and other devices used in process control. It explains the principles and practices governing many kinds of devices used to control pressure, temperature, flow, and level. It also describes the proper use of analytical instrumentation and devices that measure and control force, weight, and motion.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
271: Introduction to Process Measurement and Control					191
273: Pressure Measurement					193
274: Force, Weight, and Motion Measurement					195
275: Flow Measurement					196
276: Level Measurement					198
277: Temperature Measurement					199
278: Analytical Instrumentation					201
279: Final Control Elements					202
280: Safety, Calibration, and Testing					203

Introduction to Process Measurement and Control

Course 271: Introduction to Process Measurement and Control

Covers the function of basic devices for measuring and controlling different kinds of variables in process control. Introduces closed-loop control and PID functions. Introduces analog and digital devices and programmable logic controllers (PLCs). Covers basic principles of measurement and defines process control terms. Describes several kinds of signals and displays and traces the path of a signal through the system. Explains the operation of transducers, transmitters, signal conditioners, converters, and recorders.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: The Nature of Process Control

Topics

Process Variables; On-Off Process Control; Functions of Automatic Process Control; Typical Process Control Applications; Measuring Data in Control Systems; Controlling Variables Automatically; Error, Signal Evaluation, and Feedback; Open- and Closed-Loop Control Systems

Objectives

- Define setpoint, control point, and error.
- Explain how measurement and control are related in industrial processes.
- Describe the four essential functions of an automatic control system.
- Discuss the functions of PLCs and industrial computers in control systems.
- Identify variables in industrial processes.
- Explain the importance of feedback in a closed-loop control system.

Lesson 2: Elements of Process Control

Topics

Process Operation; Analog Control Signals; Digital Control Signals; ASCII; Measuring Process Variables; Measuring Pressure; Measuring Level; Measuring Flow Rate; Digital Pulse Control; Control System Terminology; Open- and Closed-Loop Control; Controller Action

Objectives

- Discuss the differences between modern automatic control systems and older ones.
- Identify the standard signals used in process control.
- Define the terms commonly used in control terminology.
- Describe on-off, proportional, integral, derivative, and PID controller action.

Lesson 3: Process Control Signals

Topics

Process Signals; Linear and Nonlinear Transducers; Signal Operating Values; Error in Signal Measurement; Controller Output; Pneumatic Signal Transmission; Flapper-Nozzle System; Electrical Signal Transmission; Current-Pneumatic Systems; Transmission of Other Signals; Typical Control Loops

Objectives

- Discuss standard signals and linearity and explain how to calculate the value of a variable from an instrument's span and range.
- Describe five common sources of error in signal measurement.
- Discuss the basic principles governing pneumatic signal transmission and explain how a flapper-nozzle device works.
- Describe the function of the controller in a control loop.
- Discuss the basic principles governing electrical signal transmission, including Ohm's law, and list standard current and voltage signals.
- Explain the function of I/P devices in a typical control system and discuss the use of digital signals and optical signals.

Lesson 4: Process Measurement Fundamentals

Topics

The Purpose of Measurement; Kinds of Signals; Measurement Requirements; Kinds of Displays; Remote vs Local Display; Errors in Measurement Systems; Calibration; Noise; Response Time; Measurement System Deterioration; Observation Errors; Transmitters; Proportionality

Objectives

- Explain why measurement is necessary and discuss conditions that affect the degree of accuracy required.
- Compare the advantages of linear and nonlinear displays.
- Compare analog and digital devices and explain how each is applied to measurement.
- Name five sources of measurement error.
- Discuss proportionality and explain how it applies to transmitters.

Introduction to Process Measurement and Control

Lesson 5: Principles of Transducer Operation

Topics

Signal Measurement and Transmission; Matching the Transducer to the Application; Kinds of Output; Mechanical and Electrical Elements; Pneumatic Response; Relating Distortion to Pressure; Electrical Response; Resistance Devices; Voltage Response Devices; Frequency Response Devices; Electromechanical Devices; Combining Elements; Transducers and Today's Technology

Objectives

- Discuss the need for linearity in a process.
- List examples of mechanical and electrical transducer elements.
- Compare pneumatic response and electrical/electronic response in transducers.
- Describe the operation of the bourdon tube, bellows, and diaphragm.
- Give examples of resistance, voltage response, frequency response devices and explain how they work.
- Discuss the use of the Hall-effect transducer and the differential transducer.

Lesson 6: Basic Process Measurement Systems

Topics

Interaction of System Elements; Translating the Measurement; The Transmitter as Communicator; Electrical vs Pneumatic Output; Analog Signal Conditioning; Analog Signal Converters; Converting from Analog to Digital and Back; Analog Indicators; Analog Recorders; Digital Indicators and Recorders; A Complete System

Objectives

- Discuss the basic elements of measuring systems and explain how they interact.
- Describe how a physical quantity is translated into another quantity.
- Discuss the use of transmitters to relay information from one location to another and explain the transfer function.

Pressure Measurement

Course 273: Pressure Measurement

Covers units of pressure and discusses Boyle's and Charles' laws to explain relationships among pressure, volume, and temperature. Describes sensor operation of manometers, bourdon tubes, diaphragms, and bellows. Explains the operation of potentiometric, capacitive, reluctive, servo, strain-gauge, and piezoelectric transducers. Describes devices used in low-pressure control. Discusses proper and safe methods for installing and servicing pressure instruments.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Principles of Pressure in Liquids and Gases

Topics

Properties of Matter; Principles of Liquid Pressure; Units of Pressure; Conditions Affecting Liquid Pressure; Density and Relative Density; Gauge Pressure and Absolute Pressure; Using Liquid Pressure Measurements; Gas Pressure and Volume; Gas Volume and Temperature; Gas Pressure and Temperature; Pressure, Temperature, and Volume Related; Atmospheric Pressure; Pressure and Flow

Objectives

- Compare the three forms of matter.
- Define pressure and explain the difference between gauge pressure and absolute pressure.
- Discuss the conditions that affect the pressure of a liquid.
- Describe how changes in volume affect the pressure of a gas at a constant temperature.
- Describe how changes in temperature affect the volume of a gas at constant pressure, and the pressure of a gas with a constant volume.
- Discuss the two causes of pressure drop in a pipe carrying liquid from a tank.

Lesson 2: Pressure Sensors

Topics

Functions of Measuring Instruments; Manometers; Bourdon Tube Sensors; C-Shape Bourdon Tube; Other Bourdon Tube Shapes; Bourdon Tube Metals; Diaphragm Pressure Sensors; Diaphragm Construction; Diaphragm Capsule Elements; Bellows Pressure Sensors; Sensor Application Comparisons; Maintaining Accuracy; Calibration; Pressure Switches

Objectives

- Explain how a manometer works.
- Describe four kinds of bourdon-tube sensors.
- Discuss construction details of bourdon tubes, diaphragms, and bellows.
- Explain how bellows pressure sensors work.
- Describe how calibration may be accomplished and list the steps in calibrating a pressure gauge.
- Explain how normally open and normally closed pressure switches work.

Lesson 3: Pressure Transducers

Topics

Pressure Conversion; Potentiometric Pressure Transducers; Pressure-to-Current (P/I) and Pressure-to-Pressure (P/P) Transducers; Capacitive Pressure Transducers; Reluctance; Reluctive Pressure Transducers; Servo Pressure Transducers; Strain Gauge Pressure Transducers; Piezoelectric Pressure Transducers; Response Comparisons; Environmental Considerations

Objectives

- Discuss the advantages and disadvantages of the potentiometric pressure transducer.
- Explain how a P/I transducer works.
- Describe the operation of capacitive, reluctive, and servo pressure transducers.
- Compare the three kinds of strain gauge pressure transducers.
- Describe the operation and advantages of the piezoelectric pressure transducer.
- Discuss three environmental conditions that can affect transducer operation.

Lesson 4: Low-Pressure Measurement

Topics

Vacuum; Low Pressure; Units of Low-Pressure Measurement; Methods of Conversion; DP Transmitters; Pressure Gauges; Slack-Diaphragm Gauge; Ionization; McLeod Gauge; Capacitance Manometer; Thermal Conductivity Gauges; Pirani Gauge; Thermocouple Gauge

Objectives

- Define the pressure unit torr and calculate pressure in specified units when given the pressure in other units.
- Explain the operation of a differential-pressure transmitter and a slack-diaphragm gauge.
- Name two kinds of ionization gauges and describe how they work.
- Explain how the McLeod gauge works.
- Describe the capacitance manometer.
- Compare the operation of the Pirani gauge and the thermocouple gauge.

Pressure Measurement

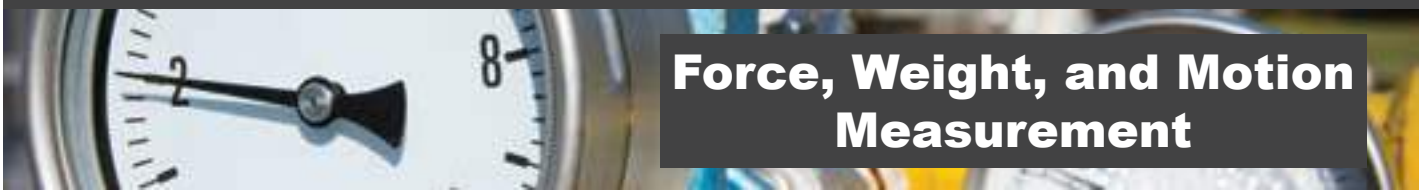
Lesson 5: Installation and Service

Topics

Components of Pressure Transmitters; Pressure Tap, Diaphragm Seal, and Pulsation Dampener; Isolation Valve, Instrument Valve, and Blowdown Valve; Instrument Piping, Connections, and Fittings; Locating and Mounting the Instrument; Piping; Electrical Wiring; Placing the Instrument into Service; Guidelines for Periodic Maintenance; Calibration; Troubleshooting and Repair; Instrument Shop; Safety

Objectives

- List the components of a pressure-transmitter installation.
- Compare methods of joining pipes and other instrumentation components.
- Describe the procedure for placing a pressure instrument into service.
- Discuss the elements of periodic maintenance.
- Explain how to calibrate pressure instruments with electrical and pneumatic outputs.
- Describe three important techniques used in troubleshooting and repair.
- List five important safety rules.



Force, Weight, and Motion Measurement

Course 274: Force, Weight, and Motion Measurement

Covers force, stress, and strain and explains the operation of strain-gauge systems. Relates weight to mass and scales to balances. Explains the operation of load-cell scales. Describes belt-scale, nuclear-scale, and weigh feeder operation. Covers position measurements by means of proximity detection, air gauging, LVDT gauges, synchros, code disks, and other devices. Explains machine tool control and accelerometer operation. Describes the measurement of angular velocity and acceleration, vibration detection, and machinery balancing.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Force, Stress, and Strain

Topics

Force and Motion; Units of Force; Static Forces; Effects of Static Forces; Elasticity; Strain Gauges; Gauge Factor; Measurement Systems for Strain Gauges; Gauge Configurations; Other Force-Measuring Devices

Objectives

- Define force, stress, strain, and deformation in terms of the English and SI units used for their measurement.
- Describe the relationship between stress and strain (Hooke's law).
- Describe the operation and construction of various kinds of strain gauges.
- Identify the electrical circuits used with strain gauges.
- Describe the piezoelectric effect and the capacitance mat and discuss typical applications.

Lesson 2: Weight and Mass Measurement

Topics

Weight vs Mass; Acceleration; Units of Mass and Force; Measuring Weight and Mass; Spring Scales; Equal-Arm Balances; Unequal-Arm Balances; Load Cell Scales; Hydraulic Load Cell; LVDT Load Cell; Pneumatic Load Cell; Industrial Batch Scales

Objectives

- Define and compare weight and mass, including SI and English units.
- Explain the relationship between a mass and the acceleration of that mass.
- Discuss Newton's first law of motion.
- Describe spring scales, equal-arm balances, and unequal-arm balances.
- Discuss the operating principles governing load cells.
- Describe the operation and application of industrial batch scales.

Lesson 3: Weighing Materials in Motion

Topics

In-Transit Weights; Belt Scale Systems; Roller Scales; Calibration of In-Transit Scales; Principles of Nuclear Scale Operation; Radiation Detectors; Weigh Feeders

Objectives

- Name the parts of a belt scale and explain how a typical belt scale operates.
- Discuss the use of roller scales.
- Describe the scale comparison, calibration chain, and electronic integrator methods of calibrating in-transit scales.
- Explain how radiation detectors work and describe the operation of a nuclear scale.
- Describe how continuous weigh feeders operate and discuss typical applications.

Lesson 4: Position Measurements

Topics

Linear Position Measurements; Micrometers and Dial Indicators; Potentiometers; Tracer Systems; Variable-Reluctance Transducer; Proximity Detection; Air Gauging; Moving-Coil Transducer; LVDT Gauge; Inspection Gauging; Angular Position Measurements; Synchros; Code Disk (Encoder); Geologic Position Measurements; Full-Field Devices

Objectives

- Describe how micrometers and dial indicators are used to gauge an object and to make a position measurement.
- Explain how precision potentiometers, tracer systems, variable-reluctance transducers, and proximity detectors measure linear position.
- Describe how air gauging is used to measure inside and outside diameters.
- Discuss the operation and uses of LVDT gauge heads.
- Explain how typical rotary potentiometers, synchros, and code disks converters operate.
- Discuss applications for extensometers and full-field devices.

Lesson 5: Acceleration, Vibration, and Shock

Topics

Linear Motion; Speed vs Velocity; Radar Devices in Traffic Control; Machine Tool Control; Linear Acceleration; How an Accelerometer Works; Angular Velocity and Acceleration; Vibration; Balancing Machinery

Objectives

- Compare speed and velocity and calculate speed from distance and time.
- Explain how the accelerometer works.
- Contrast direct and indirect speed measurement and give examples of each.
- Discuss the operation of LVDT, potentiometric, and piezoelectric accelerometers.
- Describe the undesirable effects of vibration and discuss ways of preventing them.

Flow Measurement

Course 275: Flow Measurement

Covers principles of fluid flow and how primary devices affect fluid flow. Describes flow measurement using several kinds of secondary devices. Discusses rotameters and other variable-area instruments. Explains how weirs, flumes, and other arrangements measure open-channel flow. Compares many kinds of positive-displacement meters and explains the operation of several kinds of turbine and magnetic flowmeters. Describes less-common flowmeters (including vortex-precession, mass flow, and ultrasonic devices) and instruments that meter the flow of solids. Provides guidelines for safe installation and maintenance of flow devices.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Properties of Fluid Flow

Topics

Importance of Flow Measurement; Basic Properties of Fluids; Fluids in Motion; Getting Fluids to Flow; Establishing a Pressure Difference; Ways of Indicating Fluid Flow Rate; Conditions Affecting Flow Rate; Reynolds Number

Objectives

- Explain the difference between density and relative density (specific gravity).
- Define fluid velocity, viscosity, and volume flow rate.
- Describe laminar flow and turbulent flow.
- Explain how static head, friction head, and velocity head differ from each other.
- Explain how pipe size, pipe friction, and fluid viscosity affect the measurement of fluid flow.

Lesson 2: Primary Measuring Devices

Topics

Flow Classification; Flow Measurement Methods; Flow Measurement in Completely Filled Pipes; Restricting the Flow; Pressure Drop; The Orifice Plate; Orifice Plate Design Features; Special Kinds of Orifice Plates; Annular Orifice and Wedge Element; The Flow Nozzle; Turndown and Rangeability; Location of Pipe Taps; Straight Pipe Requirements

Objectives

- Describe direct and indirect flow measurement methods.
- Describe how a primary device creates a differential pressure.
- Give at least three examples of common primary devices and explain how each works.
- Describe the significant features of orifice plates and explain their functions.
- Discuss the conditions that determine the length of straight pipe required for each kind of primary flowmeter.

Lesson 3: Secondary Measuring Devices

Topics

Secondary Measuring Devices; Basic Manometer Design; Liquid Pressure Measurement; Reading the Meniscus; Wet and Dry Manometers; Calibrating a Manometer; Hazards of Mercury; Bellows Meter; ΔP Transmitter; Integral-Orifice Transmitter; Vibrating-Wire Transmitter; Target Meter; Elbow-Mounted Measuring Device; Deadweight Tester

Objectives

- Explain why both accuracy and precision are required in a secondary measuring device.
- Describe how an inclined manometer differs from a conventional U-tube manometer.
- Explain how to calibrate dry and wet manometers.
- Give examples of secondary measuring devices and explain how they work.
- Explain how to calibrate a differential pressure transmitter and discuss the different outputs available.

Lesson 4: Variable-Area Instruments

Topics

The Rotameter; Reading a Rotameter; Conditions Affecting Rotameter Performance; Measuring Gas Flow; Relative Density, Pressure, and Temperature; Float and Tube Shapes; Special Uses for Rotameters; Piston and Vane Variable-Area Meters; Special-Purpose Variable-Area Meters

Objectives

- Discuss the similarities and differences between rotameters and orifice instruments.
- Compare the benefits of linear and nonlinear scales and explain how a square-root extractor is used.
- Explain how calibration, relative density, viscosity, and temperature affect rotameter readings.
- Describe how changes in the pressure, temperature, and relative density of a gas affect the ability of a rotameter to measure its flow rate.
- Discuss the operation of piston- and vane-type flowmeters and explain why armored rotameters and orifice-plug flowmeters are used.

Lesson 5: Open-Channel Flow Devices

Topics

Principles of Open-Channel Flow; The Weir; Shapes of Notches; Choice of Notch Shape; Design of a Weir; Weir Plate; Weir Precautions; Weir Maintenance; Using Nomographs to Calculate Flow; Flumes (Parshall Flume); Flume Terms; Flume Uses; Flume Maintenance; Ultrasonic and Capacitance Level Sensors

Objectives

- Describe the structure and function of a weir.
- Identify various weir components—notch, crest, pond, bulkhead, and head gauge.
- Describe the construction and function of a Parshall flume.
- Identify the parts of a Parshall flume—crest, throat, stilling well, and diverging and converging sections.
- Explain how ultrasonic and capacitance-level measuring devices are used to detect open-channel flow rates.

Flow Measurement

Lesson 6: Positive-Displacement Meters

Topics

Operation of Positive-Displacement Meters; Advantages and Disadvantages of Positive-Displacement Meters; Piston Meters; Reciprocating Piston Meter; Oscillating Piston Meter; Rotating-Vane Meter; Nutating-Disk Flowmeter; Lobed Impeller and Oval Flowmeters; Helix Flowmeters; Dry-Gas Bellows Meter; Calibrating Positive-Displacement Meters; Comparison of Positive-Displacement Meters

Objectives

- Describe the advantages and disadvantages of positive-displacement meters.
- Describe the operation of the reciprocating piston meter and the oscillating piston meter.
- Describe the operating principles of the sliding-vane rotary meter and the nutating-disk meter.
- Identify the elements in lobed impeller, oval, and helical flowmeters.
- Explain the operation of a dry-gas bellows meter.
- Discuss the calibration of positive-displacement meters.

Lesson 7: Turbine and Magnetic Flowmeters

Topics

Turbine Flowmeter Operation; Turbine Flowmeter Construction; Magnetic Pickups and Readout Instruments; Kinds of Turbine Flowmeters; Paddlewheel Flowmeters; Installation of Turbine Flowmeters; Advantages and Disadvantages of Turbine Flowmeters; Magnetic Flowmeters—Principle of Operation; Magnetic Flowmeter Construction; Magnetic Flowmeter Outputs; Installation Tips; Advantages and Disadvantages of Magnetic Flowmeters

Objectives

- Describe the operating principles governing turbine flowmeters.
- Discuss the construction of turbine flowmeters.
- Discuss the advantages and disadvantages of turbine flowmeters.
- Describe the operating principle governing magnetic flowmeters.
- Describe significant advantages and disadvantages of magnetic flowmeters.

Lesson 8: Specialized Flowmeters

Topics

Vortex-Precession Meters; Output System for Vortex-Precession Meters; Features of Vortex-Precession Meters; Vortex-Shedding Meters; Features of Vortex-Shedding Meters; Mass Flow; Mass Flowmeters; Thermal Flowmeters; Heat-Transfer Meter; Immersion-Probe Meter; Hot-Wire Meter; Ultrasonic Flowmeters; The Doppler-Shift Method; The Beam-Deflection Method; The Frequency-Difference Method; Characteristics of Ultrasonic Flowmeters

Objectives

- Discuss in detail the operation of a vortex-precession meter.
- Define the term vortex-shedding and describe vortex-shedding meters and their output system.
- Explain mass flow and describe a Coriolis meter.
- Describe three kinds of thermal flowmeters.
- Describe the Doppler-shift, beam-deflection, and frequency-difference methods used by ultrasonic flowmeters.

Lesson 9: Metering the Flow of Solid Particles

Topics

Measuring Volumetric and Mass Flow Rate of Solids; Volumetric Solids Flowmeter; Mass Flowmeter for Solids; Belt-Style Solids Meter; Belt-Speed Sensing and Signal Processing; Slurries; Constant-Weight Feeders

Objectives

- Define the term meter factor and explain how it is obtained.
- Explain the operation of a mass flowmeter.
- Discuss the operation of the belt-type solids meter.
- Describe how a slurry is made, transported, and metered.
- Discuss the continuous measurement and control of the flow of solid material in a process.

Lesson 10: Installation and Maintenance of Flow Instruments

Topics

Components of Flow-Measurement Systems; Primary Flow Elements; Pressure Taps; Piping and Fittings; Valves; ΔP Instrument; Miscellaneous Items; Installation of the Flow-Measurement System; Pressure Tap Installation; Instrument Piping Installation; Electrical Hookup—The Final Step; Maintenance Precautions; Preventive Maintenance; Calibration; A ΔP Instrument Calibration Procedure

Objectives

- Describe components of a differential flow measurement system.
- List guidelines for correct installation.
- Discuss the principles of thorough and safe instrument maintenance.
- List the steps in instrument calibration.
- Discuss the basic rules of safety in instrument servicing.

Level Measurement

Course 276: Level Measurement

Covers principles governing various methods of measuring level. Explains operation of conductive, capacitive, resistive, ultrasonic, and photoelectric devices. Compares the operation of several kinds of pressure-head instruments. Explains the measurement of solids by ultrasonic, microwave, radiation, and other methods. Discusses several special-application devices for both continuous and point level measurement.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Principles of Level Measurement

Topics

Measuring Liquid Level; Surface-Sensing Gauges; Storage-Tank Gauges; Sight Glasses; Magnetic Gauges; Buoyancy; Displacer Gauges; Level Switches; Mercury Level Switches; Level Switches with Multiple Displacers; Magnetic Reed Switches

Objectives

- Define datum point, and contrast direct and indirect level measurement.
- Describe the main kinds of surface-sensing gauges.
- Define buoyant force and explain how it is used in displacer gauges to measure liquid level.
- Describe maintenance procedures for float devices, displacer gauges, and sight glasses.
- Compare the use of sight glasses, mercury level switches, and magnetic reed switches.

Lesson 2: Electrical Instruments

Topics

Conductivity and Liquid Level; Using Capacitance to Measure Level; Capacitance Probes; Capacitance Probe Electronics; Zero and Span Adjustments; Ultrasonic Level Detectors; Resistance Level Detectors; Photoelectric Level Detectors; Point Level Detection

Objectives

- Differentiate between continuous and point level measurements, and between direct and indirect level measurement.
- Describe the operation of a conductance probe in a conducting liquid.
- Describe the operation of a capacitance probe in a dielectric liquid.
- Explain the operation of ultrasonic, resistance, and photoelectric level sensors.
- Describe conductance point level probes, capacitance point level probes, and ultrasonic point level detectors.

Lesson 3: Pressure Head Instruments

Topics

Hydrostatic Pressure; Relative Density (Specific Gravity); Pressurized Fluids; Pressure Head; Pressure Head Instrumentation; Air Bellows; Air Purge Systems; Liquid Purge Systems; Force-Balance Diaphragm Systems; Differential Pressure Transmitters; Density Measurement; Safety

Objectives

- Define hydrostatic pressure and explain how it is calculated by means of the relative density (specific gravity) of a liquid in a tank.
- Discuss the relationship between pressure head and the location of the pressure (level) indicator.
- Compare the air bellows and air purge systems and discuss advantages for each.
- Explain how a force-balance diaphragm system works.
- Describe the operation of a differential pressure transmitter and explain how it is used to measure level and density.

Lesson 4: Solid Level Measurement

Topics

Using Weight to Determine Level; Ultrasonic Solid Level Measurement; Microwave Solid Level Measurement; Ultrasonic and Microwave Solid Level Detectors; Radiation Level Detectors; Capacitance and Resistance Probes; Bob-and-Cable Tension Method; Point Level Detection; Controlling Level within a Band

Objectives

- List the data needed to compute the level of a bulk solid in a bin.
- Describe and compare the operation of wire strain gauges and semiconductor strain gauges.
- Compare the advantages and disadvantages of ultrasonic and microwave level measuring methods.
- Discuss the operation of capacitance probes, resistance probes, and bob-and-cable units in measuring bulk solids.
- Describe how diaphragm switches and tilt switches are used for point level detection in automatic bin fillers.
- Discuss the use of rotating paddle detectors in controlling level within a band.

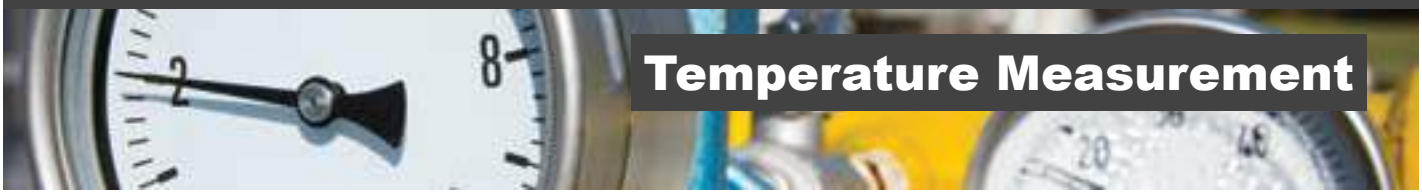
Lesson 5: Other Level Measurement Instruments

Topics

Radiation Level Detectors; Ionization Radiation Sensors; Semiconductor Radiation Sensors; Photoelectric Radiation Sensors; Infrared Level Detectors; Measuring Interface Levels; Range Suppression and Elevation; Selection of Level Measurement Equipment; Calculation of Contents

Objectives

- Explain how radiation level detectors are used for both continuous and point level measurement.
- Describe the operation of ionization radiation sensors, semiconductor radiation sensors, and scintillation counters.
- Discuss the operation of an infrared point level detector.
- Describe several methods of measuring interface levels.
- Explain how range suppression and range elevation are used.
- Discuss the important considerations in equipment selection.



Temperature Measurement

Course 277: Temperature Measurement

Covers units in thermal measurement and operation of RTDs (and wheatstone bridges), thermistors, and thermocouples and thermometers. Includes principles of pyrometry and operation of narrowband, broadband, and bandpass pyrometers. Discusses calibration standards, typical calibrating methods, and instrument testing.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Temperature Measurement Principles and Indicators

Topics

Temperature; Heat; Specific Heat; Changing Physical State; Fahrenheit and Celsius Temperature Scales; Rankine and Kelvin Scales; Calibration of Temperature Scales; Primary and Secondary Standards; Industrial Uses of Temperature Measurements; Temperature-Measuring Instruments; Color Change as a Temperature Indicator; Melting Point as a Temperature Indicator

Objectives

- Define thermal energy and explain the relationships among thermal energy, heat, and temperature in a substance.
- Correlate changes in temperature with changes in a substance's physical state.
- Compare four temperature scales, and convert temperature readings from one scale to another.
- Explain how primary and secondary temperature calibration standards are used.
- Describe various temperature-measuring devices and contrast thermometers and pyrometers.

Lesson 2: Bimetallic and Fluid-Filled Temperature Instruments

Topics

Bimetallic Thermometers; Liquid-in-Glass Thermometers; Filled-System Thermometers; Liquid-Filled Systems; Gas-Filled Systems; Vapor-Pressure Systems; Thermometer Bulbs; Capillary Tubes and Bourdon Tubes; Temperature Transmitters for Filled Systems; Advantages and Disadvantages of Filled Systems

Objectives

- Discuss the physical characteristics and operation of bimetallic thermometers.
- Describe how liquid-in-glass thermometers are constructed and how they operate.
- Compare liquid-, gas-, and vapor-filled systems and discuss their advantages and disadvantages.
- Explain how a mercury thermometer operates.

Lesson 3: Electrical Instruments

Topics

How Resistance Thermometers Work; Wheatstone Bridge Circuits; Lead-Wire Error; RTD Elements; Advantages and Disadvantages of RTDs; Thermistors; Advantages and Disadvantages of Thermistors; Thermocouples; Extension Wires; Compensating for Changes in Reference-Junction Temperature; Advantages and Disadvantages of Thermocouples

Objectives

- Discuss the relationship between temperature and electrical resistance.
- Describe the function of RTD bridge circuits and explain how to calculate lead-wire errors.
- Compare the accuracy, response time, stability, and circuit complexity of RTDs and thermistors.
- Describe the operation of a thermocouple and explain how to compensate for changes in the reference junction temperature.

Lesson 4: Pyrometry

Topics

Molecular Activity and Electromagnetic Radiation; Principles of Pyrometry; Effects of Emittance; Effects of Temperature; Wavelength of Radiated Energy; Pyrometers and Wavelengths; Narrowband Pyrometers; Manual Optical Pyrometers; Using the Optical Pyrometer; Automatic Optical Pyrometers; Broadband Pyrometers; Using the Broadband Pyrometer; Bandpass Pyrometers

Objectives

- Discuss the principles that govern noncontact thermal measurements.
- Define electromagnetic radiation and emittance.
- Discuss the characteristics of a blackbody.
- Describe the effects of temperature and emittance on radiation intensity.
- Describe the operation of optical and radiation pyrometers.

Temperature Measurement

Lesson 5: Temperature Instrument Maintenance and Calibration

Topics

Primary Calibration Standards; Primary Standard Instruments; Secondary Standard Instruments; Instrument Inspections; Controlled-Temperature Environments; Using Triple-Point Baths; Ice Baths; Other Fixed-Temperature References; Calibration and Testing Methods

Objectives

- Compare and define primary, secondary, and working calibration standards.
- Describe typical testing procedures for temperature-measuring instruments.
- Describe routine maintenance and calibration procedures for temperature-measuring instruments.
- Explain how to use controlled-temperature environments—ice baths, triple-point baths, fluid baths, and fluidized baths.
- Explain how to calibrate liquid-in-glass thermometers, thermocouples, resistance thermometers, and pyrometers.

Analytical Instrumentation

Course 278: Analytical Instrumentation

Covers principles, installation, calibration, and maintenance of conductivity probes, and methods of stack gas monitoring. Includes how to install, calibrate, and maintain pH and ORP measurement instruments and operation, installation, calibration, and maintenance of several optical analyzers. Discusses principles and safe practices governing sensors used in measuring oxygen, carbon monoxide, carbon dioxide, and other products of combustion. Concludes with operation, calibration, and system components in liquid and gas chromatography.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Measuring Conductivity

Topics

Ion Concentration; Conductivity; Variables Affecting Conductivity; Conductivity Probes; Probe Calibration; Liquid Standard Calibration; Wire Loop Calibration; Checking a Grab Sample; Probe Installation; Maintenance; Stack Gas Analyzers

Objectives

- Define conductivity and discuss the basic principles governing conductivity.
- Compare the operation of electrode probes and inductive probes.
- Describe two procedures for calibrating conductivity probes.
- Discuss proper installation and maintenance practices for conductivity probes.
- Discuss the operation of stack gas analyzers.

Lesson 2: Measuring pH and ORP

Topics

Introduction to pH and ORP; pH Measurement; Temperature and pH; ORP Measurement; pH and ORP Reference Electrodes; pH and ORP Measurement Electrodes; Calibration Using Standards; Calibration Using a Grab Sample; Calibration Problems; Probe Installation; Probe Mounts; Probe Maintenance

Objectives

- Describe pH and ORP measurement processes.
- Describe the instruments used for the measurement of pH and ORP.
- Discuss calibration procedures for pH and ORP measurement instruments.
- Discuss general installation and maintenance procedures for pH and ORP measurement instruments.

Lesson 3: Optical Measurements

Topics

Optical Measurements; Transmission-Type Optical Analyzers; Examples of Transmission-Type Optical Analyzers; Turbidimeter and Nephelometer; Refractometer; Capacity Analyzer; Analyzer Calibration; Calibration Problems; Analyzer Installation; Pressure Reduction; Temperature; Analyzer Maintenance; Maintenance Problems

Objectives

- Describe the components that make up an optical analyzer.
- Discuss the basic operating procedures of silica ion and COD optical analyzers, turbidimeters and nephelometers, refractometers, and capacity analyzers.
- Compare procedures for calibrating an optical analyzer with standards, with grab samples, and electronically.
- Discuss installation considerations and basic maintenance procedures for an optical analyzer.

Lesson 4: Measuring Products of Combustion

Topics

Gas Sensors; Oxygen Sensors; Carbon Dioxide and Carbon Monoxide Sensors; Combustible Gas Sensors; Calibrating Analyzers; Calibration Problems; Installation; Maintenance

Objectives

- Identify the main components in the combustion process.
- Describe the various kinds of instruments used for measuring the products of combustion.
- Discuss the principles of operation of instruments that measure the products of combustion.
- Describe the basic maintenance procedures for instruments that measure the products of combustion.
- Discuss the various sampling techniques for measuring the products of combustion.

Lesson 5: Chromatography

Topics

Chromatograph Operation; Gas Chromatography; System Valves; Detectors; Liquid Chromatography; Chromatograms; Calibration; Chromatography Variables; Installation and Maintenance

Objectives

- Discuss the principles of chromatograph operation.
- Describe four kinds of detectors used with chromatographs.
- Describe four kinds of liquid chromatographs.
- Explain how to read a chromatogram.
- Discuss chromatograph calibration techniques and identify variables that can affect chromatograph accuracy.
- Discuss chromatograph maintenance considerations.

Final Control Elements

Course 279: Final Control Elements

Covers how elements in a closed-loop system affect final control element. Describes components in final control subsystems. Discusses operations of solenoids, motors, relay systems, and PLCs. Explains pneumatic actuators and positioners. Describes mechanical advantage in several hydraulic control systems. Compares construction, characteristics, and applications of eight control valves. Traces operation of each element in typical feedwater, turbine, and robotic control systems.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Final Control Elements in Process Loops

Topics

What is a Final Control Element?; Compensation; Feedback Loops; A Typical System with Feedback; Effects of Disturbances on Performance; Parts of a Final Control Subsystem; Electrical Control Signals; Amplifiers; Digital Signals; Fluidic Control Signals

Objectives

- Discuss the function of final control elements in process loops.
- Explain how an actuator is used with the final control element.
- Discuss the effect of a disturbance on the performance of a process loop.
- Describe the three parts of a final control element subsystem.
- Discuss the differences between electric and fluidic control signals in the operation of final control elements.

Lesson 2: Electric Actuators

Topics

Solenoids; Solenoid-Operated Valves; Electric Motors; DC Motors; AC Motors; Three-Phase Induction Motors; Single-Phase Induction Motors; Stepper Motors; Relay Systems; Programmable Logic Controllers

Objectives

- Describe the operation of a solenoid with a valve.
- Name the basic components of dc and ac electric motors and explain how they work.
- Discuss the advantages of universal motors and stepper motors.
- Explain how an electromechanical relay works.
- Name at least three kinds of relays in use today and give typical applications for them.
- Discuss the applications and advantages of programmable logic controllers.

Lesson 3: Pneumatic and Hydraulic Actuators

Topics

Pneumatic Actuators; Effects of Changing Pressure; Relationship of Pressure, Volume, and Temperature; Effects of Changing Temperature; Diaphragm Actuators; Piston Actuators; Positioners; Hydraulic Actuators; Hydraulic Principles; Mechanical Advantage; One-Way Hydraulic System; Two-Way Hydraulic System; Uses for Hydraulic Systems; Hydraulic Fluid; Hydraulic Maintenance

Objectives

- Describe the basic principles of operation for both pneumatic and hydraulic actuators.
- Discuss the relationships among pressure, temperature, and volume in a pneumatic system.
- Compare the operation of direct- and reverse-acting actuators.
- Describe the major components of a simple hydraulic system.
- Discuss the characteristics of proper hydraulic fluid and describe elements of hydraulic system maintenance.

Lesson 4: Control Valves

Topics

Control Valve Components; Kinds of Control Valves; Globe Valves; Cage Valves; Butterfly Valves; Ball Valves; Sliding-Gate Valves; Diaphragm Valves; Split-Body Valves; Proportional/Servo Valves; Other Control Valves; Control Valve Flow Characteristics; Mechanical Requirements; Selecting Control Valves

Objectives

- Describe the components of a control valve.
- Compare the operation and advantages of globe, cage, butterfly, ball, sliding-gate, diaphragm, and split-body valves.
- Discuss the operation, advantages, and disadvantages of proportional/servo valves.
- Explain the differences in linear, quick-opening, and equal-percentage flow characteristics.
- Discuss mechanical requirements for valves and valve actuator requirements.
- Explain the relationship of flashing and cavitation to proper control valve selection.

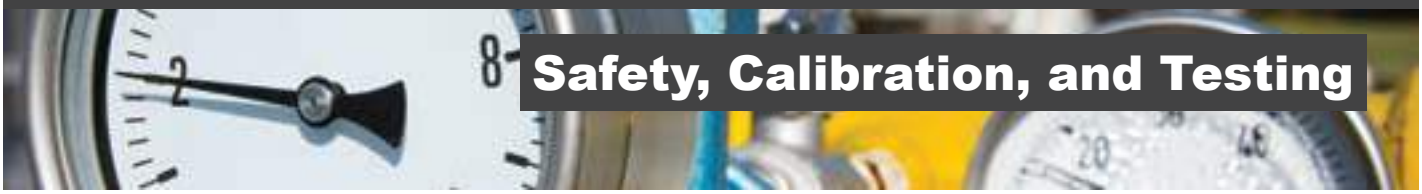
Lesson 5: Final Control Element Applications

Topics

Feedwater Control Systems; How the Feedwater Control System Works; Sequential Valve Control; Control and Block Valves; Relay Logic; Automatic Valve Control; Turbine Control Systems; Robotic Systems

Objectives

- Describe the sequential valve control used in a typical feedwater control system.
- Describe a typical relay logic system.
- Discuss the use of limit switches for automatic valve control.
- Describe the operation of a hydraulic fluid supply system for a turbine generator.
- Describe the operation of an industrial robotic system.



Safety, Calibration, and Testing

Course 280: Safety, Calibration, and Testing

Covers the responsibilities of employer, employee, and regulatory agencies in maintaining safety. Discusses ways of identifying and handling chemical, electrical, biological, radiation, and mechanical hazards. Discusses importance of maintenance (including calibration) and proper record keeping. Describes use of common electrical and electronic test instruments. Offers guidelines for handling heavy equipment, decontaminating and servicing pneumatic and hydraulic equipment, and troubleshooting. Discusses specification details, conversion between English and SI units, calibration methods, and the maintenance of records.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Safety Standards and Practices

Topics

Identifying Hazards; Safety Regulations; Employer Responsibility; Your Responsibilities; Government Safety Regulations; Compressed Gases; Chemical Hazards; Electrical Hazards; Biological Hazards; Radiation Hazards; Mechanical Hazards; Noise Pollution; General Precautions

Objectives

- Discuss kinds of hazards and compare employer and employee responsibilities relating to safe job practices.
- Describe safe procedures for working with compressed gases, acids, flammable solvents, and other hazardous chemicals.
- Describe ways to minimize the possibilities of hazardous or lethal electric shock, including safe lockout procedures.
- Explain the use of dosimeters.
- Identify potential safety hazards in the instrument shop and along the process control network and describe the use of appropriate safety equipment for each hazard.

Lesson 2: Servicing Fundamentals

Topics

Why Is Instrument Servicing Necessary?; Repair Modes; Repair Records; Failure Mode Analysis; Maintenance Modes; Maintenance Records; Calibration Modes; Calibration Records; Calibration Seals; Care of Tools and Equipment; Shop Layout and Operations

Objectives

- Compare methods of on-site and shop repair of malfunctioning instruments.
- Describe the differences between repairing, maintaining, and calibrating instruments.
- Describe the contents of an equipment history file and a process loop file.
- Discuss the benefits of failure mode analysis.
- Describe proper calibration procedures, including use of calibration seals, and explain what NIST-traceable means.
- Describe the typical main sections of an industrial instrument shop.

Lesson 3: Electrical and Electronic Stations

Topics

Test Station Requirements; Electrical Station; Electronic Station; Electrical Test Equipment; Electronic Test Equipment; Pneumatic and Hydraulic Test Equipment; Test Stands; On-Site Operations; Calibration; Maintenance Records and Files

Objectives

- Describe the differences between electrical and electronic test areas.
- Describe how the ammeter, megohmmeter, wattmeter, and dynamometer are used in electrical work.
- Describe how the multimeter, signal/waveform generator, oscilloscope, voltage and current source, and frequency counter are used in electronics.
- Discuss the benefits of accurate calibration and thorough equipment maintenance records.
- Explain how test stands are used and name three kinds of operations that are typically conducted on site.

Lesson 4: Pneumatic and Hydraulic Stations

Topics

Purpose of Pneumatic/Hydraulic Stations; Power Requirements; Handling Heavy Equipment; Cleaning and Decontamination; Safety in Cleaning; Testing and Evaluation; Disassembling the Equipment; Reassembling the Equipment; Calibration; Test Stands; On-Site Servicing

Objectives

- Describe the layout and power requirements of a typical pneumatic/hydraulic station.
- Describe safe and efficient methods of cleaning pneumatic and hydraulic instruments and controls.
- Discuss procedures for testing and evaluating a faulty component, using the calibration of a pressure-to-current (P/I) transmitter as an example.
- Describe proper procedures for disassembling and reassembling pneumatic and hydraulic components.
- Name the steps in preparing to service instruments on site.

Safety, Calibration, and Testing

Lesson 5: Instrument Troubleshooting

Topics

Troubleshooting Requirements; Knowledge of the Equipment; Manufacturer's Literature; Maintenance and Repair Records; Tools and Test Instruments; Calibration Standards; Troubleshooting Techniques; Gathering Information; Checking the Records; Returning the Loop to Operation; Inspecting the Instrument; In-Shop Troubleshooting; Recording the Repair

Objectives

- Explain how an understanding of the process and its instrumentation reduces troubleshooting time.
- List at least four kinds of information typically included in a manufacturer's manual or instruction book.
- Describe the contents of an instrument history file and explain its usefulness in troubleshooting.
- Discuss the kinds of tools, including calibration standards, you are apt to use in troubleshooting.
- Describe the steps in a typical troubleshooting procedure and explain how to use a branching troubleshooting chart.
- Describe cascading failure.

Lesson 6: Systems Specifications and Instrument Calibration

Topics

Interpreting Specifications; Error; Accuracy; Precision; Resolution; Transfer Function and Sensitivity; Hysteresis; Response Time; Time Constant; Units of Measurement; SI Units; English Units; Calibration; Standards; Calibration Laboratory; Field Calibration

Objectives

- Discuss the specifications of a typical measurement system.
- Explain how to read a graph showing a linear or nonlinear transfer function, hysteresis, or the time constant.
- Discuss SI and English systems of units and explain how to convert from one to the other.
- Describe the elements of instrument calibration.
- Discuss the standards commonly used in instrument calibration.

PROCESS CONTROL SYSTEMS

The Process Control Systems Series explains how the elements discussed in Process Control Instrumentation work together. It develops concepts of system control from basic controller and control loop PID operation through integrated systems, with emphasis on distributed control systems. In addition, the series discusses data transmission methods, including fiber optics, and describes safe ways of maintaining system quality.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
281: Working with Controllers					206
282: How Control Loops Operate					207
283: Data Transmission					209
284: Computers in Process Control					211

Working with Controllers

Course 281: Working with Controllers

Covers the purposes and kinds of controllers and their relationship to other components in process control systems. Explains the concepts of current-, position-, and time-proportioning control. Compares the operation of several kinds of controllers. Describes the operation of proportional, integral, and derivative modes, and discusses tuning procedures for each. Discusses cascade, feedforward, ratio, and auctioneering control systems as well as other operations. Describes ways to eliminate or reduce controller problems.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Introduction to Controls

Topics

Development of Controllers; Purpose of Automatic Controllers; Kinds of Controllers; Variables; Process Dynamics; Final Control Elements; Current Proportioning; Position Proportioning; Time Proportioning; Controller Modes and Actions; Controller Terminology; Controller Alarms and Options; Advanced Controllers; Safety in Control Loops; Accuracy in Control Loops

Objectives

- Describe the kinds of controllers most often used in industrial applications.
- Discuss six important problems of process dynamics that controllers must overcome.
- Compare the actions of current proportioning, position proportioning, and time proportioning.
- Name four kinds of controller alarms.
- Discuss the importance of safety in control loops.

Lesson 2: Controller Operations

Topics

Kinds of Controllers; Automatic/Manual Control; Controller Range and Span; Direct- and Reverse-Acting Controllers; On/Off Controllers; Proportional Controllers; Controller Tuning; Kinds of Output; Current-Proportioning Control; Time-Proportioning Control;Position-Proportioning Control; Control Strategies

Objectives

- Explain why automatic/manual control is necessary.
- Explain how on/off controllers work and discuss the difference between on/off and proportional controllers.
- Describe a basic controller tuning process.
- Describe current-, time-, and position-proportioning controllers and name possible uses for each.
- Explain how split control works.

Lesson 3: Controller Modes and Tuning

Topics

Controller Tuning; Proportional Mode; Offset; Integral Mode (Reset); Derivative Mode (Rate); Single-Mode Controller; Two-Mode Controller; Three-Mode Controller; Tuning the Control Loop; Step-Change Response Method

Objectives

- Describe the effect of the proportional, integral, and derivative modes on a controller's response to process changes.
- Discuss proper uses for the proportional, integral, and derivative modes.
- Explain how the proportional, integral, and derivative modes affect the tuning of a controller.
- Describe the procedure for tuning a controller by the step-change response method.

Lesson 4: Special Controller Applications and Options

Topics

Cascade Control; Feedforward Control; Ratio Control; Auctioneering Control; Hardware Options for Controllers; Auto/Manual Station; Remote Setpoint; Auxiliary Outputs; Indicators; Operational Features; Limits and Alarms

Objectives

- Compare cascade, feedforward, ratio, and auctioneering control strategies.
- Describe three optional features used with auto/manual controllers.
- Discuss the use of remote setpoint, auxiliary outputs, and several kinds of indicators as hardware options for controllers.
- Explain how input signal conditioning, anti-reset windup, adaptive gain, error-squared calculation, and setpoint/output ramp and clamp affect controller operation.
- Discuss the use of limit and alarm options available for controllers.

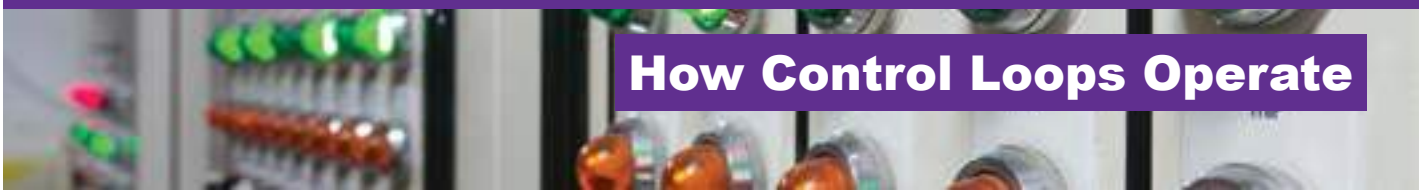
Lesson 5: Maintaining Controller Systems

Topics

Preventing Controller Problems; Electrical Noise; Electrical Noise Suppression; Regulating Primary Power; Electrical Coupling; Effects of Temperature Variations; Test Equipment; Test Connections; Maintenance and Troubleshooting

Objectives

- Describe five ways of suppressing electrical noise.
- Discuss the effects of an inadequate power supply and explain how to regulate it.
- Describe ways to avoid the harmful effects of electrical coupling.
- Explain how temperature variations affect controllers.
- Describe the kinds of equipment and proper connections needed to test controllers.
- Discuss elements of effective controller maintenance and troubleshooting.



How Control Loops Operate

Course 282: How Control Loops Operate

Covers definition of control loop terms and characteristics. Includes specific examples of operation of control loops of many kinds. Discusses proportional, integral, and derivative modes in detail. Describes advanced control methods by means of four strategies with specific examples. Examines the effects of loop dynamics on system stability. ISA and SAMA instrumentation symbols and interpretation and use of process drawings and diagrams are covered.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Fundamentals of Control Loops

Topics

Control Loops; Control Loop Definitions; Process Sensors; Sensor Characteristics; Controllers; Recorders; Signal Conditioners; Final Control Elements; Control Loop Applications

Objectives

- Explain the difference between an open loop and a closed loop.
- Define error, feedback, disturbance, and feedforward control.
- List several kinds of process sensors and describe the operation of each.
- Explain how accuracy, resolution, sensitivity, linearity, and step response affect sensor operation.
- Describe the functions of process controllers, recorders, signal conditioners, and final control elements.
- Explain the basic operation of a typical control loop.

Lesson 2: Control Loop Characteristics

Topics

Classification of Control Modes; Two-Position Control; Floating Control; Continuous Control Modes; Proportional Mode; Integral Mode (Reset); Derivative Mode (Rate); PID Mode; Digital Control Systems; Supervisory Control; Direct Digital Control (DDC); Distributed Control System (DCS)

Objectives

- Describe the difference between continuous and discontinuous control modes and give an example of each.
- Describe the action of the various continuous control modes.
- Define proportional band, reset time, and rate time.
- Discuss the advantages of each of the combination control modes.
- Name several advantages of digital controllers.
- Discuss the differences between supervisory control, direct digital control, and distributed control systems.

Lesson 3: Advanced Control Methods

Topics

Advanced Control; Cascade Control System; Feedforward Control; Ratio Control System; Ratio Control in a Secondary Loop; Multivariable Control System; Multivariable Loop Example

Objectives

- Describe how a cascade control system works.
- Identify the primary and secondary variables in a cascade loop.
- Compare feedforward and feedback control.
- Identify dependent and independent variables in ratio control.
- Explain the advantage of having a secondary control loop in ratio control.
- Describe how a multivariable control system works and define interaction.

Lesson 4: Loop Dynamics

Topics

Loop Dynamics; Effects of Process Time Lag; Compensating for Dead Time; Higher-Order Delay Lags; System Stability and Transient Response; Controller Tuning for Stability; Gain and Phase Shift

Objectives

- Describe two kinds of process time lags and give an example of each.
- Discuss the effects of capacitance and resistance on loop dynamics.
- State the three main objectives of a well-designed process control system.
- Describe how PI, PD, and PID controllers are adjusted to achieve optimum response.
- Discuss the effects of system gain and phase shift on system stability.

Lesson 5: Loop Protection

Topics

Loop Protection in Hazardous Areas; Explosion-Proof Enclosures; Intrinsically Safe Instrument Systems; Additional Loop Protection; Fail-Safe Mechanisms; Hard and Soft Constraints; Alarms and Annunciators; Interlocks

Objectives

- Discuss the classification of hazardous locations as identified in the NEC Handbook.
- Define volatility and flash point, and explain the purpose of a purged enclosure.
- Describe two kinds of explosion-proof enclosures.
- Discuss ways of making a system intrinsically safe.
- Describe examples of fail-safe mechanisms, and differentiate between hard and soft constraints.
- Compare latching and nonlatching alarm systems, and explain the function of annunciators.
- Discuss the purpose and operation of interlocked and sequential control.

Lesson 6: Process Control Symbols and Drawings

Topics

Instrument Identification; Symbols Used in Process Control; Symbol Recognition; Piping and Instrument Drawing; Location Drawing; Loop Diagram; Installation Drawing; Wiring Diagram; Other Kinds of Symbols

Objectives

- Recognize standard symbols used in process control diagrams.
- Describe a process control system through the use of instrument symbols.
- Recognize and use four kinds of process control diagrams.
- Analyze a process control drawing for the elements, signal flow, and process flow.

How Control Loops Operate

Lesson 7: Flowcharts and Electrical Diagrams

Topics

Sequence of Operation; Flowchart; Switches; Relays; Motor Starters; Electrical Elementary Diagram; Pump System Schematic Diagram; Programmable Controller Diagram; Electronic Symbols

Objectives

- Convert sequence-of-operation text to a flowchart.
- Read electrical and electronic control diagrams and drawings.
- Recognize symbols used on electrical and electronic diagrams, including those for PLCs and SAMA logic.
- Convert electrical diagrams to PLC diagrams.
- Discuss the role of computers in process control.

Data Transmission

Course 283: Data Transmission

Covers mechanical, hydraulic, pneumatic, telemetric, and wireless data transmission methods. Discusses indicators, other devices, and methods used for electrical/electronic data transmission in detail. Compares methods and standards for parallel and serial digital data transmission. Describes optical isolation and the operation of optical data transmission systems in detail. Provides specific methods for preventing common kinds of data transmission interference.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Process Data Transmission Methods

Topics

Data Handling; Open-Loop and Closed-Loop Control; Local Indicators; Remote Indicators; Analog, Digital, and Discrete Control; Environmental Conditions; Process Transmission Methods; Mechanical Data Transmission; Hydraulic Data Transmission; Pneumatic Data Transmission; Electronic Data Transmission; Optical Data Transmission; Telemetric Data Transmission

Objectives

- Describe the differences between data transmission in open- and closed-loop systems and with local and remote indicators.
- Discuss the differences among analog, digital, and discrete control.
- Discuss the use of intrinsically safe and explosion-proof equipment.
- List the advantages and disadvantages of mechanical, hydraulic, and pneumatic data transmission.
- Compare voltage-loop and current-loop transmission for analog data and explain the importance of resolution for digital data transmission.
- List the advantages and disadvantages of optical and telemetric data transmission.

Lesson 2: Electrical Data Transmission

Topics

Analog and Digital Data; Electronic PV Indicators; Recorders and Data Loggers; Sensors and Transducers; Strain Gauge; Signal Conditioning; Signal Conversion; Compensation; Span and Zero Adjustment; Linearization; Conversion to Engineering Units

Objectives

- Compare analog and digital data representation.
- Discuss uses for bar graph displays, CRT displays, recorders, and data loggers.
- Describe the characteristics of the electrical output signals from analog sensors and transducers, using a strain gauge as an example.
- Discuss the significance of the common-mode rejection ratio in signal conditioning.
- Describe the processes of signal conversion, compensation, zero and span adjustment, linearization, and conversion to engineering units.

Lesson 3: Digital Data Transmission

Topics

Digital Data; Number Systems; Data Formats; ASCII; Error Correction; Analog-to-Digital Conversion; Distributed Process Control; Parallel Data Transmission; Parallel Transmission Standard; Serial Data Transmission; Serial Transmission Standards

Objectives

- Discuss the differences between analog and digital data forms.
- Discuss several reasons for using digital data.
- Describe methods used to interface process control data signals to a communications network.
- Explain how analog data are converted to digital form for transmission and display.
- Discuss the differences between parallel and serial data transmission systems.

Lesson 4: Optical Data Transmission

Topics

Optical Data Transmission; Optical Isolation; Fiber Optic Transmission; Fiber Optic Transmission Advantages; Fiber Optic Cable; Optical Propagation; Fiber Optic Connections; Installation of Fiber Optic Cables; Light Sources; Detectors; Fiber Optic Standards

Objectives

- Name the basic elements in a data transmission system based on light energy.
- Explain how optoisolators work and why they are used.
- Describe the advantages and disadvantages of optical data transmission.
- Explain how light rays are propagated down glass fibers.
- Discuss connection and installation methods for fiber optic cables.
- Discuss the selection of light sources and detectors.

Data Transmission

Lesson 5: Data Transmission Interference

Topics

Electrical Noise; Process Noise; Signal-to-Noise Ratio; Noise Sources; Alternating Current Power Line Noise; Electromagnetic Interference; Capacitive Coupling; Ground Loops; Noise Reduction Techniques; Filters; Reducing Alternating Current Power Line Noise; Reducing Electromagnetic Coupling; Electrostatic Shielding; Differential Measurements; Reducing Ground Loop Noise; Reducing RFI; Nonelectrical Coupling

Objectives

- Define electrical noise, process noise, and the signal-to-noise ratio.
- Explain how ac power lines, EMI, capacitive coupling, and ground loops cause electrical noise.
- Describe two kinds of noise filters and explain three methods of reducing ac power line noise.
- Compare methods for reducing electromagnetic and electrostatic coupling.
- Discuss the use of differential measurements and the CMRR.
- Describe ways of reducing ground loop noise and RFI and explain when optical coupling might be used.

Computers in Process Control

Course 284: Computers in Process Control

Covers the evolution of today's process control computer systems. Compares smart components to older conventional system devices. Compares PLCs and PACs. Includes an introduction to Fieldbus. Covers the architecture (hardware and software), configuration, and operation of distributed control systems in depth (two entire lessons) by using as an example a typical DCS controlling an ice cream plant. Defines common terms used in today's integration of discrete and continuous processes with plant business functions.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: History and Overview

Topics

Introduction; Development of Computers in Process Control; Business Computer Experiments; Supervisory Control and Data Acquisition (SCADA); Microprocessor-Based Instruments; Distributed Control; Personal Computers; Programmable Logic Controllers; Artificial Intelligence, Expert Systems, and Fuzzy Logic; Integrated Control Systems

Objectives

- Discuss the history of the application of computers to continuous and batch process control.
- Describe the function of an RTU in a SCADA system.
- Describe the development of distributed control systems from microprocessor-based instruments, including programmable logic controllers.
- Compare the hardware, operating systems, software, and applications of a PC with a household VCR.
- Compare the concepts of artificial intelligence, expert systems, and fuzzy and crisp logic.

Lesson 2: Small Computers in Process Control

Topics

Small Computers; Smart Sensors and Transmitters; Smart Signal Conditioners; Smart Final Control Elements; Special Instruments; Microprocessor-Based Panelboard Instruments; Single-Loop Controllers; Multiloop Controllers; Networks; Microprocessor-Based Indicator Circuits; Microprocessor-Based Recorders; Programmable Logic Controllers; Integrated Control Systems; Personal Computers

Objectives

- Describe the various kinds of small computers used in process control.
- Explain how a "smart" device differs from its conventional counterpart.
- Discuss the similarities between microprocessor-based instruments and conventional instruments and list several advantages of microprocessor-based instruments.
- Describe the roles of two kinds of PCs (programmable controllers and personal computers) in process control.

Lesson 3: DCS Architecture

Topics

Importance of Distributed Control Systems; Distributed Control System Hardware; Workstations; Remote Processing Units;Host/Guest Computers; Transmission System; Distributed Control System Software; Distributed Control System Reliability; Peripherals; What is Fieldbus?

Objectives

- Describe the elements of a typical workstation.
- Discuss the functions of remote processing units and host/guest computers in DCSs.
- Compare star, hub, and ring network topologies and token-passing, contention, and polling protocols.
- Explain why today's DCS users must be more computer literate than previously.
- Discuss ways of calculating and ensuring DCS reliability.
- Describe the functions of six typical DCS peripherals.
- List advantages and disadvantages of all-digital process control systems, such as fieldbus.

Lesson 4: DCS Configuration and Operation

Topics

Setting Up Distributed Control Systems; Configuration; Hierarchical Displays; DCS Model TPC-284; Preparation for Configuration; Configuring Operating Displays; Configuring Auxiliary Displays; Operation

Objectives

- Describe the basics of a simple configuration process.
- Discuss the preparatory steps required for configuration.
- Describe a typical hierarchical display arrangement and discuss the progression of the configuration process from level to level.
- Discuss the automatic configuration of auxiliary displays.
- Discuss the DCS functions for which the operator is and is not responsible.

Lesson 5: Systems and Application Integration

Topics

The Scope of Integration; Total Business Integration; Discrete Processes and Manufacturing Systems; Flexible Manufacturing and Materials Control; Statistical Process Control; Integration of Continuous and Batch Processes

Objectives

- Discuss the development of integration in industry.
- Describe how continuous and discrete processes fit into the concept of total business integration.
- Describe the purposes of MAP and OSI.
- Discuss the functions of CAD, CADD, CAE, CAM, and cell control in discrete processes.
- Discuss the importance of FMS, MRP, JIT, and MMS in today's integrated industrial plant.
- Explain how SPC ensures quality control in open-loop processes.
- Discuss the advantages of integrating batch, continuous, and discrete processes throughout a plant.

PROGRAMMABLE LOGIC CONTROLLERS

Programmable Logic Controllers (PLCs) presents many aspects of PLC systems, both large and small - their structure, how they operate, their capabilities, and their limitations. It supplies numerous application examples and describes PLC functions in such a way as to pertain to a great number of models in current use. The course treats PLC programming procedures in a generic manner so the trainee can adapt them to specific procedures outlined in any manufacturer's programming manual.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
298: Programmable Logic Controllers					213

Programmable Logic Controllers

Course 298: Programmable Logic Controllers

Covers the basic hardware and operating principles of PLCs, their inputs and outputs, programming, maintenance/troubleshooting, and networking.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Introduction to Programmable Logic Controllers

Topics

The Electromagnetic Relay; Characteristics of Programmable Controllers; Applications of Programmable Controllers; Limitations of Programmable Controllers; Parts of a Programmable Logic Controller System; The Input Side; The Processor; The Output Side; Programming Devices; Power Supplies

Objectives

- Describe an electromagnetic relay and define the terms control circuit, power circuit, NO and NC.
- Define programmable logic controller.
- Describe the general type of application in which a programmable logic controller would best be used, and give examples.
- Define scan time.
- Name each of the blocks in a block diagram of a programmable logic controller system and explain how each functions within the system as a whole.
- Define memory and explain the different types.

Lesson 2: Number Systems and Logic

Topics

Number Systems; Binary-Coded Decimal (BCD); ASCII; Gray Code; Boolean Logic; Ladder Logic

Objectives

- Compare the decimal, binary, octal, and hexadecimal number systems.
- Explain the purpose for using each of the following: BCD, Gray code, and ASCII.
- Explain what AND, OR, and NOT mean in Boolean logic, and identify the symbols for each.
- Identify AND and OR logic circuits in a relay ladder diagram, and construct a truth table for each.
- Explain the basic concepts of ladder logic.

Lesson 3: Programming the System

Topics

PLC Programming; Ladder Logic Programming; Boolean Programming; The AND Instruction; The OR Instruction; The Stack Register

Objectives

- Explain the relationship between a programmable logic controller processor and program.
- Define the term scan and explain the basic steps involved in a scan.
- Explain the basic concepts of ladder logic programming.
- Explain the purpose of a parallel branch in a ladder logic program.
- Explain the basic concepts of Boolean programming.
- Define stack register and state the stack rule.

Lesson 4: Input/Output Devices and Modules

Topics

Definition of I/O Devices; Discrete Input Devices; Analog Input Devices; Digital Input Devices; Discrete Output Devices; Analog Output Devices; Sourcing and Sinking; Definition of I/O Modules; Input Modules; Output Modules

Objectives

- Explain the operation of common input and output devices and identify their symbols.
- Describe the relationship of an input/output device to a terminal on an input/output module.
- Contrast the basic concepts of a sourcing device and a sinking device.
- Explain the operation of various input and output modules.

Lesson 5: Developing a Programmable Logic Controller System

Topics

Before You Begin; Equipment Operation Specifications; Sizing the System; Program Development; Assembling the Documentation Package; Functional Model; Startup and Debugging

Objectives

- Explain the importance of working with accurate information from a specification.
- Demonstrate how to size a system.
- List the elements in a good documentation package.
- Name the steps involved in specifying the hardware and developing the program for a simple control system.
- Describe system startup and debugging procedures.

Lesson 6: Maintenance and Troubleshooting

Topics

The Importance of Documentation in Maintenance Troubleshooting; Using the Hardware Documentation; The Maintenance Log; Using the Program Documentation; Operational Documentation; Routine Maintenance; Batteries; Troubleshooting; Problems in Troubleshooting; Troubleshooting in Practice

Objectives

- Explain the importance of good documentation.
- Tell what type of information can be found in user's manuals and operations manuals.
- Tell what types of logs are kept and why they are necessary.
- Explain the major concepts of troubleshooting, including problems sometimes encountered.
- Describe routine maintenance procedures required by a programmable controller system.

Programmable Logic Controllers

Lesson 7: System Expansion and Data Networks

Topics

I/O Expansion; Configuring the System; Math and Data Handling Instructions; Timers and Counters; The Shift Register; Spray Booth Retrofit; Indexing Table Retrofit; Local Area Networks; Uses for LANs; Transmission Media; Transmission Schemes; Vendor Offerings

Objectives

- Compare the procedures involved in local and remote I/O expansion.
- Explain what is meant by configuring a system.
- Describe the operation of the shift register instruction.
- Explain how math and data-handling instructions work and why they are added to PLC systems.
- List important items to consider in I/O expansion and retrofitting.
- Define the terms local area network, baud rate, and throughput.
- List and explain the contents of a data packet used in LAN data transmission.
- Name and define the three main applications of LANs.
- List advantages and disadvantages of the three common transmission media used with LANs.

RIGGING AND EQUIPMENT INSTALLATION

The rigging and installing of machinery requires critical basic knowledge if the job is to be done with maximum efficiency and safety. With TPC Training's Rigging and Equipment Installation Series, your trainees will get the knowledge they need. The first course introduces them to the proper and safe use of rope, chains, hoists, and cranes. The second course shows how to apply these skills to the moving, leveling, aligning, and anchoring of equipment. The focus is on safety throughout this series, especially when it comes to lifting, moving heavy equipment, and working in elevated positions.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
318: Industrial Rigging Principles and Practices	✓	✓	✓	✓	216
319: Equipment Installation		✓	✓	✓	218

Industrial Rigging Principles and Practices

Course 318: Industrial Rigging Principles and Practices

Covers techniques and safeguards in the use of rope, chain, hoists, and scaffolding when moving heavy plant equipment and maintaining plant utilities.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Introduction to Industrial Rigging

Topics

Tools of Industrial Rigging; the Rigging System; Determining the Weight of a Load; Calculating an Allowable Load; Determining Center of Gravity; Vertical and Horizontal Force; Types of Slings; Hooks; Hoist Hooks; Special-Purpose Rigging Hooks; Hook Operating Practices

Objectives

- Identify the tools used in rigging and explain the purpose of each.
- Give examples of three methods of calculating the weight of a load.
- Explain center of gravity and its importance in rigging a load.
- Describe four common sling arrangements and the relation between sling angle and horizontal force.
- Name five types of hooks frequently used in rigging and explain the purpose of each.
- Discuss proper hook use and cite four reasons for removing a hook from service.

Lesson 2: Wire Rope and Wire-Rope Slings

Topics

Wire Rope; Wire-Rope Construction; Wire-Rope Classification; Wire-Rope Strength; Factors Affecting Wire-Rope Strength; Seizing, Cutting, and Splicing; Wire-Rope Slings; Inspecting Wire-Rope Slings

Objectives

- Identify the component parts of wire rope and describe its construction and classification.
- Identify and discuss the factors that affect wire rope strength.
- Describe the basic single-leg and multiple-leg slings and the calculation of their allowable loads.
- Enumerate the signs of damage that would probably cause a wire rope to be removed from service.

Lesson 3: Chain and Metal-Mesh Slings

Topics

Welded-Link Chain; Chain Grades; Chain Strength; Factors Affecting Chain Strength; Chain Slings; Inspecting Chain Slings; Metal-Mesh; Metal-Mesh Slings; Metal-Mesh Sling Materials; Factors Affecting Metal-Mesh Sling Strength; Inspecting Metal-Mesh Slings

Objectives

- Identify the different grades of chain and name some of their applications.
- Define the terms working load limit, proof test, and minimum breaking force.
- List and discuss four factors that affect the strength of chain slings.
- Describe three types of damage you might see in a daily inspection of chain slings that would lead you to set the sling aside for more thorough examination.
- Describe the two standard types of end fittings for metal mesh slings and the hitches for which each can be used.
- Name several advantages of, and applications for, metal mesh slings.
- List the visible signs of damage that would cause you to recommend a sling's removal from service.

Lesson 4: Fiber Rope and Webbing Slings

Topics

Fiber Rope; Natural-Fiber Rope; Synthetic-Fiber Rope; Fiber-Rope Strength; Factors Affecting Fiber-Robe Strength; Whipping Rope Ends; Splicing Fiber Rope; Inspecting Fiber-Rope Slings; Encased Polyester-Fiber Slings; Synthetic Webbing; Synthetic-Web Slings; Factors Affecting Web-Sling Strength; Inspecting Synthetic-Web Slings

Objectives

- Identify the grades of manila rope that can be used for overhead lifting.
- Name the three commonly used synthetic-fiber ropes and list three of their advantages over manila.
- Discuss the factors that affect the strength of fiber rope.
- Name the signs of wear or damage that would warrant setting a fiber-rope sling aside for more detailed inspection.
- Describe an encased polyester fiber sling.
- Explain the construction of synthetic-web slings and name four of the basic types.
- List examples of visible damage that should cause a synthetic-web sling to be removed from service.

Industrial Rigging Principles and Practices

Lesson 5: Industrial Hoists and Cranes

Topics

Industrial Hoists and Cranes; Overhead Manual Chain Hoists; Overhead Power Hoists; Overhead Wire-Rope Hoists; Types of Wire-Rope Hoists; Operating a Wire-Rope Hoist; Side Pull;Overload Limit Device; Underhung and Top-Running Cranes; Jib Cranes; Hoist and Crane Inspection; Inspecting Hooks, Wire Rope, and Chain

Objectives

- Describe the characteristics of the various kinds of overhead hoists.
- Explain the differences between single and double reeving.
- Explain the proper function and operation of an upper limit switch and an overload limit device.
- Describe and contrast the construction of top-running and underhung cranes.
- Identify the three basic types of jib cranes.
- Describe what the rigger's daily visual inspection should include.
- List examples, from the additional criteria given in this lesson, of conditions that should warrant removal of wire rope or hoist load chain from service.

Lesson 6: Operating Practices

Topics

General Practices; Sling Operating Practices; Hoist and Crane Operation; Special Heavy Lifts; Pulling a Load; Setting a Load; Turning a Load; Eyebolts; The Thought Process of Rigging

Objectives

- Enumerate the general operating practices that apply to all tools of rigging.
- Explain the 11 operating practices that apply to slings.
- Discuss nine operating practices that should be observed when using a hoist or crane.
- Detail the special circumstances under which a hoist or crane may be used to pull a load or lift a load heavier than the equipment's rated capacity.
- Describe three methods of turning a load.
- Discuss the eight questions that a rigger must answer in the thought process that should precede any lift.

Lesson 7: Scaffolds and Ladders

Topics

Scaffolds; Scaffold Planking; Types of Scaffolding; Workmen's Lift Platforms; Suspension Scaffolds; Guy Lines; Scaffolding Accessories; Ladders; How to Raise a Ladder; Inspecting Ladders; Life Belts; Scaffold Safety; Ladder Safety

Objectives

- Explain the construction of pole and suspension scaffolds and lift platforms, and the safety measures that apply to them.
- Name several scaffolding accessories and explain their use.
- Discuss recommended usage and inspection of the three common types of ladders.

Equipment Installation

Course 319: Equipment Installation

Covers installation procedures for large plant equipment. Considers factors affecting proper installation in detail, from preparatory relocation of underground piping and wiring, through equipment anchoring, aligning, and test running.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Preparing the Site

Topics

The Engineer Plans the Installation; The Maintenance Supervisor's Responsibilities; Relocating Underground Piping; Relocating Underground Wiring and Cables; Protecting Nearby Buildings and Equipment; Barricading the Work Area; Removing Excavated Material; Foundation and Footings; Reinforced Concrete; Materials for Reinforcing Concrete; Using Wooden Forms; The Right Concrete Mixture; Materials for Fill around Foundation; Positioning Anchor Bolts with a Template; Installing Alignment Plates; Surface Finish of Concrete; Setting or Curing Time for Concrete; Finishing Flooring around Foundation; Outdoor Foundations; Safety Precautions for Excavation Work

Objectives

- Tell who plans the installation of new equipment and list the steps involved.
- Define the terms foundation and footing.
- Tell which type of ground will support the most weight.
- Explain how steel rods are held in position when pouring a concrete footing.
- Name the best materials for filling around a foundation.
- Explain how to protect concrete that might come into contact with oil or chemicals.
- Tell how long new concrete must sit before equipment is installed on it.

Lesson 2: Vibration Control and Anchoring

Topics

Reasons for Controlling Vibration; How to Control Vibration; Selecting Anchors and Isolators; Isolating the Foundation; Isolator Mounts; Using Anchor Bolts; Types of Anchor Bolts; Drilling Anchor Bolt Holes; Using Power Hammers; Grouting

Objectives

- Define vibration and tell how it enters and leaves equipment.
- Tell what type of isolation is best to use on sensitive testing instruments.
- Explain how to isolate anchor bolts when mounting equipment on pads.
- Tell what type of wrench to use for tightening anchor bolts.
- Name the best tool for drilling anchor bolt holes in concrete.
- Tell why the bases of production and processing equipment should be grouted.
- Explain why you must not use a concrete mix to grout anchor bolts.

Lesson 3: Moving and Setting

Topics

Uncrating New Equipment; Relocating Existing Equipment; Know the Weight of the Load; Machinery for Lifting Equipment; Raising Equipment with Jacks; Lifting Plant Equipment with Slings; Hand Tools for Moving Equipment; Crowbars; Preparing to Move the Equipment; Making the Move; Setting the Equipment in Position; Personal Safety during Installation

Objectives

- Explain the procedures involved in relocating existing equipment.
- Tell two things you must know before lifting equipment with a hoist.
- List three things to consider when selecting a jack.
- Explain the operation and uses of a roller skid.
- Tell where to find a floor's allowable load.

Lesson 4: Leveling and Aligning

Topics

Leveling Devices; Checking the Accuracy of Levels; Using Spirit and Electronic Levels; Using the Optical Level; Leveling Feet and Bolts; Wedges and Shims; Tools for Checking Alignment; Aligning Equipment on the Foundation; Using Alignment Screws; Aligning Machine Tool Equipment; Other Plant Equipment

Objectives

- Explain the correct way to handle a master precision level.
- Explain how to check the accuracy of a level.
- Name the greatest enemy of precision tools.
- Explain how to level V-shaped ways.
- Tell which leveling device is used most often on small equipment.
- Name three tools commonly used to check alignment.
- Tell how to set an alignment screw to prevent its movement.

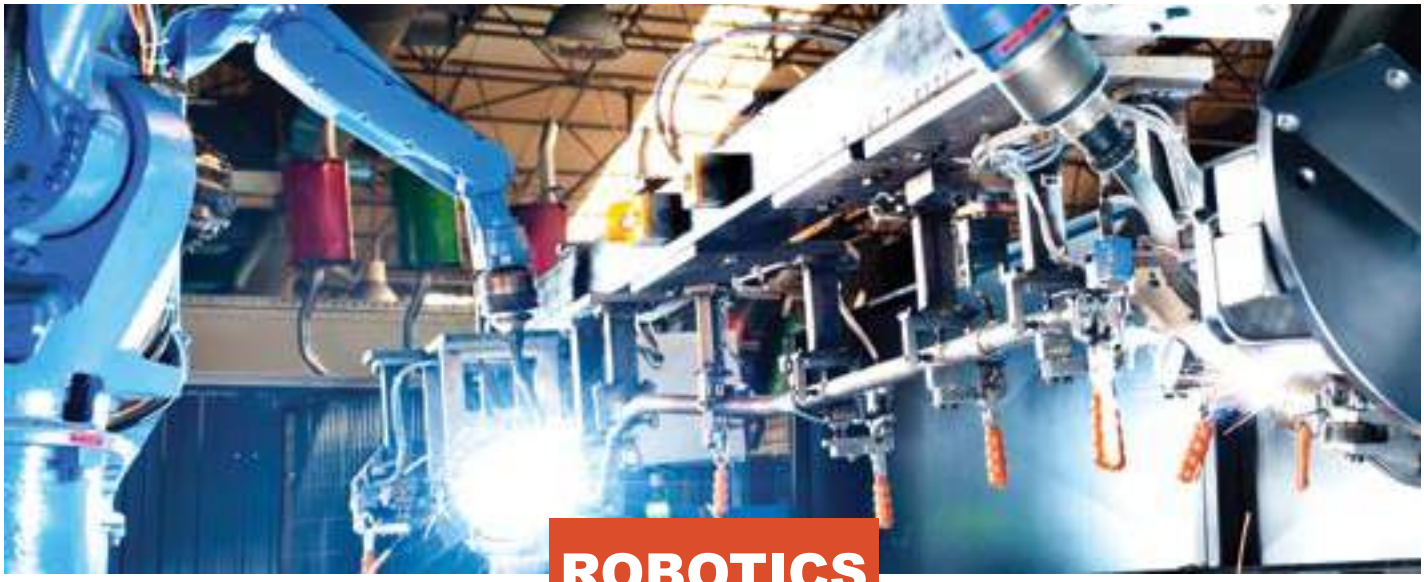
Lesson 5: Checking and Test Running

Topics

Electric Power Connections; Hydraulic and Pneumatic Power Connections; Coolant Systems for Equipment; Equipment Safety Devices; Settings and Adjustments; Equipment Operating Pressure; Limit Switches and Stops; Checking the Equipment Setup; Initial Running under Power; Test Run Guidelines; Making the Test Run; Safety Precautions for Installing Equipment

Objectives

- Explain how to test for the presence of moisture in electrical equipment.
- Tell what device is commonly used to prevent excessive pressure in a hot water heater.
- Explain the function of a pressure regulating valve.
- List the steps to take before initial equipment startup.
- Tell the usual cause of excessive temperature during equipment startup.



ROBOTICS

Robotics covers a basic survey of what robots do, how they operate, and how they are integrated into automated manufacturing. It explains robotic terminology, the classification of robots, and their principles of operation. It traces the interaction of sensors and machines in a robotic work cell, and concludes with a look at programming and "teaching" methods.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
501: Introduction to Robotics					220

Introduction to Robotics

Course 501: Introduction to Robotics

Provides the background required for a detailed study of robot systems and their maintenance. Introduces the trainee to the basics of robotics, using clear, easy-to-follow language. Includes expanded coverage of robot safety and updated sensor and programming information.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Robotics in Automated Manufacturing

Topics

Evolution of Robotics; What is an Industrial Robot?; Essential Characteristics; Robots and Automated Manufacturing; Project Manufacturing; Job Shop; Batch Manufacturing; Repetitive (Flow) Manufacturing; Continuous Manufacturing; Robot Safety

Objectives

- Identify why robots did not appear in large numbers in manufacturing until the late 1970s.
- State the Robot Industries Association's definition of an industrial robot and explain the two key words.
- Describe how industrial robots are used in batch production systems.
- Explain how industrial robots are used in repetitive manufacturing systems that utilize transfer lines.
- List at least three factors that should be considered as part of a risk assessment when a robot system is in the development stage.
- Describe and contrast the following guarding methods: barrier, presence-sensing device, awareness device, warning system.
- Define the term zero-energy state.

Lesson 2: The Basic Robot System

Topics

Manufacturing and Robot Systems; Robot Arm; Robot Controller; Power Source; Tooling; Teaching/Programming Devices; Data Storage; Definition of Terms; Critical Specifications; Payload; Degrees of Freedom; Drive Power; Repeatability; Accuracy; Work Envelope Dimensions; Speed; Memory Capacity; Programming Support; End-of-Arm Tooling; Environmental Requirements

Objectives

- Name and describe the basic building blocks of an industrial robot.
- Name and describe the additional components that make up a robot system.
- Define the following robot terms: degrees of freedom, position axes, orientation axes, work envelope, tool center point.
- Define and give an example of the following specifications for industrial robots: payload, repeatability, memory capacity, and environmental requirements.
- Explain the difference between accuracy and repeatability in robots.

Lesson 3: Robot Classification I

Topics

Robot Classification; Classification by Control System; Open-Loop Control; Nonservo Operation; Advantages of Open-Loop Control; Disadvantages of Open-Loop Control; Applications for Open-Loop Control; Closed-Loop Control; Advantages of Closed-Loop Control; Disadvantages of Closed-Loop Control; Applications for Closed-Loop Control; Classification by Application

Objectives

- Identify the five methods of classifying industrial robots.
- Explain the difference between robots with closed-loop control and those with open-loop control.
- Describe the techniques used in closed- and open-loop control in robot systems.
- List the advantages and disadvantages of open-and closed-loop control in robot systems.
- Distinguish between assembly and nonassembly robots according to the application for which they were designed.

Lesson 4: Robot Classification II

Topics

Classification by Arm Geometry; Cartesian (Rectangular) Arm Geometry; Cylindrical Arm Geometry; Spherical (Polar) Arm Geometry; Articulated Arm Geometry; Classification by Power Source; Classification by Path Control; Classification by Intelligence Level

Objectives

- Classify robots by arm geometry, power source, and path control techniques.
- Identify the basic robot work envelopes and name the arm geometries that produce them.
- Name the basic power sources used for robot motion and give an advantage and disadvantage of each.
- Identify the basic path-control techniques and describe their characteristics.

Introduction to Robotics

Lesson 5: Work-Cell Sensors

Topics

Sensor Overview; Simple Contact Sensors; Simple Noncontact Sensors; Simple Process Control Sensors; Complex Sensors; Complex Sensor Interface; Complex Contact Sensors; Complex Noncontact Sensors; Complex Process Control Sensors

Objectives

- List the two types of interfaces and three groups of sensors used in industrial robot systems.
- Describe the primary simple contact sensor commonly found in robot systems.
- Identify and explain the operation of the two simple noncontact sensors most often used in industrial robot installations.
- Explain the difference between the simple sensor interface and complex sensor interface.

Lesson 6: End-of-Arm Tooling

Topics

General Requirements; Tooling Terms; Tooling Power Sources; Tooling Overview; Standard Grippers; Servo or Nonservo Grippers; Vacuum Devices; Magnetic Devices; Flexible Pneumatic Devices; Special-Purpose Tooling; Protecting End-of-Arm Tooling; Compliance

Objectives

- Name the five general requirements all tooling must satisfy.
- Identify and describe briefly the four basic tooling power sources.
- Describe the five categories of end-of-arm tooling used in robot applications.
- Explain the function and advantages of a quick-change device.
- Define the term compliance and explain why it is important.

Lesson 7: Robot Teaching and Programming

Topics

Work-Cell Programming; Controller Functions; Robot Programming; On-Line Programming; On-Line Programming Example; Off-Line Programming; Defining Programmed Points; Writing Program Statements; Work Cell Control with a PLC; PLC Programming Example

Objectives

- List and describe the four basic functions of the computer(s) controlling an automated work cell.
- Name the two major types of robot programming and give advantages and disadvantages of each.
- Name and describe two basic methods of teach programming and tell when each is used.
- List three advantages of off-line programming.
- Name the two elements of a computer program for off-line robot programming.
- Explain the basics of ladder logic programming.

WATER / WASTEWATER TREATMENT

We rely on modern methods of water and wastewater treatment to help prevent disease and to preserve our environment. The Water / Wastewater Treatment Series concentrates on water treatment in municipal plants. Therefore, it is most useful to those who are interested in water treatment on the community level.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
381: Introduction to Water Technology					223
382: Wastewater Treatment Processes					224
383: Maintaining Wastewater Equipment					225

Introduction to Water Technology

Course 381: Introduction to Water Technology

Covers the nature, use, and properties of water. It traces the history of water treatment methods from ancient times to today's sophisticated systems. The effects of chemical and biological factors on the purity of water are explained.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Water: The Basic Resource

Topics

The Water Cycle; Precipitation; Surface Runoff; Groundwater; Lots of Water, But...; How We Use Water; Municipal Use; Industrial Use; Agricultural Use; Waste Disposal; Waste Not - Want Not; Beginning of Waterworks; Roman Waterworks; Centuries of Neglect; Beginning of Water Treatment; Upgrading Water Today

Objectives

- Name the continuing processes that make up the water or hydrologic cycle.
- Describe the atmospheric process that produces precipitation.
- Identify the users of municipal water supplies.
- Point out some of the important advances made in water treatment since 1900.
- List the benefits of the Federal Water Pollution Control Act Amendment of 1972.

Lesson 2: Water Collection, Treatment, and Distribution

Topics

Collecting Surface Water; Collecting Ground Water; Transmission of Water; Why Treat the Supply Water?; Types of Treatment; Treatment in the Treatment Plant; Distributing Treated Water; Collecting Wastewater; Treating Wastewater; Primary Treatment; Secondary Treatment; Tertiary Treatment

Objectives

- Explain the differences between a confined aquifer and an unconfined one.
- Tell why it is necessary to treat water for drinking and for manufacturing purposes.
- Describe the treatment processes of sedimentation and coagulation.
- Describe how a system for the distribution of treated water operates.
- Tell what takes place during the primary treatment of wastewater.

Lesson 3: Physical Properties of Water

Topics

Basic Properties of Water; The Color of Water; Measuring Water Color; Taste and Odor of Water; The Temperature of Water; Solids in Water; Total Solids in Water; Volatile and Fixed Solids; Turbidity and Suspended Matter; Electrical Conductivity; Measuring Conductivity

Objectives

- Distinguish between the apparent color and the true color of water.
- Name the four basic tastes of water that a person can sense.
- Tell how a rise in temperature affects the various properties of water.
- Name the sources of organic and inorganic solids that pollute wastewater.
- Explain the differences between suspended solids and dissolved solids.

Lesson 4: Chemical Properties of Water

Topics

Atoms and Molecules; Acids, Bases, and Salts; The Ionization of Water; Alkalinity; Acidity; Hardness of Water; Other Unwanted Chemicals; Dissolved Oxygen

Objectives

- Identify the particles in an atom, and tell how they fit together to form the atom.
- Describe the relationship between a pH number and the concentration of H+ ions.
- Name the two color tests for alkalinity of water and tell what colors they produce.
- Describe the ion exchange and lime-soda processes for removing hardness from water.
- Tell why a certain amount of dissolved oxygen (DO) is necessary in surface water.

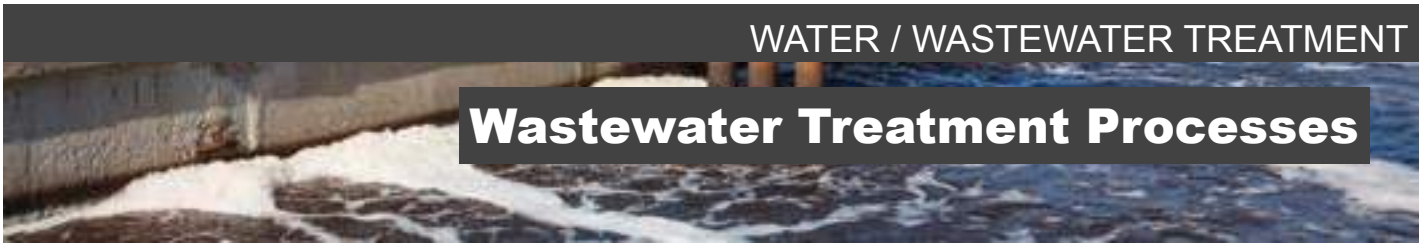
Lesson 5: Biological Properties of Water

Topics

Pathogenicity; Disinfection; Stabilization of Organic Matter; Biochemical Oxygen Demand; Factors Affecting Growth; The Food Chain; Types of Living Things; Bacteria; Environmental Classifications of Bacteria; Bacteria in Treatment Plants; Viruses; Algae; Protozoa; Higher Organisms

Objectives

- List the methods commonly used to disinfect water.
- Tell how temperature changes affect the rate at which living organisms grow in water.
- Tell how—and how rapidly—common bacteria reproduce.
- List the most effective methods used to inactivate viruses.
- Explain how the presence of algae speeds the process of eutrophication.



Wastewater Treatment Processes

Course 382: Wastewater Treatment Processes

Covers the various stages of wastewater treatment. Goes into detail on the removal of solids, then explains the use of chemical and biological processes for water purification. Covers the treatment and disposal of the extracted solids.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Overview of Wastewater Treatment

Topics

Purpose of Treatment; Sources of Wastewater; Wastewater Collection Systems; Typical Treatment Facilities; Influent; Preliminary Treatment; Primary Treatment; Secondary Treatment; Tertiary Treatment; Disinfection and Effluent Discharge; Solids Handling

Objectives

- List the purposes of wastewater treatment.
- Describe the way organic wastes pollute water.
- Identify elements of wastewater collection systems.
- Stages of wastewater treatment at typical treatment facility.
- Explain what happens to wastewater during preliminary, primary, secondary, and tertiary treatment.
- Describe methods of solids handling.

Lesson 2: Physical Separation of Solids

Topics

Screening; Grinding; Grit Removal; Primary Sedimentation; What Happens During Sedimentation?; Factors Affecting Settling Rates; Types of Clarifiers; Air Flotation; Filtration; Eflluent Disposal

Objectives

- Identify and describe the different types of bar and woven screens used for screening.
- Identify and describe common types of grit-removal equipment.
- List factors affecting settling rates.
- Figure the length of detention time needed to settle out settleable particles.
- Describe the three principal methods of land disposal.

Lesson 3: Chemical Treatment Processes

Topics

Solids in Wastewater; Chemical Coagulants; Phosphate Removal; Chemical Clarification Equipment; Disinfection; Factors Affecting Disinfection; Disinfection with Chlorine; Equipment Used in Chlorine Feeding

Objectives

- Describe what colloidal particles are and outline the problems associated with removing them from wastewater.
- List chemicals used as coagulants.
- Explain how the flocculation process works.
- Explain the function of a precipitant.
- List chemical agents commonly used as disinfectants.
- Identify factors affecting disinfection.
- Describe methods for applying chlorine to wastewater.

Lesson 4: Biological Processes

Topics

Lagoons; Activated Sludge; Aeration with Pure Oxygen; Trickling Filters; Distribution Systems; Trickling Filter Operations; Synthetic Media; Activated Biofilter Process (ABF); Rotating Biological Contactors (RBC); Secondary Clarifiers

Objectives

- Differentiate between the way unaerated and aerated lagoons function.
- Distinguish between suspended growth and fixed-growth systems.
- List and describe different methods of utilizing activated sludge to stabilize wastewater.
- Tell how trickling filters, ABFs, and RBCs operate.
- Explain how secondary clarifiers are used in conjunction with fixed- and suspended-growth systems.

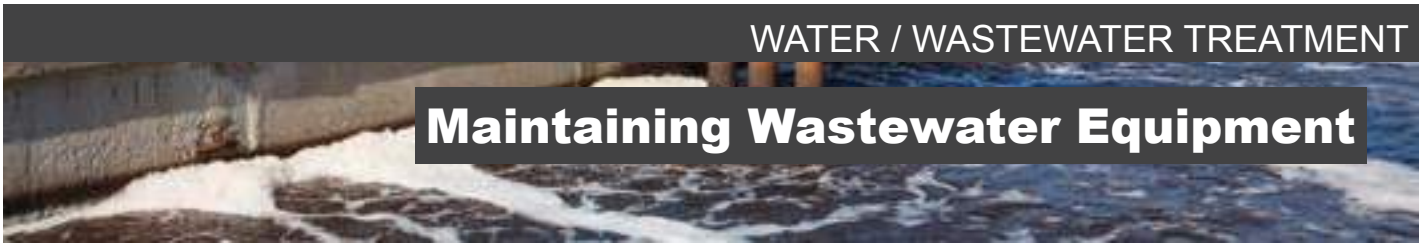
Lesson 5: Solids Treatment and Disposal

Topics

Three Processes; Sludge Conditioning; Thickening; Dewatering; Drying Beds; Lagoons; Vacuum Filtration; Filter Presses;Further Reduction of Water Content; Composting; Ultimate Disposal

Objectives

- Distinguish between conditioning, thickening, and dewatering.
- List the factors that affect which conditioning, thickening, and dewatering methods are used.
- Describe four methods of sludge conditioning.
- Describe three methods of thickening.
- List factors that affect drying-bed operation.
- Describe methods for disposing of digested or dewatered sludge.



Maintaining Wastewater Equipment

Course 383: Maintaining Wastewater Equipment

Covers the equipment used in handling and treating wastewater. Outlines correct facility maintenance procedures, including necessary checks and testing of solids handling equipment. Covers the maintenance of flow measurement devices and the safety precautions of workers in the treatment plant environments.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Pumping Stations

Topics

Collection Systems; Pumping Stations; Pumping Station Components; Pump Operation; Pump Types; Pump Maintenance; Pump Drive Units; Piping System; Ventilation System; Control System; Level Detection; Station Start-Up and Shutdown; Station Operation and Maintenance; Safety Considerations

Objectives

- Describe a typical collection system layout.
- Name the three types of pumping stations currently in use and explain how they differ.
- List seven basic components of wet-well and dry-well stations.
- Use the following terms in an explanation of pump operation: impeller, shroud, volute case, stuffing box, shaft sleeve, wearing ring.
- Name the important elements of a good preventive maintenance program for pumps.
- Explain the importance of a pump station ventilation system.
- Demonstrate the necessary procedures to follow before pump start-up.

Lesson 2: Screening and Grinding Equipment

Topics

Hand-Cleaned Bar Screens; Mechanically Cleaned Bar Screens; Grinders; Rotating Drum Comminutors; Stationary Screen Comminutors; Barminutors

Objectives

- Name the two basic parts of a hand-cleaned bar screen and explain their functions.
- Describe the operation of a mechanically cleaned bar screen.
- Explain why grinders are used and how they are maintained.
- Compare and contrast a rotating drum comminutor and a stationary screen comminutor with an oscillating cutter.
- Explain how a Barminutor combines the functions of a bar screen and a comminutor.
- Give examples of important safety rules to follow when working with screening and grinding equipment.

Lesson 3: Grit Removal Systems

Topics

The Nature of Grit; Hand-Cleaned Grit Chambers; Maintaining Hand-Cleaned Grit Chambers; Detritus Tanks; Maintaining Detritus Tanks; Chain and Flight Grit Collectors; Maintaining Chain and Flight Grit Collectors; Aerated Grit Chambers and Cyclone Separators; Maintaining Aerated Grit Chambers

Objectives

- Tell why grit removal is important.
- Name the three phases of the grit removal process.
- Explain the functions of slide gates and dewatering drains in hand-cleaned grit chambers.
- Describe the action of a reciprocating rake and explain its purpose.
- List several maintenance checks to make on chain and flight grit collectors.
- Explain how an aerated grit chamber works and how to tell if it is not working correctly.
- Describe the operation of a cyclone grit separator.

Lesson 4: Sludge- and Scum-Collection Apparatus

Topics

Sedimentation; Rectangular Clarifiers; Scum Removal; Circular Clarifiers; Pre-Operational Checks; Daily Maintenance Activities; Sludge Removal; Laboratory Testing; Troubleshooting; Safety Considerations

Objectives

- List the five major components common to all clarifiers.
- Describe the operation of slotted pipe and helical-type skimmers.
- Name the two flow patterns possible in circular clarifiers.
- Discuss the daily maintenance requirements of clarifiers.
- Explain the importance of laboratory testing on the contents of a clarifier.
- Identify possible safety hazards associated with clarifier operation.

Maintaining Wastewater Equipment

Lesson 5: Flow Measurement Devices

Topics

Properties of Flowing Liquids; Flow Measurement Methods; Flow Measurement in Batch Processes; Flow Measurement in Open Channels; Measuring Flow from Freely Discharging Pipes; Methods of Depth Measurement; Flow Measurement in Completely Filled Pipes; Methods of Pressure Measurement; Maintenance of Flow Measurement Devices

Objectives

- Define flow and differentiate between flow rate and total flow.
- List the three basic types of flow systems.
- Distinguish between direct and indirect flow measurements, and between primary and secondary devices.
- Give a brief description of a current meter, a pitot tube, a weir, and a flume, and tell how each functions in open channels.
- Describe several methods of measuring flow from freely discharging pipes.
- Name at least five level detection devices and explain their operation.
- Describe the following flow measurement devices as they are used in completely filled pipes: orifice, venturi, flow nozzle, rotameter, magnetic flowmeter, and ultrasonic flowmeter.

WELDING

The Welding Series begins by explaining how to read welding blueprints. It goes on to introduce the basics of both gas and arc welding. Then, in logical sequence, it proceeds into specific “how-to” instructions on all types of welding practices. It also explains the proper procedures for brazing and cutting with welding equipment. Safety is stressed throughout this series.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
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417: Welding Principles					229
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419: Arc Welding Operations					233

Blueprint Reading for Welders

Course 416: Blueprint Reading for Welders

Covers basic shop math and measurement skills. Explains how to read, use, and make blueprints. Discusses various welds, weld joints, and weld symbols. Explains advanced shop math and measurement skills.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Shop Math and Measurement

Topics

Fractions; Common Fractions; Reducing Common Fractions; Improper Fractions; Mixed Numbers; Calculations Involving Common Fractions; Shortcuts for Working with Common Fractions; Decimal Fractions; Calculations Involving Decimal Fractions; Converting Common Fractions to Decimal Fractions; Converting Decimal Fractions to Common Fractions; Standard Rules and Tape Measures; Reading a Rule or Tape Measure; Using a Calculator

Objectives

- Define and identify common fractions and decimal fractions.
- Define the term equivalent fraction.
- Perform calculations using common fractions and decimal fractions.
- Convert between common fractions and decimal fractions.
- Read and perform measurements using a standard rule or tape measure.
- Explain the use of calculators in welding

Lesson 2: Introduction to Blueprints

Topics

Purpose of Blueprints; Types of Blueprints; Making Blueprints; Parts of a Blueprint; Body; Title Block; Bill of Material; Revision Block; Zoning; Security; Care and Handling of Blueprints

Objectives

- Explain the importance of information on blueprints.
- Explain the differences between assembly drawings and detail drawings.
- Describe methods used to create and reproduce blueprints.
- Define and describe parts of a blueprint.
- Identify elements located within the title block of a detail drawing.
- List methods of care and security of blueprints.

Lesson 3: Lines and Views on Blueprints

Topics

Lines Used on a Blueprint; Views on a Blueprint; Perspective; Orthographic Projections; Oblique Projections; Isometric Projections; Other Views; Selecting Views; Sketching

Objectives

- Identify the standard lines used on blueprints.
- Explain the meaning and applications of standard lines on blueprints.
- Identify common views used on a blueprint.
- Name the advantages and disadvantages of various projection types.
- Explain the concept of visualization.

Lesson 4: Welds and Weld Joints

Topics

Basic Weld Joints; Butt Joint; Lap Joint; Tee Joint; Corner Joint; Edge Joint; Weld Types; Groove Welds; Fillet Welds; Plug and Slot Welds; Spot and Seam Welds; Stud Welds; Surface Welds; Backing Welds; Welding Positions and Locations

Objectives

- Identify and describe the five basic weld joints.
- Define the following terms: bead, stringer bead, weave bead, base metal, filler metal, root pass, hot pass, fill pass, cap, hardfacing.
- Identify and describe the basic weld types.
- Name the basic welding positions and give advantages of the flat position.

Lesson 5: Welding Symbols

Topics

Structure of Welding Symbols; Reference Line; Arrow; Weld Symbol; Dimensions; Special Symbols; Tail; Reading Welding Symbols

Objectives

- Identify which side of a structure a weld is to be made from.
- Identify the kind of chamfer to be cut on a joint to be welded, and which part is to be chamfered.
- State the required dimensions of a weld.
- Identify the contour required on a finished weld.
- State how a weld contour is to be finished.
- Differentiate between welds that are to be made at the site of final assembly and welds that are to be made before the parts are shipped to the site.

Lesson 6: Advanced Shop Math and Measurement

Topics

Squares and Square Roots; Angles; Triangles; Circles; Linear Measurement; Calipers; Slide Calipers; Vernier Calipers; Micrometer Calipers; Angular Measurement; Metric Measurement

Objectives

- Explain the concepts of squares and square roots of numbers.
- Define the following kinds of angles: zero degree, acute, straight, right, and obtuse.
- State the Pythagorean Theorem and explain its usefulness.
- Define the following terms related to circles: radius, diameter, arc, and circumference.
- Give the equations for finding a circle's circumference and area if you know its radius.
- Explain the use of the following measuring tools: calipers, micrometers, and protractors.
- Demonstrate how to convert measurements from inches to millimeters and from millimeters to inches.

Welding Principles

Course 417: Welding Principles

Covers fundamentals of welding, Discusses welding safety considerations and precautions. Covers both oxyfuel and arc welding equipment. Describes welding techniques. Discusses ways to avoid weld faults.

TPC Training is accredited by IACET to offer **0.6 CEU** for this program.

Lesson 1: Fundamentals of Welding

Topics

The Working of Metals; Common Welding Processes; Production Welding Processes; Kinds of Welded Joints; Kinds of Welds; Indentifying Weld Parts; Fusion and Penetration; Joint Design and Fitup

Objectives

- Describe fusion welding, resistance welding, filler rods, and electrodes.
- Compare the oxyfuel and arc welding processes and compare the SMAW, GMAW, and GTAW processes.
- Describe and sketch the following kinds of joints—butt, lap, tee, corner, and edge.
- Describe the following kinds of welds—groove, fillet, plug, slot, spot, and seam.
- Name and locate the parts of a weld.
- Discuss basic considerations in joint design and fitup.

Lesson 2: Welding Safety

Topics

Your Surroundings; Fire and Explosion Hazards; Burns; Fumes and Gases; Ventilation and Respiratory Protection; Eye and Face Protection; Protective Clothing; Hearing Protection; Fuel Cylinders; Oxygen Cylinders; Handling Cylinders; Regulators, Hoses, Torches, and Tips; Electric Shock

Objectives

- Explain the importance of good housekeeping in an area where welding is taking place.
- List at least three precautions to take to avoid fires and explosions when welding.
- Describe two methods of protecting yourself against the fumes and gases associated with welding.
- Describe the personal protective equipment required when welding.
- Explain the precautions to take when using and handling cylinders and regulators.

Lesson 3: Oxyfuel Welding Equipment

Topics

The Oxyfuel Welding Process; Equipment and Accessories; Gas Pressure Regulators; Check Valves; Welding Hoses; Welding Torches and Tips; The Sparklighter; Filler Rods; Protective Gear; Preparing to Weld; Adjusting the Flame; Making a Weld; Shutdown Procedures

Objectives

- Briefly describe the oxyfuel welding process and the components of an oxyfuel welding outfit, including the lighting device.
- Discuss safety precautions and personal protective gear required for working with oxyfuel equipment.
- List the steps involved in preparing to weld.
- Compare the neutral, carburizing, and oxidizing flames.
- List the steps in safely shutting down an oxyfuel welding system.

Lesson 4: Arc Welding Equipment

Topics

Comparison of Oxyfuel and Arc Welding; Welding with Electricity; AC and DC Welding Currents; Constant Current Power Sources; Constant Voltage Power Sources; Welding Machine Ratings; Kinds of Welding Machines; Welding Cables; Electrode Holders; Electrodes for Arc Welding; Arc Welding Safety Gear and Accessories

Objectives

- List similarities and dissimilarities between oxyfuel welding and arc welding.
- Describe the electric welding circuit, including choice of ac or dc, dc polarity, and power sources.
- Discuss welding machine ratings in terms of amperage and duty cycle and describe features and uses of transformer, generator, rectifier, and inverter welding machines.
- Discuss welding cable considerations and describe the electrodes and electrode holders used for SMAW, GMAW, and GTAW processes.
- Discuss the personal safety gear and precautions necessary for arc welding and explain how arc welding accessories are used.

Lesson 5: Welding Techniques

Topics

Selecting a Welding Process; Welding Positions; Oxyfuel Welding Procedures; SMAW Procedures; GMAW Procedures; GTAW Procedures; How to Develop Practical Welding Techniques

Objectives

- Explain what considerations affect the selection of a welding process.
- Describe the four welding positions.
- Explain why overhead welds are difficult to make and tell how to make them.
- Describe the preparation required for oxyfuel welding, SMAW, GMAW, and GTAW processes.
- Describe the procedures involved in oxyfuel welding, SMAW, GMAW, and GTAW processes.

Welding Principles

Lesson 6: Avoiding Weld Faults

Topics

Proper Welding Procedures; Common Weld Problems; Effects of Poor Fitup; Shape and Dimensional Problems; Internal Defects; Effects of Heat; Controlling Expansion and Contraction; Identifying Metals

Objectives

- Describe the effects of electrode selection, current, arc length, and travel speed on arc welding procedures.
- Describe common causes of arc blow, a hard-to-start arc, and spatter, and explain why proper fitup is important.
- Define the terms overlap, undercut, blowhole, and inclusion and explain the causes of each.
- Explain how expansion and contraction can be controlled when welding.
- Name and describe the various tests used to identify metals.

Oxyfuel Operations

Course 418: Oxyfuel Operations—Joining, Cutting, and Surfacing

Covers the welding of ferrous and nonferrous metals. Describes oxygen cutting as well as brazing and soldering. Discusses surfacing techniques.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Welding Ferrous Metals

Topics

Fusion Welding with an Oxyfuel Flame; Other Uses for the Oxyfuel Flame; Fluxes; Flame Characteristics; Temperature Control in Weldments; Welding Common Mild Steels; Welding Stainless Steel; Welding Cast Iron and Wrought Iron

Objectives

- Explain how oxyfuel welding joins metals and how it differs from arc welding.
- Explain how braze welding and torch brazing are different from oxyfuel welding and from each other.
- Discuss the purposes for using flux and characteristics that make a flux suitable for an application.
- Compare the appearance and general uses of the carburizing flame, neutral flame, and oxidizing flame.
- Explain why preheating and postheating are used.
- List important considerations in welding common mild steels, stainless steel, and cast and wrought iron.

Lesson 2: Welding Nonferrous Metals

Topics

Welding Characteristics of Aluminum; Aluminum Alloy Designations; Aluminum Joint Preparation; Aluminum Welding Procedures; Welding Characteristics of Copper and Copper Alloys; Welding Copper; Welding Brass; Welding Bronze; Welding Lead; Welding Nickel; Welding Magnesium; Making Optimum Welds

Objectives

- Discuss characteristics of aluminum that are important in welding.
- Explain how to use aluminum alloy designations.
- Describe procedures used in aluminum joint preparation and in aluminum welding.
- Discuss characteristics of copper and copper alloys that are important in welding.
- Discuss procedures for welding copper, brass, and bronze.
- Discuss procedures for welding lead, nickel, and magnesium.
- Summarize general standard procedures for making optimum welds.

Lesson 3: Oxygen Cutting

Topics

The Oxygen Cutting Process; The Cutting Torch; The Cutting Tips; Cutting Operation Safety; The Cutting Operation; Cutting Bevels; Piercing Holes and Cutting Circles; Removing Rivets; Gouging, Scarfing, and Washing; Cutting Difficult Metals; Adding Iron and Steel as Cutting Catalysts

Objectives

- Explain the similarities and differences between oxyfuel cutting and oxyfuel welding.
- Describe the equipment and safety precautions necessary for torch cutting and list standard steps in the torch cutting operation.
- Describe special equipment or methods used in cutting bevels, piercing holes, cutting circles, and cutting away rivets.
- Explain why gouging, scarfing, and washing are used.
- Explain methods used on metals that are otherwise difficult to cut.

Lesson 4: Brazing and Soldering

Topics

Brazing and Braze Welding; Brazing Filler Alloys and Fluxes; Brazing and Braze Welding Procedures; Braze Welding Cast and Malleable Iron; Brazing Stainless Steel; Safety Precautions; Soldering; Kinds of Solder; Preparing to Solder; The Soldering Tool; Soldering Procedures; Sweat Soldering

Objectives

- Compare and contrast brazing, braze welding, and oxyfuel fusion welding.
- Describe the materials and procedures used in brazing and braze welding.
- Explain important special considerations in braze welding cast and malleable iron, brazing aluminum, and brazing stainless steel.
- List the safety precautions necessary for brazing and braze welding operations.
- Explain how soldering differs from brazing and describe the materials and procedures used in soldering.

Oxyfuel Operations

Lesson 5: Surfacing Techniques

Topics

Surfacing Processes; Thermal Spraying; Hard Facing Welds; Torch Hard Facing Procedures; Flame Spraying; Surfacing Materials; Thermal Spraying for Shaft Repairs; Other Thermal Spraying Applications; Safety Precautions

Objectives

- Define hard face welding and thermal spraying as used for surfacing purposes and discuss general uses of each.
- Discuss advantages and disadvantages of detonation-gun, plasma, and electric arc thermal spraying and explain how each is done.
- Describe the processes of torch hard facing and flame spraying.
- Name several common surfacing materials and discuss one or more characteristics of each.
- List the steps, including those for surface preparation, in repairing a shaft by means of thermal spraying.
- Discuss the safety precautions necessary to prevent or minimize hazards from surfacing processes.

Arc Welding Operations

Course 419: Arc Welding Operations

Covers shielded metal arc welding, selecting electrodes for SMAW, gas metal and tungsten arc welding, preheating, reheating, welding ferrous and nonferrous metals, pipe welding, hard facing, and rebuilding.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Shielded Metal Arc Welding

Topics

How to Process Works; Welding Current and Measurement; Arc Length; Welding Machines (Power Sources); Polarity; Tools and Accessories; Selecting an Electrode; Equipment Setup and Operation; Personal Protection for Welding

Objectives

- Explain how the shielded metal arc welding process works.
- Tell what provides the shield in shielded metal arc welding.
- Define arc length and explain its importance.
- List factors to consider when selecting an electrode.
- Describe the personal protective equipment necessary for welding.

Lesson 2: Selecting Electrodes for SMAW

Topics

Electrodes for Shielded Metal Arc Welding; Identification of Electrodes; Current Ranges; Electrode Coverings; Electrode Selection; Commonly Used Electrodes; Handling, Storing, and Conserving Electrodes

Objectives

- Explain the factors involved in selecting SMAW electrodes.
- Explain how to identify different welding electrodes.
- Give examples of several kinds of electrode coverings and tell when each is used.
- Describe correct procedures for handling, storing, and conserving electrodes.

Lesson 3: Gas Metal Arc Welding

Topics

The Gas Metal Arc Process; Comparing GMAW to SMAW; Metal Transfer Methods; Short-Circuit Transfer; Shielding Gases; Electrode Wire; Equipment and Accessories; GMAW Gun Operation; Preparing to Weld; How to Stop Welding; Welding Conditions and Variables; Safety Practices

Objectives

- Name and describe the three basic types of metal transfer for GMAW.
- Name the most common shielding gases used in GMAW and tell what factors influence their selection.
- List factors that affect the selection of an electrode for GMAW.
- Describe GMAW gun operation.

Lesson 4: Gas Tungsten Arc Welding

Topics

The GTAW Process; GTAW Equipment; GTAW Welding Machines and Current; GTAW Torches; Electrodes for GTAW; Shaping Tungsten Electrode; Shielding Gases; Filler Metals; Preparing to Weld; Welding Procedures; Adding Filler Metal; Techniques for Welding Common Materials; GTAW Spot Welding; Safety Practices

Objectives

- List the advantages of GTAW over other welding processes.
- Describe the equipment and supplies needed for GTAW.
- Explain the purpose of the electrode in GTAW and tell how this differs from other types of welding.
- Properly select shielding gases and filler metals for GTAW.
- Describe how to use GTAW to weld common metals.

Lesson 5: Other Welding Processes

Topics

Resistance Welding; Flash Welding; Percussion Welding; Flux-Cored ARC Welding; Submerged Arc Welding; Plasma Arc Welding; Stud Welding; Laser Beam Welding; Friction Welding; Ultrasonic Welding

Objectives

- Describe resistance spot welding and resistance seam welding.
- Define flash welding, upset welding, and percussion welding, and tell how they differ.
- Explain how submerged arc welding and plasma arc welding differ from other arc welding methods.
- Describe the three forms of friction welding.
- Describe two advantages of ultrasonic welding.

Lesson 6: Preheating and Postheating

Topics

Preheating; Stress; Changes in Mechanical Properties; Postheating; When to Preheat; When to Postheat; Equipment for Preheating and Postheating; Preheating Methods; Consider Shape When Preheating; Spot Preheating; Postheating Methods; Consider Shape When Cooling

Objectives

- Describe the effects of uneven or rapid heating and cooling on base metals and weld beads.
- Define the heat-affected zone and tell what changes can occur there during welding.
- Explain the benefit of preheating and when it should be used.
- List several factors in welding jobs that make postheating advisable.
- Describe methods and materials for preheating and postheating.

Arc Welding Operations

Lesson 7: Welding Ferrous Metals

Topics

Ferrous Metals; Cast Irons; Carbon Steels; Alloy Steels; Effects of Production on Carbon Steels; Effects of Rolling on Carbon Steels; How to Identify Ferrous Metals; Edge Preparation; Welding Cast Irons; Welding Cast Irons with SMAW; Welding Carbon Steels; Welding Low-Carbon Steels with SMAW; Welding Carbon Steels with GTAW; Welding Carbon Steels with GMAW; Welding Alloy Steels; Low-Hydrogen Welding for Alloy Steels

Objectives

- Define ferrous metals and describe their characteristics, including weldability.
- Explain cleaning and edge preparation required prior to welding ferrous metals.
- Name the welding processes and practices that are used for different types and thicknesses of ferrous metals.
- List several different electrode types and their advantages for welding ferrous metals.
- Explain specific procedures to use when welding alloy steels.

Lesson 8: Welding Nonferrous Metals

Topics

Nonferrous Metals; Production of Nonferrous Metals; How to Indentify Nonferrous Metals; Edge Preparation; Cleaning; Welding Aluminum; Welding Stainless Steel; Welding Nickel; Welding Copper

Objectives

- Name the special properties of several nonferrous metals and explain how these properties affect welding preparations and procedures.
- Describe some of the methods of identifying different nonferrous metals.
- Compare seven arc cutting processes used for edge preparation of nonferrous metals.
- Explain proper methods of cleaning nonferrous metals prior to welding.
- Identify the welding processes that are suitable for nonferrous metals.

Lesson 9: Pipe Welding

Topics

Types of Piping Systems and Joints; Codes and Qualifications; Metal Pipe Materials and Applications; Pipe Sizes; Pipe Repair Safety; Arc Welding Processes; Oxyfuel Welding Processes; Types of Welding Joints; Edge Preparation and Fitup; Preheating and Postheating; Welding Procedures

Objectives

- Compare the advantages of welded pipe joints to bolted or screwed connections.
- Discuss pipe welding codes and what they cover.
- List the welding processes used for joining pipe and their advantages and disadvantages.
- Identify some special methods and accessories that are used in pipe welding as opposed to flat welding.
- Give examples of the uses of preheating and postheating in pipe welding.

Lesson 10: Hard Facing and Rebuilding

Topics

Surfacing; Uses of Hard Facing and Rebuilding; Types of Wear; Types and Uses of Surfacing Alloys; Base Metals; Preparing the Base Metal; Preheating; Surface Bonding; Oxyacetylene Hard Facing; Manual Arc Hard Facing; Semiautomatic Hard Facing; Automatic Hard Facing; Thermal Spraying; Hard-Facing Patterns

Objectives

- List several purposes of hard facing and rebuilding.
- Identify the different types of surfacing alloys and their particular uses.
- Describe effective cross-checking and explain why it is desirable.
- Explain the special techniques used in hard facing and tell why they are necessary.
- Name the welding processes used in hard facing and tell why they are adapted to this work.

MAINTENANCE MANAGEMENT

Managers constantly need to acquire new sets of skills to perform well. This is the reasoning behind TPC's Maintenance Management Series. By gaining strong supervisory skills early on, these new supervisors will have a head start on building the confidence they need to supervise and motivate their crews.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
901: Maintenance Organization					236
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903: Controlling Maintenance Resources					239
904: Improving Performance in Maintenance					240
905: Effective Communication for Supervisors					241
906: Employee Relations					242
907: Managing a Training Program					244

Maintenance Organization

Course 901: Maintenance Organization

Covers the basic types of maintenance organizations. Discusses cost-saving concepts of using work order systems. Explains how to develop and use information sources to implement maintenance management. Shows how to apply work standards and planning procedures to simplify a supervisor's job. Introduces the use of computers for first-line supervisors.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Types of Maintenance Organization

Topics

Maintenance Management; Objectives and Priorities; Performing Effectively; Overcoming Maintenance Problems; Types of Maintenance Organizations; Comparing Organizations; Who Controls Maintenance?; Span of Control; Organizational Charts; Department Changes

Objectives

- Describe the functions of the first-line supervisor, the middle-level supervisor, and the top-level supervisor.
- List some of the common problems that lead to difficulties in operating a maintenance department.
- Outline the differences among functional organizations, area organizations, and the centrally controlled maintenance organization.
- Explain the chain of command of a company using its organizational chart.
- Identify the elements that make employees resistant to reorganization, and what can be done to counter this resistance.

Lesson 2: Maintenance Planning and Operations

Topics

Maintenance Management System; Defining the Workload; Maintenance Vocabulary

Objectives

- Describe the way the first-line supervisor's position fits into the overall maintenance system.
- List five types of written orders that can be used for assigning work.
- Classify different kinds of repairs and list them in proper order of importance.
- List the duties of the maintenance planner and the maintenance engineer as they relate to the duties of the first-line supervisor.
- Define standard terms of the maintenance supervisor's vocabulary.

Lesson 3: Work Order Systems

Topics

Work Orders; Controlling Costs with Work Standards: Other System Components; When to Use the EWO or MWO; MWO Format; Reporting Resource Use; Standing Work Orders; Equipment Master File; Planner's Use of the MWO; Function of the EWO; PM Work Orders; Manual Work Orders; Master Schedule as a Work Order

Objectives

- Describe the use of the maintenance work order.
- Explain the importance of job priorities.
- Identify two basic types of work standards.
- Distinguish between the uses of the engineering work order and the maintenance work order.
- Describe the uses of the master schedule and the PM work order

Lesson 4: Using Information Sources

Topics

The Uses of Maintenance Information; Controlling Maintenance through Information; Controlling Labor Uses and Costs; The Computer-Based Management System; Labor Control Information; Reporting Labor Information; Controlling Major Jobs; Material Control; Maintenance Costs; Noncomputer Information; Informal Information; Performance Information You've Always Wanted To Have; Supervisors Need Information; Improving the Information Environment

Objectives

- Explain the importance if using information sources.
- List the types of information that originate within the maintenance department and from other sources.
- List the elements that must be considered when developing a computer-based information system.
- Describe the uses of labor control information.
- Calculate manhour performances indexes.

Lesson 5: Controlling Backlog through Planning

Topics

Why is Maintenance Planning Important?; Planning as a Maintenance Management Tool; Planning Concepts; Coordinating the Plan; Detailed Maintenance Planning Procedures; Plan for Craft Skills; Special Planning Considerations; Sources of Planned Work; Effect of Planning on Manpower Use

Objectives

- Explain the role planning plays in reducing downtime costs and improving manpower use.
- List the five steps of the decision-making process.
- Define goals, objectives, policies, procedures, and programs in the context of maintenance planning.
- Describe the role of the maintenance planner.
- List six areas in which planning enhances labor use.

Lesson 6: Applying Work Standards

Topics

Why Use Standards?; Time Standards; How Are Time Standards Used?; Standards Help to Reduce Costs; Using Engineered Performance Standards; The Spreadsheet; Controlling the Backlog; Assigning Priorities; Scheduling Work; Craft Use and Backlog; Analyzing Backlog Data

Objectives

- Explain why standards are used.
- Describe quality and quantity standards and their uses.
- List five conditions a maintenance department must meet in order for standards to be workable.
- Describe how different types of standards are developed.
- State how the backlog can be analyzed to evaluate the makeup of the workforce.

Maintenance Organization

Lesson 7: Managing Maintenance by Computer

Topics

The Computer's Function; Information Sources; Computer Files; Processing Data; Sources of Data-Processing Support; Package Programs; Accessing and Inputting Information; Computerizing Essential Maintenance Information; Making Use of Computer Information

Objectives

- Describe the function of the computer in maintenance information management.
- List the types of information that should be stored in a computer.
- List types of data processing support available to maintenance departments.
- Use basic computer terminology.

Implementing Preventive Maintenance

Course 902: Implementing Preventive Maintenance

Covers what PM is and why it is necessary. Develops procedures for setting up a practical PM program, and describes effects of PC on scheduled and unscheduled work. Explains the requirements and advantages of the program as it applies to maintenance management. Provides information on the relationship of PM to production and quality control.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: The Need for PM

Topics

The Scope of PM; Good Programs Pay Off; Costs Cut Dramatically; Inspections; Establishing Maintenance Routes; Steps in Planning; Review; Decide; Implement; Maintenance Job Orders; Priorities; Scheduling

Objectives

- List the six functions of a typical PM Program.
- List the major benefits of PM.
- Explain the three stages involved in the planning process.
- Describe the function of the maintenance job order.
- Explain the use of a priority system.

Lesson 2: Setting Up a PM Program

Topics

Strategies for Gaining Support; Setting Up the Program; Organizing for Action; Checklists; Securing Cooperation; Setting Up a Lube Program; Lubrication Follow-Through

Objectives

- Describe the elements needed to establish a preventive maintenance program.
- List the data that can be obtained from review of inspection reports.
- Distinguish between preventive and predictive maintenance.
- Explain the preparation of inspection checklists.
- Explain how to set up a lubrication program.

Lesson 3: Scheduling PM

Topics

Scheduling—What It Is and Isn't; Long-Range Planning; Forecasting; Forecasting Tips; Short-Range Scheduling; Scheduling Meetings; Conducting the Scheduled Meeting; Measuring Schedule Compliance; Using Work Orders in Scheduling

Objectives

- Describe the importance of scheduling to the maintenance program.
- Describe the role that the production department plays in maintenance scheduling.
- Explain the uses of forecasting and long-range planning.
- List the types of jobs that should appear on a weekly schedule.
- Explain how and why weekly scheduling meetings should be held.
- Measure compliance with scheduling.

Lesson 4: Controlling Work

Topics

Control of Emergency Work; Control of Unscheduled Work; Repetitive Preventive Maintenance Services; Using the Standing Work Order; Forecasting Scheduled Work; Forecasting Planned Scheduled Work; Using the Schedule Effectively; Work Order Flow; Handling Work Assignments; Reporting Labor and Material Use; The Engineering Work Order; Span of Control; Communications and Control; Controlling Specific Types of Work; Maintenance Management Network

Objectives

- List the criteria for assigning emergency status to a situation.
- Describe the use of the master schedule and standing work order.
- Describe the techniques for controlling emergency, scheduled, unscheduled, and preventive maintenance work.
- Explain the role forecasting plays in planning and scheduling.
- Report labor and material use.

Lesson 5: Quality Control

Topics

Before the Job Starts; Organizing Materials; Tool Control; Transportation and Rigging; Contact with Planning; Sizing Up Labor Requirements; Control During the Job; Actions at the Worksite; After the Work is Completed; Follow-Up Report

Objectives

- List short cuts for obtaining spare parts and other materials that are often used in routine repairs.
- Estimate crew labor necessary for efficient job execution.
- Describe the supervisor's role at the work-site in terms of labor control, accident prevention, and quality control.
- Explain the role of quality control.
- Describe the steps involved in evaluating a completed job.

Controlling Maintenance Resources

Course 903: Controlling Maintenance Resources

Covers methods of using maintenance resources for greatest efficiency, and tells how to implement the techniques effectively. Explains what workload is and how to measure it. Provides a thorough investigation into the control of labor, parts, and materials—both in the field and in the shop. Examines the budget process and how to control costs through budgeting.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Measuring Workload

Topics

What is the Workload?; Categories of Workloads; Techniques for Computing Workloads; Distributing the Workload; Effects of Absenteeism, Overtime on Workloads; Workloads vs. Backlog Levels

Objectives

- Define workload and explain its importance in control of maintenance work.
- List the seven workload categories.
- Compute workload measurements for each of the seven categories.
- Explain how the workload should be distributed.
- Describe the effects of absenteeism and overtime on the workload.

Lesson 2: Controlling Labor

Topics

Maintenance Labor Control; Overall Control of Maintenance Labor; Responsibility of Control; Observe and React; Handling Absenteeism; Overtime vs. Bringing on Extra People; Planning Vacation Schedules; Processing Vacation Requests; Productivity and the Supervisor;

Objectives

- Identify the seven categories of maintenance labor discussed.
- Describe the most effective means of controlling each of the seven categories of maintenance labor.
- Explain the effect a well-executed PM program has on other maintenance work.
- State the leading factors contributing to absenteeism.
- Determine the breakeven point between overtime and hiring additional workers
- Schedule vacation periods so that production still proceeds smoothly.

Lesson 3: Controlling Parts and Materials

Topics

Material Control; Controlling Inventory; Who Should Control the Inventory?; Administrative Control of Maintenance Work; Duties of the Material Controller; Inventory Control Systems; Operating a Manual System; Reordering Stock; Rebuilt and Fabricated Parts; Calculating Order Quantities and Reorder Points; The Two-Bin System

Objectives

- Explain the importance of effective material control to maintenance work.
- Describe the duties of the material controller.
- Describe the operation of a typical manual inventory control system.
- Calculate economic order quantities and reorder points.
- Operate a two-bin inventory control system.

Lesson 4: Managing Shop Operations

Topics

Shop Control; Engineering Project Support; Shop Rebuilds and Overhauls; The Shop Workload; Mobile Equipment Maintenance; Material Support; Parts and Component Rebuilding; Performance in the Shop; Shop Location, Layout, and Configuration; Work Area Considerations; Shop Care and Cleanup; Central Shop vs. Area Shops

Objectives

- Describe the differences in labor control between shop and field work.
- Describe the role played by a shop that supports a field crew.
- List the steps required to rebuild parts.
- Explain how shop location, layout, and configuration affect work.
- List the advantages and disadvantages of central and area shops.

Lesson 5: Controlling Costs through Budgeting

Topics

Cutting Maintenance Costs; Effect of Improved Productivity; The Structure of Maintenance Costs; Budgeting Maintenance Costs; Types of Budgets Used by Maintenance; Key Equipment in the Budget; Maintenance Cost Reduction Strategy; All Work Must be Approved

Objectives

- Describe the effect increased productivity has on maintenance costs.
- List the uses of a budget.
- Describe zero-based budgeting.
- Describe the factored budgeting.
- List the eight steps in formulating equipment repair projections.
- Explain the reason why all maintenance work should be approved before it is performed.

Improving Performance in Maintenance

Course 904: Improving Performance in Maintenance

Covers instructions to first-line supervisor in the strategies involved in improving performances, and presents proven methods for increasing maintenance productivity. Develops ways of evaluating training effectiveness and the management of time. Describes the information necessary to stimulate improvement in all facets of the maintenance program.

TPC Training is accredited by IACET to offer **0.5 CEU** for this program.

Lesson 1: Evaluating Performance

Topics

Determining Areas of Responsibility; Measures of Performance; Utilizing Labor; Measuring Material Use; Control Practices; Supervisory Practices; Hourly Activity Patterns; Controlling Costs; Controlling Personnel; Reading Performance Trends; Reports to Keep Weekly; Reports to Keep Monthly; Measuring Performance

Objectives

- Give examples of the different interest levels of key maintenance personnel.
- Compute annual productive hours per worker.
- Compute costs per productive hour.
- List indicators that can help a supervisor control costs.
- Tell how performance trends are established.

Lesson 2: Increasing Productivity

Topics

Factors Affecting Productivity; Improving Labor Use; The Technique of Work Sampling; Random Sampling; Conducting Work Sampling; Observation Periods; Tabulating Results

Objectives

- List factors that adversely affect maintenance labor utilization.
- List factors that have an adverse effect on maintenance labor effectiveness.
- Describe the role of the supervisor in improving labor productivity.
- State how and why random sampling and work sampling are conducted.

Lesson 3: Effects of Training

Topics

The Supervisor's Role in Training; Training Workers from Multicraft Crews; Safety Training; Apprentice Training; Creating the Environment for Learning; Conducting Effective Training; Motivating Crew Members During Training; Enhancing the Learning Process; Using Competition Wisely; Avoiding Elements that Slow Learning; Successful Training Requires a Plan

Objectives

- Describe the first-line supervisor's role in training crew members.
- List the various forms in which training materials are available.
- Recognize the importance of on-going safety training.
- Give examples of how to conduct effective training sessions.
- Identify the roles that motivation, competition, and performance evaluation play in training crew members.

Lesson 4: Managing Time

Topics

Handling Pressure; Establishing Time Objectives; Deadlines and Progress Reports; Handling a Crisis; The Art of Delegation; Improving Your Own Productivity; Try Saying "No"; Organizing Work Control Methods; Don't Put Off; What Do You Do With Your Time?

Objectives

- Describe the influence that the quality and amount of supervision has on crew productivity.
- Explain the importance of setting deadlines and using progress reports.
- Indicator the importance of delegating work.
- List procedures a supervisor can follow to increase his or her own productivity.

Lesson 5: Stimulating Improvement

Topics

Factors Influencing Improvement; Improvement Factors; Dealing with the Factors; The Facility Manager's Role; The Maintenance Supervisor's Role; A Look at Several Solutions; Developing a Maintenance Concept; The Maintenance Objective; Maintenance Policies; Procedures Development

Objectives

- List the 15 factors that influence the success of any maintenance improvement effort.
- Recognize the importance and use of the maintenance concept.
- Trace the importance and use of the maintenance objective.
- Explain the importance and formation of maintenance policies
- Identify the development and role of maintenance procedures.

Effective Communication for Supervisors

Course 905: Effective Communication for Supervisors

Covers how to use verbal and written communication tools. Explains how to motivate personnel through effective communication. Discusses how to organize written communication, best utilizing the elements of writing—parts of speech, phrases, clauses, sentences, structure, punctuation, and syntax. Gives examples of business writing used for reporting progress and motivating employees.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Communication Objectives

Topics

How Communication Works; Training New Employees; Learning About Your Crew; Setting an Example; Giving and Receiving Instructions; Motivating Your Crew; Using Communication Tools; Speaking on the Telephone; Publishing in the Company Newsletter; Giving and Taking Interviews

Objectives

- Explain how communication works.
- Explain how to use the various communication tools.
- Give examples of effective telephone use.
- Tell how to give and receive instructions effectively.
- Demonstrate effective interview techniques.

Lesson 2: Verbal and Nonverbal Communication

Topics

Understanding the Surrounding Circumstances; Understanding the Receiver's Background; Understanding Nonverbal Language; Working with Language; Language Growth; Building Word Awareness; Phrasing the Message; Understanding Varied Meanings; Understanding Other Verbal Clues; Understanding Levels of Language; Words for Maintenance Workers; Changes in Workplace Vocabulary

Objectives

- Describe the importance of context in communication.
- Describe how a receiver's background affects the message.
- Define and give examples of nonverbal language.
- Describe ways to improve vocabulary.
- Explain the importance of precise word choice.

Lesson 3: How to Listen

Topics

Listening is Important; What Makes a Poor Listener; What Good Listening Means; Head Off Trouble by Listening; How to be a Good Listener; The Importance of Getting Feedback; Asking Questions and Paraphrasing; How to be Open to New Ideas

Objectives

- Tell how to be a good listener.
- Explain what makes a poor listener.
- Give techniques for identifying problems through good listening.
- Explain the importance of getting feedback.
- Show how to ask questions and paraphrase.

Lesson 4: Communication Maintenance

Topics

What You Need to be a Supervisor; Oral Communication Skills; Making Sure Your Instructions are Clear; Handling Bad News; Motivating Your Crew; Communication Maintenance; How Language is Understood; Checking Your Language Skills; Developing Your Vocabulary; Listening as a Supervisory Skill; Asking for Feedback; Management Vocabulary

Objectives

- Give techniques for developing a management vocabulary.
- Tell how to check and maintain language skills.
- Show how to make sure instructions are clear.
- Explain how communication can motivate a crew.
- Give techniques for improving listening as a supervisory skill.

Lesson 5: Planning Your Writing

Topics

Determining Your Purpose; Writing to Inform; Persuasive Writing; Knowing Your Audience; The Audience's Effect on What You Write; Point of View; Tone; Prewriting; Organizing Your Writing; Writing to Motivate; Think Before You Write

Objectives

- Tell how to determine the purpose for writing.
- Explain why it is crucial to know the audience.
- Give examples of a writer's point of view.
- List techniques used in prewriting.
- Describe how to organize a written piece.

Lesson 6: The Mechanics of Writing

Topics

Syntax; Syntactical Problems; Passive and Active Voice; Parallel Structure; Punctuation; Stoppers; Interrupters; Introducers; Commas

Objectives

- Explain the importance of syntax.
- Compare the passive voice with the active voice.
- Recognize parallel structure.
- Identify the different types of punctuation.
- Give examples of comma usage.

Lesson 7: Business Writing

Topics

Using Writing Effectively; Communicating Email; Email Memos; How Email Memos are Planned; Email Memo Format; Letters; Letter Format; Reports; Report Format; Progress Reports; Recommendation Reports

Objectives

- Give examples of memo, letter, and report format.
- Explain how to use and write a memo.
- Explain how to use and write a letter.
- Explain how to use and write a report.

Employee Relations

Course 906: Employee Relations

Defines the supervisor's job in terms of maintenance planning, operations, and employee interaction. Demonstrates how good leadership requires administering discipline fairly, recognizing employee needs, and preventing employee strife. Discusses the basic information supervisors need in handling grievances and union disputes.

TPC Training is accredited by IACET to offer **0.8 CEU** for this program.

Lesson 1: Defining the Supervisor's Job

Topics

Administrative vs. Job-Related Duties; Performance Evaluations; Orientation and Training; Discipline; Job-Related Supervisory Duties; Budget Your Time; Improving a Difficult Job; Symptoms of the Supervisor in Trouble

Objectives

- List the elements of the supervisor's administrative duties.
- Calculate workload.
- Explain why a strong preventive maintenance program is desirable.
- Calculate crew efficiency.
- Explain the values and uses of counseling, progressive discipline, and training.
- Calculate productivity.
- List the elements of the supervisor's job-related duties.

Lesson 2: Supervising Hourly Personnel

Topics

Working within the System; Personnel Services; Promoting Productivity; Evaluating Crew Members; Absenteeism; Leadership and Motivation; Getting Along with the Union; Why Things Go Wrong; The Good Side of the Job; Communicating with Crew Members

Objectives

- Explain the importance of safety and comfort in the workplace.
- Explain the importance of further training both to crew members and in terms of increased productivity.
- Describe the effect that a supervisor's good attitude can have on crew members.
- Describe the effect that dishonesty, incompetence, or indifference has on crew members

Lesson 3: Becoming a Successful Leader

Topics

Encouraging Employees; Positive Leadership; Lead by Example; Conduct for Employment; Enforcing the Rules; Leadership Methods; Building a Team; Motivating Employees; When Motivation Fails; The Supervisor's Limits

Objectives

- Explain the need to encourage the full participation of employees and methods for obtaining this participation.
- Describe positive leadership style.
- Explain how a supervisor can win the respect of his or her employees.
- List several factors to consider when determining corrective action measures.
- Identify three different management styles.

Lesson 4: The Supervisor's Role in Employee Relations

Topics

The Importance of Good Labor Relations; Productivity is Affected by Relationships; Your Role as Supervisor; Group Leaders; Your Leadership Style; Relations with a Union; Functions of Union and Management; Responsibilities of Union and Management; The Grievance Procedure; Managing with the Union

Objectives

- Explain how good labor relations affect productivity.
- List several characteristics of a successful leader.
- Explain why it is important for a supervisor to be directly involved with employees.
- Give examples of different leadership styles.
- Identify the functions of labor unions and company management.
- Tell what to expect and what not to expect from union representatives.

Lesson 5: Responding to Interpersonal Problems

Topics

What is Insubordination?; Refusal to Comply with Orders; Failure to Follow Directions; Threats, Obscene Language, and Physical Assault; Horseplay; Fighting

Objectives

- Define insubordination.
- Give examples of refusals to comply with orders and explain how to deal with such acts.
- Describe instances in which employees fail to follow directions, along with the appropriate corrective action.
- Explain how to deal with threats, obscene language, and physical assault.
- Explain how to deal with horseplay.
- Describe ways of dealing with fighting among employees.

Lesson 6: Taking Corrective Action

Topics

Handling Personal Misconduct; Objectives of Corrective Action; Backing Up Corrective Action; Organize for Consistent Corrective Action; Examples of Misconduct; Your Role Viewed by Third Parties

Objectives

- List the steps of progressive discipline.
- Recognize the types of evidence that you should or should not use to support your corrective action measures.
- Explain how to deal with absenteeism and other forms of lost time.
- List the factors that must be considered when correcting employees who have damaged company property.
- List procedures for dealing with employees who are suspected of theft.
- Contrast the performance of substance abusers against the performance of other employees.
- Recognize the types of false statements workers might make.

Employee Relations

Lesson 7: The Grievance Procedure

Topics

The Purpose of the Grievance Procedure; Your Responsibilities as a Supervisor; Steps in the Grievance Procedure; Step One-Your Share; Step Two-Your Boss's Share; Step Three-Last Chance Prior to Arbitration; Arbitration-The Final Step; Arbitrators and Their Selection; Preparation for Arbitration; Avoiding Problems Leading to Grievances

Objectives

- Explain a supervisor's responsibilities with regard to a grievance procedure.
- Describe the various steps involved in a grievance procedure.
- Explain the importance of a no-strike/no-lockout clause.
- Describe the processes used to select arbitrators.
- List ways a supervisor can help a company prepare for an arbitration hearing.
- Tell why it is important to rehearse testimony before a hearing.
- Discuss ways to avoid problems leading to grievances.

Lesson 8: Labor Law Basics

Topics

The Supervisor and Labor Law; Equal Employment Opportunity; EEO and the Supervisor; Labor/Management Legislation; The Wagner Act; The Taft-Hartley Act; The Landrum-Griffin Act; Unfair Labor Practices; Occupational Safety and Health Act; Additional Acts

Objectives

- Explain the supervisor's responsibilities in relation to equal employment opportunity.
- Name the basic labor law of the United States and two Acts that amended it.
- List the functions of the National Labor Relations Board.
- Give examples of unfair labor practices.
- Explain how an unfair labor practice charge is handled.
- State an employer's basic responsibility under the Occupational Safety and Health Act.
- Explain what happens if an employer fails to comply with OSHA standards.

Managing a Training Program

Course 907: Managing a Training Program

Covers analysis of training needs. Describes various kinds of training and lists important steps in administering training. Compares group management techniques to self-study. Discusses the training environment. Examines how to keep training records and how to evaluate training results.

TPC Training is accredited by IACET to offer **0.4 CEU** for this program.

Lesson 1: Analyzing Your Training Needs

Topics

Reasons for Training; Why People Want to be Trained; Your Training Attitude; What is Training?; Kinds of Training; Front-End Analysis; Written Performance Objectives; Making Sure Training Works

Objectives

- Define training and state the main reason for training today.
- Explain the problems involved with trial-and-error learning.
- List three important steps in administering training.
- Explain why good communication is important in training.
- Name three distinct kinds of training.
- Explain the steps involved in a front-end analysis.
- Tell why it is important to write performance objectives.

Lesson 2: The Supervisor as Trainer

Topics

Training Situations; Self-Paced Training; Group-Paced Training; The Environment; Starting Out; Keeping Them with You; Supervised Self-Study; The Level of Training Material; Developing Your Own Training Programs; Using Commercially Prepared Training Practices

Objectives

- List the advantages, disadvantages, and applications of self-paced and group-paced training.
- Lists several important aspects of the training environment and tell why each is important.
- Explain several group management techniques.
- Name at least three advantages of supervised self-study.
- Explain the importance of determining the level of your training needs.
- Evaluate the suitability of commercially prepared training programs.

Lesson 3: Using Training Media

Topics

Introduction to Training Media; Lecture; Lecture with Visual Aids; Computer Slide Shows; Training with DVDs and Videotapes; Manuals; Programmed Instruction; Computer-Based Training

Objectives

- List at least six factors that influence the usefulness of a training medium.
- Name several types of visual aids and explain how each can be used to improve a lecture.
- Explain how to put together a useful sample set.
- Trace the steps involved in the making of a computerized slide show.
- List several advantages of videotapes over films.
- List the advantages of DVDs over videotapes.
- Give the main reason programmed instruction is effective.
- Describe the usefulness of computers in training.

Lesson 4: Teaching and Evaluating Success

Topics

Twelve Rules for Adult Learners; Before Class Starts; Ensuring You Reach Trainees; Points to Keep in Mind; Making Training Relatable; What These Rules Mean; Record Keeping and Data Collection; Types of Records to Keep; Time Standards; Evaluating Training; Pre-test/Post-Test; Writing Tests; On-the-Job Observation; Questionnaires; Record Keeping and Evaluation

Objectives

- List several reasons for keeping training records.
- Name the three types of training records that are important to keep.
- Explain how time standards are established and how they can be used to measure performance.
- Name three common training evaluation methods and explain the applications of each.
- Give examples of five types of written test questions and give advantages and disadvantages of each type.
- Tell why an on-the-job observation checklist is an important evaluative tool.
- Describe the purpose of a questionnaire.

KWIKREF E-LEARNING

KwikRef courses provide production personnel and new mechanics with the appropriate knowledge needed to understand equipment operation and components and to facilitate problem solving. The KwikRef courses include engaging animations throughout that create interest with students and build a desire in them to learn more. Like TPC Technical Skills courses, KwikRef courses are designed by industry experts for use within industry.

Course Titles	Online	Course Manual	ISM	Testing Material	Page
KR1001: Industrial Hydraulics					246
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Industrial Hydraulics

KR1001: Industrial Hydraulics

This course begins by introducing the physics of applied hydraulics, hydraulic components, and applications. It explains how a simple system functions, including symbols and basic formulas. It concludes with the subject of proportional control, including types of proportional-control valves.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Introduction to Hydraulics

Covers the essential physics of applied hydraulics, introducing the basics of hydraulic components and their applications, and explaining how a simple hydraulic system functions. A discussion of symbols, along with application of basic hydraulic formulas, enhances learning.

Topics

Course Introduction, Applied Physics, Force and Motion, Work, Torque, Power, Horsepower, Conservation of Energy, Flow Principles, Flow Rate, Fluid Velocity, Pascal's Law, Series, Resistance, Parallel Resistance, Load Pressure, Pressure Drop, System Pressure, Flow and Pressure, Basic Components, Fluids, Reservoirs, Pumps, Actuators, Flow Control, Directional Control, Pressure Control, Fluid Filtration, Hydraulic Systems, Industrial System, Mobile System, Schematics

Lesson 2: Hydraulic Pumps

Identifies the various types of pumps and how they function. Gives an understanding of applicable control mechanisms, how to identify pump schematic symbols, and applying formulas.

Topics

Fixed Displacement, External Gear, Crescent, Geroter, Axial Piston, Radial Piston, Vane, High Performance Vane, Double Pumps, Tandem Pumps, Variable Displacement, Axial Piston, Variable Vane, Radial Piston, Pump Controls, Pressure Compensated, Load Sense, Symbols, Pump Symbols

Lesson 3: Hydraulic Actuators

Explains how to identify the various types of hydraulic cylinders, the different types of hydraulic motors, how they function, and their associated schematic symbols. Goes on to discuss the basic hydraulic formulas associated with calculating force and torque, as they relate to hydraulic actuators.

Topics

Introduction, Hydraulic Cylinders, Tie Rod Cylinders, Mill Cylinders, Welded Cylinders, Telescoping Cylinders, Rotary Actuators, Hydraualic Motors, Motor Torque and Speed, External Gear, Geroller, Geroter, Axial Piston, Bent Axis Piston, Radial Piston, Actuator Symbols, Cylinder Symbols, Motor Symbols

Lesson 4: Hydraulic Valves

Covers the various types of hydraulic control valves and how they function. Identifies applicable control valve circuits and hydraulic valve schematic symbols.

Topics

Pressure Control Valves, Direct Acting Pressure Valves, Pilot Operated Pressure, Valves, Relief Valves, Remote Pressure Control, Venting Relief Valve, Reducing Valve, Reducing Circuit, Sequence Circuit, Counterbalance Valve, Double CB Valve, Counterbalance, Circuit, Brake Circuit, Unloading Circuit, Directional Control Valves, Spool Porting, Spool Positions, Spool Centers, Open vs. Closed Center, Manual Actuator, Mechanical Actuator, Pneumatic Actuator, Hydraulic Actuator, Solenoid Actuated, 3-Position Direct Acting, 2-Position Direct Acting, Pilot Operated Valves, Pilot Valve Chokes, Poppet Directional Valves, Mobile Monoblock Valves, Multiple Spool Monoblock, Mobile, Sectional Valves, Multiple Spool Sectional Valves, Power Beyond Application, Ball Valves, Flow Control Valves, Gear-Type Flow Divider, Spool-Type Flow Divider, Priority, Flow Divider, Meter-In Flow Control, Meter-Out Flow Control, PC Flow Control, Double Flow, Control, Check Valves, Inline Check Valve, Pilot Operated Check Valves, Prefill Valves, Shuttle Valves, Hydraulic Valve Symbols, Pressure Control Symbols, Flow Control Symbols, Directional Control Symbols, Check Valve Symbols

Lesson 5: Hydraulic Modular Valves

Explains the various types of modular valve applications. It goes on to discuss their functionality and associated symbols.

Topics

Introduction, Stack Valves, Manifold Application, Schematic Arrangement, Cartridge Valves, Pressure Control, Flow Control, Directional Control, Logic Valves, Pressure Control, Directional Control, Flow Control

Lesson 6: Hydraulic Accumulators

Identifies types of accumulators with their corresponding schematic symbol. Also explains how accumulators function, their applications, and basic accumulator maintenance requirements.

Topics

Introduction, Accumulator Application, Piston Type, Bladder Type, Safety Isolation Block, Applications, Functionality, Pump Uploading, Emergency Operation, Pilot Pressure

Industrial Hydraulics

Lesson 7: Hydraulic Fluid Conditioning

Covers the various types of fluid conditioning components with their corresponding schematic symbols as well as an understanding of their proper applications. Also introduces terminology associated with fluid cleanliness, such as micron, beta ratio, and ISO code.

Topics

Introduction, Terminology, Filtration, Micron, Beta Ratio, ISO Code, Filter Applications, Filter Operation, Filter Breather, Pressure Filter, Return Filter, Kidney Loop Filtration, Reservoirs, Industrial, L-Shaped, Overhead, Vertical Assemblies, Mobile, Temperature Control, Tank Heaters, Tube and Shell Heat Exchange, Air Cooled Heat Exchanger, Mobile Heat Exchanger, Symbols, Filter Symbols, Reservoir Symbols, Heat Exchangers

Lesson 8: Hydraulic Conductors and Connectors

Shows how to identify the various types of fluid power conductors and connectors. Explores how their application works together to deliver fluid throughout the system.

Topics

Introduction, Conductors, Hose, Tubing, Pipe, Port Connectors, NFPT, Sae ORB, 4-Bolt Flange, Tube Ends, 37 Degrees, ORS, Compression, Specialty, Connectors, Quick Disconnects, Minimus Connector, Flow Considerations, Conductor Sizing, Fluid Velocity

Lesson 9: Sensors and Switches for Hydraulics

Describes the operating principles of limit switches and inductive, capactive, ultrasonic, and photoelectric sensors.

Topics

Introduction, Flow and Pressure, Pressure Gauge, Flow Meter, Electromechanical Switches, Pressure Switch, Limit Switch, Temperature Switch, Level Switch, Proximity Switches, Inductive, Capacitve, Optical, Transducers, Pressure, Temperature

Lesson 10: Hydraulic Proportional Control Valves

Introduces the funamentals of proportional control, identifying the various types of proportional control valves and how they function, the applicable control valve circuits, and hydraulic valve schematic symbols.

Topics

Introduction, Introduction to Proportional Controls, Theory of Operation, Proportional Solenoids, Control Amplifier, Proportional Valve Applications, Directional Control, Feedback Control, Pressure Control, Flow Control, Mobile Proportional Control, Pulse Width Modulation, Communication, Mobile Proportional Valves, Circuit Types, Open Loop Circuit, Closed Loop Circuit

Mobile Hydraulics

KR1002: Mobile Hydraulics

This course introduces the physics of applied hydraulics, hydraulic components, and applications. It explains how a simple system functions, including symbols and basic formulas. It discusses the components in the hydrostatic drive transmission and examines open- versus closed-center circuits and the functional description of forward, neutral, and reverse drive circuits. It concludes with the subject of proportional control, including types of proportional-control valves.

TPC Training is accredited by IACET to offer **0.7 CEU** for this program.

Lesson 1: Introduction to Hydraulics

Covers the essential physics of applied hydraulics, introducing the basics of hydraulic components and their applications, and explaining how a simple hydraulic system functions. A discussion of symbols, along with application of basic hydraulic formulas, enhances learning.

Topics

Course Introduction, Applied Physics, Force and Motion, Work, Torque, Power, Horsepower, Conservation of Energy, Flow Principles, Flow Rate, Fluid Velocity, Pascal's Law, Series, Resistance, Parallel Resistance, Load Pressure, Pressure Drop, System Pressure, Flow and Pressure, Basic Components, Fluids, Reservoirs, Pumps, Actuators, Flow Control, Directional Control, Pressure Control, Fluid Filtration, Hydraulic Systems, Industrial System, Mobile System, Schematics

Lesson 2: Hydraulic Pumps

Identifies the various types of pumps and how they function. Gives an understanding of applicable control mechanisms, how to identify pump schematic symbols, and applying formulas.

Topics

Fixed Displacement, External Gear, Crescent, Geroter, Axial Piston, Radial Piston, Vane, High Performance Vane, Double Pumps, Tandem Pumps, Variable Displacement, Axial Piston, Variable Vane, Radial Piston, Pump Controls, Pressure Compensated, Load Sense, Symbols, Pump Symbols

Lesson 3: Hydraulic Actuators

Explains how to identify the various types of hydraulic cylinders, the different types of hydraulic motors, how they function, and their associated schematic symbols. Goes on to discuss the basic hydraulic formulas associated with calculating force and torque, as they relate to hydraulic actuators.

Topics

Introduction, Hydraulic Cylinders, Tie Rod Cylinders, Mill Cylinders, Welded Cylinders, Telescoping Cylinders, Rotary Actuators, Hydraualic Motors, Motor Torque and Speed, External Gear, Geroller, Geroter, Axial Piston, Bent Axis Piston, Radial Piston, Actuator Symbols, Cylinder Symbols, Motor Symbols

Lesson 4: Hydraulic Valves

Covers the various types of hydraulic control valves and how they function. Identifies applicable control valve circuits and hydraulic valve schematic symbols.

Topics

Pressure Control Valves, Direct Acting Pressure Valves, Pilot Operated Pressure, Valves, Relief Valves, Remote Pressure Control, Venting Relief Valve, Reducing Valve, Reducing Circuit, Sequence Circuit, Counterbalance Valve, Double CB Valve, Counterbalance, Circuit, Brake Circuit, Unloading Circuit, Directional Control Valves, Spool Porting, Spool Positions, Spool Centers, Open vs. Closed Center, Manual Actuator, Mechanical Actuator, Pneumatic Actuator, Hydraulic Actuator, Solenoid Actuated, 3-Position Direct Acting, 2-Position Direct Acting, Pilot Operated Valves, Pilot Valve Chokes, Poppet Directional Valves, Mobile Monoblock Valves, Multiple Spool Monoblock, Mobile, Sectional Valves, Multiple Spool Sectional Valves, Power Beyond Application, Ball Valves, Flow Control Valves, Gear-Type Flow Divider, Spool-Type Flow Divider, Priority, Flow Divider, Meter-In Flow Control, Meter-Out Flow Control, PC Flow Control, Double Flow, Control, Check Valves, Inline Check Valve, Pilot Operated Check Valves, Prefill Valves, Shuttle Valves, Hydraulic Valve Symbols, Pressure Control Symbols, Flow Control Symbols, Directional Control Symbols, Check Valve Symbols

Lesson 5: Hydraulic Modular Valves

Explains the various types of modular valve applications. It goes on to discuss their functionality and associated symbols.

Topics

Introduction, Stack Valves, Manifold Application, Schematic Arrangement, Cartridge Valves, Pressure Control, Flow Control, Directional Control, Logic Valves, Pressure Control, Directional Control, Flow Control

Lesson 6: Hydraulic Accumulators

Identifies types of accumulators with their corresponding schematic symbol. Also explains how accumulators function, their applications, and basic accumulator maintenance requirements.

Topics

Introduction, Accumulator Application, Piston Type, Bladder Type, Safety Isolation Block, Applications, Functionality, Pump Uploading, Emergency Operation, Pilot Pressure

Mobile Hydraulics

Lesson 7: Hydraulic Fluid Conditioning

Covers the various types of fluid conditioning components with their corresponding schematic symbols as well as an understanding of their proper applications. Also introduces terminology associated with fluid cleanliness, such as micron, beta ratio, and ISO code.

Topics

Introduction, Terminology, Filtration, Micron, Beta Ratio, ISO Code, Filter Applications, Filter Operation, Filter Breather, Pressure Filter, Return Filter, Kidney Loop Filtration, Reservoirs, Industrial, L-Shaped, Overhead, Vertical Assemblies, Mobile, Temperature Control, Tank Heaters, Tube and Shell Heat Exchange, Air Cooled Heat Exchanger, Mobile Heat Exchanger, Symbols, Filter Symbols, Reservoir Symbols, Heat Exchangers

Lesson 8: Hydraulic Conductors and Connectors

Shows how to identify the various types of fluid power conductors and connectors. Explores how their application works together to deliver fluid throughout the system.

Topics

Introduction, Conductors, Hose, Tubing, Pipe, Port Connectors, NFPT, Sae ORB, 4-Bolt Flange, Tube Ends, 37 Degrees, ORS, Compression, Specialty, Connectors, Quick Disconnects, Minimus Connector, Flow Considerations, Conductor Sizing, Fluid Velocity

Lesson 9: Sensors and Switches for Hydraulics

Describes the operating principles of limit switches and inductive, capactive, ultrasonic, and photoelectric sensors.

Topics

Introduction, Flow and Pressure, Pressure Gauge, Flow Meter, Electromechanical Switches, Pressure Switch, Limit Switch, Temperature Switch, Level Switch, Proximity Switches, Inductive, Capacitve, Optical, Transducers, Pressure, Temperature

Lesson 10: Hydrostatic Transmissions

Discusses the functionality and applications of the charge pump, the charge pressure relief valves, the high pressure reliefs, and the servo controller in the hydrostatic drive transmission. Further examines open versus closed center circuits and the functional description of forward, neutral, and reverse drive circuits.

Topics

Introduction, Introduction to HST, Open Circuits, Closed Circuits, Hydrostatic Drive Schematic, Drive Circuits, Forward, Neutral, Reverse

Lesson 11: Hydraulic Proportional Control Valves

Introduces the fundamentals of proportional control, identifying the various types of proportional control valves and how they function, the applicable control valve circuits, and hydraulic valve schematic symbols.

Topics

Introduction, Introduction to Proportional Controls, Theory of Operation, Proportional Solenoids, Control Amplifier, Proportional Valve Applications, Directional Control, Feedback Control, Pressure Control, Flow Control, Mobile Proportional Control, Pulse Width Modulation, Communication, Mobile Proportional Valves, Circuit Types, Open Loop Circuit, Closed Loop Circuit

Pneumatics

KR1003: Pneumatics

This course introduces the basic physics of energy, work, and power as related to pneumatics. It explains gas laws, flow, pressure, and the basic components of a pneumatic system. It includes air preparation and conditioning, calculation of force and torque, and graphic symbols. It emphasizes the importance of schematics in technical communication related to pneumatic circuits.

TPC Training is accredited by IACET to offer **0.4 CEU** for this program.

Lesson 1: Pneumatic Fundamentals

Course introduces the basic physics of energy, work, and power as related to pneumatics. Explains gas laws, flow and pressure application, and basic components of a pneumatic system.

Topics

Course Introduction, Applied Physics, Force & Motion (Energy), Work, Power, Horsepower, Flow, Pressure, Pressure Scales, Pressure Drop, Boyle's Law, Charles' Law, Lussac's Law, Combined Gas Law, Bernoulli's Principle

Lesson 2: Pneumatic Compressors

Discusses how compressed air is stored and cooled. Also explains the different types of compressors and their graphic symbols.

Topics

Course Introduction, Compressor Terminology, SCFM, Compressed CFM, Staging, Unloading, Displacement Compressors, Piston, Diaphragm, Vane, Screw, Support Components, Inlet Filter, Intercooler, Aftercooler, Air Receiver, Safety Relief Valve, Pressure Switch

Lesson 3: Pneumatics Air Preparation

Course covers air preparation and conditioning components, specifically their functionality and application. Also discusses corresponding grpahic symbols.

Topics

Course Introduction, Dryers, Dew Point Dryers, Refrigerant Dryers, Deliquescent Dryers, Desiccant Dryers, Air Preparation, Filters, Standard Filters, Coalescing Filters, Absorbing Filters, Air Regulators, Non-Relieving, Relieving, Lubricators, Functional Description

Lesson 4: Air Conductors and Distribution

Describes various types of air line conductors. Including steel pipe, copper tubing, and plastic tubing. Discussion continues by examining how their different applications work together within the network.

Topics

Course Introduction, Conductors, Pipe, Hoses, Tubing, Connectors, Air Distribution, Primary Lines, Secondary Lines, Dead End System, Loop System, Decentralized System

Lesson 5: Pneumatic Actuators

Covers the various types of pneumatic actuators, how they function, and their schematic symbols. Also discusses the basic pneumatic formulas for calculating force and torque, in relation to pneumatic actuators.

Topics

Course Introduction, Cylinders, Disposable, Tie Rod, Non-Rotating, Rodless, Air Motors, Vane, Piston, Rotary Actuators, Vane, Rack & Pinion

Lesson 6: Pneumatic Control Valves

Teaches the various types of valves and their graphic symbols. Also discusses valve functions and applications.

Topics

Course Introduction, Directional Control Valves, Direct Acting, Pilot Operated, Spool Type, Poppet, Sliding Plate Valves, Valve Actuators, Defined, Valve Application, Defined, Power Valves, Control Valves, Miscellaneous Valves, Check Valve, Shuttle Valve, Pulse Valve, Quick Exhaust Valve, Flow Controls, Slow Start Valve, Lockout Valve, Excess Flow Valve

Lesson 7: Vacuum Control Fundamentals

Course discusses the basis for understanding pneumatic vacuum control. Explains the basic physics of vacuum and how it applies to the pneumatic control system. Continues with a look at the vacuum control components as well as their graphic symbols.

Topics

Course Introduction, Basic Physics, Vacuum Defined, Vacuum Pressure Scale, Vacuum Generation, Vacuum Pumps, Vacuum Generators, Vacuum Applications, Lifting, Forming, Holding

Lesson 8: Pneumatic Symbols and Circuits

Course covers graphic symbols, their function, and method of operation. Emphasizes that graphic schematics are critical for technical communication in the pneumatic circuit.

Topics

Course Introduction, Symbolism, Lines, Air Receiver/Air Dryer, Energy Source/Exhaust, Flow Control, Directional Control, Compressor/Vacuum Pump, Check/Shuttle/Quick Exhaust Valves, FRL, Coolers, Miscellaneous Components, Actuators

Mechanical

KR1004: Mechanical

This course introduces the physics of energy, work, and power in relation to mechanics. It introduces simple machines and their application. It describes linear actuators, mechanical clutches and brakes, anti-friction bearings, gears and gear terminology, belt and chain drives, and mechanical couplings, including their principles of operation and applications.

TPC Training is accredited by IACET to offer **0.3 CEU** for this program.

Lesson 1: Fundamentals of Mechanics

Introduce the basic physics of energy, work, and power in relation to mechanics. Also discusses simple machines and their application.

Topics

Course Introduction, Applied Physics, Force & Motion, Work, Torque, Power, Horsepower

Lesson 2: Mechanical Actuators

Describes the types of linear actuators, their function, and their application. Also discusses the formulas for calculating load and torque in relation to linear actuators.

Topics

Course Introduction, Actuators, Jack Screws, Machine Screw, Ball Screw, Slider Crank, Rack & Pinion

Lesson 3: Mechanical Clutches

Describes the types of mechanical clutches, principles of operation, and applications.

Topics

Course Introduction, Introduction to Clutches, Clutch Types, Friction/Disc, Spring, Sprag, Roller Ramp, Electromagnetic

Lesson 4: Mechanical Brakes

Explores the types of mechanical brakes, their operation, and application.

Topics

Course Introduction, Introduction to Brakes, Brake Types, Friction/Disc, Band, Drum, Electromagnetic

Lesson 5: Bearings

Discusses the various types of anti-friction bearings. Goes on to explain bearing terminology and application.

Topics

Course Introduction, Introduction to Bearings, Applications, Terminology, Bearing Types, Ball Bearing, Roller Bearing, Thrust Bearing, Cylindrical Roller, Needle Roller, Spherical Roller

Lesson 6: Gears

Explains gear terminology, the various types of gears, and the application of gear box drives.

Topics

Course Introduction, Gear Fundamentals, Applications, Terminology, Gear Boxes, Gear Types, Spur, Helical, Bevel, Hypoid, Worm

Lesson 7: Belt and Chain Drives

Introduces the various types of belt and chain drives. Course further explains terminology and applications for belt and chain drives.

Topics

Course Introduction, V-Belts, Description of Operation, Terminology, Synchronous Belts, Functional Description, Terminology, Chain Drives (Same module as V-Belt Terminology)

Lesson 8: Mechanical Couplings

Explores the different types of mechanical couplings, their principles of operation, and applications.

Topics

Course Introduction, Coupling Types, Rigid, Flexible, Gear, Chain, Metal-Disc, Metal Beam, Elastomeric Jaw, Elastomeric Shear Tire, Universal Joints

Introduction to Electricity

KR1005: Introduction to Electricity

This course explains the fundamentals of electricity, including voltage, current, magnetism, and Ohm's Law. It introduces inductance, capacitance, and resistance, and discusses the basics of dc circuits, including series, parallel, and series parallel. It continues with the fundamental components that control circuit current and voltage, their applications, and their associated symbols.

TPC Training is accredited by IACET to offer **0.2 CEU** for this program.

Lesson 1: Electrical Fundamentals

Explains the fundamentals of electricity including voltage, current, basics of magnetism, and Ohm's Law. Also introduces inductance, capacitance, and resistance.

Topics

Course Introduction, Electron Theory, Bohr's Atom, Electron Transfer, Units & Symbols, Constants, Variables, SI Prefixes, Electrical Charges, Charge, Voltage, Voltage Defined, Volts Applied, Current, Current Defined, Density, Electrical Energy, Current Applied, Joule's Law, Resistance, Conductance, Resistors, Inductance, Inductors, Inductor Voltage, Energy Stored, Capacitance, Capacitors, Current, Voltage, Energy Stored, Electrical Laws, Ohm's Law, Watt's Law/Power, Basic Magnetism, Applications, Magnetism, Magnetic Fields, Polarity, Right Hand Rule

Lesson 2: Introduction to Electrical Circuits

Discusses the basics of dc circuits, including series, parallel, and series parallel. Course continues with the fundamental components that control circuit current and voltage, their applications, and their associated symbols.

Topics

Course Introduction, Circuits Defined, Introduction, Circuits, Node, Loop, Branch, Open-Closed, Short Circuit, Disconnection, Ground, Circuit Protection, Series Circuits, Defined, Batteries, Resistors, Inductors, Capacitors, Series Laws, Ohm's Law, Watt's Law, Parallel Circuits, Defined, Batteries, Resistors, Inductors, Capacitors, Combination Circuits, Reduction, Circuit Components, Switches, Diodes, Transistors, ICs, Solenoids, Relays, Transformers, Resistors, Fuses & Circuit Breakers

Mobile Electricity

KR1006: Mobile Electricity

This course explains the fundamentals of electricity, including voltage, current, magnetism, and Ohm's Law. It introduces inductance, capacitance, and resistance, and discusses the basics of dc circuits, including series, parallel, and series parallel. It continues with the fundamental components that control circuit current and voltage, their applications, and their associated symbols. It explains how a battery stores and dispenses electrical power and how an alternator generates electricity and concludes with the starting systems and remote start/stop features associated with many vehicles.

TPC Training is accredited by IACET to offer **0.2 CEU** for this program.

Lesson 1: Electrical Fundamentals

Explains the fundamentals of electricity including voltage, current, basics of magnetism, and Ohm's Law. Also introduces inductance, capacitance, and resistance.

Topics

Course Introduction, Electron Theory, Bohr's Atom, Electron Transfer, Units & Symbols, Constants, Variables, SI Prefixes, Electrical Charges, Charge, Voltage, Voltage Defined, Volts Applied, Current, Current Defined, Density, Electrical Energy, Current Applied, Joule's Law, Resistance, Conductance, Resistors, Inductance, Inductors, Inductor Voltage, Energy Stored, Capacitance, Capacitors, Current, Voltage, Energy Stored, Electrical Laws, Ohm's Law, Watt's Law/Power, Basic Magnetism, Applications, Magnetism, Magnetic Fields, Polarity, Right Hand Rule

Lesson 2: Introduction to Electrical Circuits

Discusses the basics of dc circuits, including series, parallel, and series parallel. Course continues with the fundamental components that control circuit current and voltage, their applications, and their associated symbols.

Topics

Course Introduction, Circuits Defined, Introduction, Circuits, Node, Loop, Branch, Open-Closed, Short Circuit, Disconnection, Ground, Circuit Protection, Series Circuits, Defined, Batteries, Resistors, Inductors, Capacitors, Series Laws, Ohm's Law, Watt's Law, Parallel Circuits, Defined, Batteries, Resistors, Inductors, Capacitors, Combination Circuits, Reduction, Circuit Components, Switches, Diodes, Transistors, ICs, Solenoids, Relays, Transformers, Resistors, Fuses & Circuit Breakers

Lesson 3: Starting and Charging Circuits

Explains how a battery stores and dispenses electrical power, how an alternator generates electricity - charging the battery and supplying additional electricity. Then, various components of starting systems are discussed, followed by remote start and stop features associated with many mobile vehicles.

Topics

Course Introduction, Battery Systems, Battery Basics, Charging Systems, Charging System Basics, Starting System, Starting System Basics, Control & Crank Circuits, Starting Components, Remote Start and Stop

KR1007: PLC

This course introduces PLCs and related hardware, basic PLC functions, and programming. It covers number systems used with PLCs, integers, floating-point numbers, and the handling of negative numbers. It provides information on I/O accessing, program storage, types of data, fault detection, and how the PLC coordinates these functions. It includes timers and typical PLC timing tasks, as well as simple ladder programs.

TPC Training is accredited by IACET to offer **0.4 CEU** for this program.

Lesson 1: Introduction to PLC

In this module, you will learn what a PLC is, and what kind of hardware goes into a PLC. You will also learn about basic PLC functions, as well as the PLC programming commands.

Topics

What is a PLC, Basic PLC Operation, Computer and PLC, PLC Size Categories

Lesson 2: PLC Hardware

In this course, you will be introduced to the more common topics involving PLC hardware, including power supply, processor, and input/output.

Topics

Mounting Enclosure, Power Supply, Processor and Memory, Processor and Communication Ports, Input/Output (I/O) Modules, Discrete I/O, Analog I/O, Specialty I/O, Programming Devices

Lesson 3: PLC Numbering Systems

In this module, you willlook at some of the numbering options used with PLCs, such as binary, hexadecimal, and ASCII codes. You will also learn about integers and floating-point numbers and how negative numbers are handled.

Topics

Decimal Numbering, Binary Numbering, Hexadecimal Numbering, ASCII Code, Integer, Floating Point, Negative Numbers

Lesson 4: How a PLC is Structured

Every PLC has an internal system that defines how the I/O is accessed, where the program is stored, what types of data are used, how faults are detected, and how the PLC coordinates use all this information. This module will provide you with a general understanding of these issues.

Topics

Decimal Numbering, Binary Numbering, Hexadecimal Numbering, ASCII Code, Integer, Floating Point, Negative Numbers

Lesson 5: How to Program a PLC

This lesson will concentrate on the use of Ladder Logic language for programming a PLC.

Topics

Ladder Logic, Relay Instructions, Internal Contacts and Coils, One-shot Relay, Latch/Unlatching Coil, Uploading and Downloading, Operating Modes

Lesson 6: Devices Connected to a PLC

In this course, you will be introduced to the more common topics involving PLC hardware, including power supply, processor, and input/output.

Topics

Electromagnetic Relays, Control Relays, Latching Relays, Contactors, Motor Starters, Solenoids, Control Devices with PLC, Manually Operated Switches, Electromechanical Switches, Limit Switch, Temperature Switch, Pressure Switch, Other Switches, Proximity Switches, Electronic Proximity Switch, Inductive Proximity Switch, Capacitive Proximity Switch, Ultrasonic Proximity Switch, Optical Proximity Switch, Process Transducers, Temperature Transducers, Pressure Transducers, Strain or Weight Transducers, Flow/Speed/Other Transducers

Lesson 7: How to Use Timers

IIn this module, you will learn about mechanical timers, PLC timers, the basic timer commands, cascading timers, and typical PLC timing tasks. This lesson will give you the tools you need to be able to describe PLC timer instructions, understand timer bit controls, select timer lengths and accuracies, and write simple ladder programs with integrated timer instructions.

Topics

Mechanical Timer Relays, Pneumatic Timers, Electrical Timers, PLC Timers, Timer Identification, Timebase, Preset Time, Accumulator Time, Programming Bit, Timer On-Delay (TON), Timer Off-Delay (TOF), Retentive Timer (RTO), Cascade Timer

Lesson 8: How to Use Counters

In this module, we will focus on up-counters and how they are programmed.

Topics

Electromechanical Counters, PLC Counters, Addressing, Preset Time, Accum, CU and DN Bits, Reset, Cascade Counters

AC-DC Drives

KR1008: AC-DC Drives

This course covers electromechanical systems, their terminology, and how the components function together. It examines the magnetic and electromagnetic properties of dc motor components, motor operation and classification, the creation of mechanical energy by ac motors and how electromagnetism and induction produce rotation. It discusses methods for stopping motors, the components of a brushless servo motor, and speed torque curves. It concludes with coverage of output power, the control section, and I/O servo drives.

TPC Training is accredited by IACET to offer **0.4 CEU** for this program.

Lesson 1: Fundamentals of AC-DC Drives

This course explains electromechanical systems. It begins by looking at their related terminology. It goes on to explain how the various components function together.

Topics

ST-Overview, ST-Electromechanical System, ST-Voltage, ST-Current, ST-Frequency, ST-Sine Wave, ST-Resistance, ESC-Overview, ESC-Power Source, ESC-Controller, ESC-Drive, ESC-Motor, ESC-Feedback Loops, ESC-Coupling, ESC-Machine, HTS-Overview, HTS-Horsepower, HTS-Torque, HTS-Speed, LIC-Overview, LIC-Constant Torque Loads, LIC-Constant Horsepower, LIC-Variable Torque Loads

Lesson 2: DC Motors

Examines the magnetic and electromagnetic properties of dc motor components. The influences that affect motor operation and classification are later discussed.

Topics

ME, ME-Magnetism, ME-Electromagnetism, DCMT, DCMT-Armature Current, DCMT-Base Speed, DCMT-Commutation, DCMT-Field Current, DCMT-Flux, DCMO, DCMO-Power Electromagnetism, DCMC, DCMC-Series Wound Motor, DCMC-Shunt Wound Motor, DCMC-Compound Motor, DCMC-Stabilized Shunt Motor

Lesson 3: AC Motors

Covers how ac motors create mechanical energy. Discusses how electromagnetism and induction produce rotation by becoming familiar with the related terms and concepts. Explains how motors are classified by NEMA.

Topics

AC Motor Hardware, OP1, OP1-Breakdown Torque, OP1-Cogging, OP1-Slip, OP1-Starting Current, OP1-Starting Torque, OP2-Induction, OP2-Induction Magnetism, OP2-Motoring Action, OP2-Slip Calculation, OP2-Torque Production, NEMA, NEMA-Design A, NEMA-Design B, NEMA-Design C, NEMA-Design D

Lesson 4: DC Drives

Covers the control section, armature bridge, and dc drive controls. The various components of each are examined and explained.

Topics

Control Section, Power Section, AB, AB-DC Contractor, AB-AC DC Conversion, AB-Field Bridge, DCDF, DCDF-Power Conversion

Lesson 5: AC Drives

Covers the two main sections of AC drives: control and power. The control section explains how a series of control boards performs the drive's control functions. Under power, DC conversion, filters, and inverters are discussed.

Topics

Hardware, Control Section, PS-Overview, PS-DC Converter Section, PS-Filter, PS-Inverter, PS-Driver Inverter Classification, AC Drive Functions, PC-Overview, PC-Power Conversion Path, PC-AC DC Conversions, PC-Voltage Spike Smoothing, PC-DC AC Inversion

Lesson 6: AC-DC Braking Methods

Discusses the three methods for stopping motors: coasting, mechanical braking, and electrical braking. Other types of ac motor braking are also explained.

Topics

Coasting, Mechanical Braking, Electrical Braking, Dynamic Braking, Regeneative Braking, Deceleration Modes

Lesson 7: Brushless DC Motors

The components of a brushless servo motor are discussed. The course goes on to describe speed torque curves. It concludes by examining how to select a brushless dc motor.

Topics

MC-Overview, MC-Rotor, MC-Stator, MC-Feedback, MC-Holding Brake, COM-DC Motor Commutation, COM-Brushless Commutation, MP-Motor Specifications, MP-Speed Torque Curves, Speed/Torque Curves 1, Speed/Torque Curves 2, Selecting, Constant Torque, Distance in Motor Rev, Maximum Rotational Speed, Angular Acceleration, Load Component Inertia, Motors Rotor Inertia, Load to Motor Inertia, Acceleration Deceleration, Peak Torque, RMS Torque, PIS-Bus Discharge

Lesson 8: Brushless Servo Drives

The output power, control section, and I/O servo drives are discussed. The function of various components for each are explained.

Topics

POS-Overview, POS-Transistor Types, POS-Three Phase Bridge, POS-PWM, CS-Commutation, CS-Loop Closure, CS-PID, PID1, PID2, Digital IO, Analog IO, IO-Fieldbus, Power Cables, Servo Actuators

Multimeter Basics

KR1009: Multimeter Basics

This course demonstrates the differences between analog and digital testers and their proper usage. It also covers the fundamentals of using electrical testers as well as the testing of circuits and circuit components.

TPC Training is accredited by IACET to offer **0.1 CEU** for this program.

Lesson 1: Using Electrical Testers

Demonstrates the differences between analog and digital testers and their proper usage. Also covers the fundamentals of using electrical testers as well as testing circuits and different circuit components.

Topics

Course Introduction, Types of Meters, Analog Meters, Digital Meters, Meter Features, Display, Dial, Port Panel, Safety in Electrical Testing, Personal Safety, Equipment Safety, Multimeter Basics, Resolution, Digits & Counts, Range & Resolution, Accuracy, Testing Voltage, Testing DC Voltage, Testing AC Voltage, Testing Current, Clamp-on Meter, Current Probe, Standard Probes, Testing Components, Testing Continuity, Testing Resistance, Testing Capacitance, Testing Diodes

Lesson 2: Starting and Charging Circuits

Explains how a battery stores and dispenses electrical power, how an alternator generates electricity - charging the battery and supplying additional electricity. Then, various components of starting systems are discussed, followed by remote start and stop features associated with many mobile vehicles.

Topics

Course Introduction, Battery Systems, Battery Basics, Charging Systems, Charging System Basics, Starting System, Starting System Basics, Control & Crank Circuits, Starting Components, Remote Start and Stop

GENERAL SAFETY AND HEALTH

TPC Training's General Safety and Health Series deals with safety and health issues that are important to employees in their day-to-day job functions, such as back safety, ergonomics, fire safety, and much more.

COURSES

- Accident Investigation
- Active Shooter: Surviving an Attack
- Arc Flash
- Back Safety
- Bullying and Other Disruptive Behavior - 2 versions
- Compressed Gas Cylinders
- Computer Workstation Safety
- Conflict Resolution - 2 versions
- Crane Safety
- Dealing with Drug and Alcohol Abuse - 2 versions
- Dealing with Hazardous Spills
- Distracted Driving
- Driving Defensively
- Driving Safety
- Driving Safety: The Basics
- Electrical Safety
- Ergonomics - 2 versions
- Evacuation Procedures
- Eye Safety
- Fall Protection
- Fire Extinguishers
- Fire Prevention - 3 versions
- First Aid
- Fitness and Wellness
- Hand & Power Tool Safety
- Hand, Wrist, & Finger Safety
- Hazard Recognition
- Hazardous Materials Labels
- Heat Stress
- Hot Work Safety and the Permitting Process
- I2P2 - Injury and Illness Prevention
- Ladder Safety
- Machine Guard Safety
- Materials Handling Safety
- Office Safety
- Rigging Safety
- Safe Lifting
- Safety Audits
- Safety Awareness for New Employees
- Safety Housekeeping and Accident Prevention
- Safety Orientation
- Safety Showers & Eye Washes
- Sexual Harassment - 2 versions
- Sexual Harassment Investigations
- Slips, Trips, & Falls
- Walking and Working Surfaces
- Warehouse Safety
- Welding Safety
- Winter Safety
- Workplace Harassment - 2 versions
- Workplace Stress
- Workplace Violence
- Workplace Violence in Healthcare Facilities

Our safety courses are updated frequently, please contact a Training Solutions Consultant or visit our website for the most current information.

REGULATORY COMPLIANCE

TPC Training's Regulatory Compliance Series is comprised of training products that help organizations comply with relevant laws and regulations, mandated by Occupational Safety and Health Administration (OSHA), the Environmental Protection Agency (EPA), and the Department of Transportation (DOT). Essential topics are covered in this series, including personal protective equipment (PPE), lockout/tagout, confined space, bloodborne pathogens, and more.

COURSES

- Aerial Lifts in Industrial and Construction Environments
- Asbestos Awareness
- Bloodborne Pathogens – 3 versions
- Confined Space Entry
- DOT HAZMAT Series – 4 versions
- Emergency Planning
- Forklift Safety: Industrial Counterbalance Lift Trucks
- Forklift/Powered Industrial Truck Safety
- Introduction to GHS - the Globally Harmonized System
- GHS Container Labeling
- GHS Safety Data Sheets
- Hazard Communication (Right-To-Know) – 5 versions
- Hearing Conservation and Safety
- HIPPA Rules and Compliance
- Indoor Air Quality
- Introduction to OSHA
- Lead Exposure in General Industry
- Lock-Out/Tag-Out
- OSHA Lead Standards
- OSHA Recordkeeping – 3 versions
- Personal Protective Equipment
- Respiratory Protection and Safety
- Scissor Lifts in Industrial and Construction Environments
- Supported Scaffolding Safety
- Suspended Scaffolding Safety
- Tuberculosis in the Healthcare Environment

Our safety courses are updated frequently, please contact a Training Solutions Consultant or visit our website for the most current information.

HAZWOPER

TPC Training's HAZWOPER Series is designed to provide employees with important information that the HAZWOPER regulation requires them to receive. By combining various programs in the series, training packages can be configured to help your employees meet all of the OSHA HAZWOPER training requirements.

COURSES

- 40-Hour Training Package
- 8-Hour Annual Retraining Series Package
- Accidental Release Measures and Spill Cleanup Procedures
- All 23 HAZWOPER Series Programs
- Confined Space Entry
- Dealing with the Media in Emergency Situations
- Decontamination Procedures
- Electrical Safety in HAZMAT Environments
- Emergency Response - Awareness Package
- Emergency Response - HAZMAT Technician Package
- Emergency Response - Operations Package
- Emergency Response Plan
- Exposure Monitoring and Medical Surveillance
- Fire Prevention and Safety
- General Training Package
- Handling Hazardous Materials
- HAZMAT Labeling
- Heat Stress
- Introduction to HAZWOPER Retraining
- Medical Surveillance Programs
- Monitoring Procedures and Equipment
- Personal Protective Equipment
- Personal Protective Equipment and Decontamination Procedures
- Respiratory Protection
- Safety Data Sheets in HAZWOPER Environments
- Safety Orientation
- Site Safety and Health Plan
- Supplemental Training Package
- Understanding Chemical Hazards
- Understanding HAZWOPER
- Work Practices and Engineering Controls

Our safety courses are updated frequently, please contact a Training Solutions Consultant or visit our website for the most current information.

LABORATORY

The laboratory environment poses unique safety challenges for your workforce, and requires training oriented specifically to Laboratory safety. TPC's Laboratory Safety Series brings you high-quality courses designed specifically to cover virtually every aspect of maintaining a safe laboratory work environment.

COURSES

- Compressed Gas Cylinders
- Electrical Safety
- Flammables & Explosives
- GHS Safety Data Sheets in the Laboratory
- Laboratory Ergonomics
- Laboratory Hoods
- Orientation to Laboratory Safety
- OSHA Formaldehyde Standard
- Planning for Laboratory Emergencies
- Preventing Contamination
- Safe Handling of Laboratory Glassware
- Safety Showers & Eye Washes

Our safety courses are updated frequently, please contact a Training Solutions Consultant or visit our website for the most current information.

INSTRUCTOR-LED COURSES

Our open enrollment and on-site seminars meet OSHA and NFPA requirements for classroom training and offer an extensive list of industrial, facility, and building maintenance training seminars. TPC Training conducts more than 2,000 seminars nationwide each year to provide intensive training that gets your employees back to the workplace quickly to apply what they've learned.

SEMINAR TOPICS

HVAC

- Air Conditioning and Refrigeration
- Boiler Operation, Maintenance & Safety
- Chilled Water Systems
- HVAC Electrical Controls & Air Distribution
- Water Treatment for Boilers, Chillers & Cooling Towers

Mechanical & Industrial

- Maintenance Welding
- Plumbing and Pipefitting for Plants and Buildings
- Pump Repair and Maintenance
- Pumps & Pump Systems: Specification, Installation & Operation
- Steam Systems Maintenance, Safety & Optimization
- Troubleshooting Essentials
- Troubleshooting Mechanical Drive Systems & Rotating Equipment
- Understanding & Trobleshooting Hydraulics

Plant Management

- Maintenance Management Basics for First-Line Supervisors
- Inventory Control for Maintenance
- Maintenance Planning and Scheduling
- Predictive Maintenance and Condition Monitoring
- Total Productive Maintenance (TPC) Planning

Electrical

- Basic Electricity for the Non-Electrician
- Electrical Troubleshooting & Preventive Maintenance
- 2017 National Electrical Code
- Arc Flash Electrical Safety NFPA 70E®
- Arc Flash Electrical Safety NFPA 70E® with Certification
- High Voltage Electrical Safety
- Introduction to General Maintenance
- Troubleshooting Essentials
- Changes to the 2018 NFPA 70E® Standard
- PLCs for Non-Programmers
- PLC Programming & Applications
- Variable Frequency Drives
- Variable Frequency Drives Advanced Applications
- Electrical Motors and Motor Control Circuits
- Instrumentation Process Measurement & Control
- DC Electrical Systems for Mobile Vehicles & Equipment
- ControlLogix
- Generators and Emergency Power
- Uninterruptible Power Supply (USP) Systems
- Photovoltaic Solar Power

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CURRICULUM WORKSHEET

Recommended Curriculum by Job Title

MST	Mechanical Systems Technician	W	Welder	MTD	Machinist/Tool & Die Maker
MMT	Multi-Craft Maintenance Technician	EST	Electrical Systems Technician	HT	HVAC Technician
MW	Millwright	EIS	Electrical/Instrumentation Systems Technician	RUT	Refrigeration/Utilities Technician
PF	Pipefitter	ICS	Instrumentation/Control Systems Technician	MLS	Maintenance Lead/Supervisor
LO	Lubricator/Oiler	FBM	Facility/Building Maintenance Technician		

Customized Curriculum by Job Title

1. _____ 2. _____ 3. _____

Fundamentals

101: Reading Blueprints	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM	MTD	HT	RUT				
102: Reading Schematics and Symbols	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM	MTD	HT	RUT				
103: Mathematics in the Plant	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM	MTD	HT	RUT				
104: Making Measurements	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM	MTD	HT	RUT				
105: Metals in the Plant	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM	MTD	HT	RUT				
106: Nonmetals in the Plant	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM		HT	RUT				
107: Hand Tools	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM	MTD	HT	RUT				
108: Portable Power Tools	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM	MTD	HT	RUT				
109.1: Industrial Safety and Health	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM	MTD	HT	RUT				
110: Troubleshooting Skills	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM		HT	RUT				

Electrical Systems

201: Basic Electricity and Electronics		MMT	MW			W	EST	EIS	ICS	FBM	MTD	HT	RUT				
202: Batteries and DC Circuits		MMT				W	EST	EIS	ICS	FBM							
203: Transformers and AC Circuits		MMT				W	EST	EIS	ICS	FBM		HT	RUT				
204.1: Electrical Measuring Instruments		MMT				W	EST	EIS	ICS	FBM			RUT				
205.1: Electrical Safety and Protection		MMT				W	EST	EIS	ICS	FBM		HT	RUT				
206: DC Equipment and Controls		MMT				W	EST	EIS	ICS								
207: Single-Phase Motors		MMT					EST	EIS	ICS	FBM							
208: Three-Phase Motors		MMT					EST	EIS	ICS	FBM			RUT				
209: AC Control Equipment		MMT					EST	EIS	ICS	FBM		HT	RUT				
210: Electrical Troubleshooting		MMT					EST	EIS	ICS	FBM		HT	RUT				
211: Electrical Safety in the Workplace - NFPA 70E		MMT				W	EST	EIS	ICS	FBM		HT	RUT				

Mechanical Systems

301: Basic Mechanics	MST	MMT	MW	PF	LO		EST	EIS	ICS	FBM	MTD	HT	RUT				
302: Lubricants and Lubrication	MST	MMT	MW		LO		EST	EIS	ICS	FBM	MTD	HT	RUT				
303.1: Power Transmission Equipment	MST	MMT	MW		LO			EIS	ICS	FBM	MTD		RUT				
304: Bearings	MST	MMT	MW		LO		EST	EIS	ICS	FBM	MTD	HT	RUT				
305: Pumps	MST	MMT	MW	PF	LO			EIS	ICS	FBM		HT	RUT				
306: Piping Systems	MST	MMT	MW	PF				EIS	ICS	FBM		HT	RUT				
307: Basic Hydraulics	MST	MMT	MW	PF	LO		EST	EIS	ICS				RUT				
308: Hydraulic Troubleshooting	MST	MMT	MW	PF				EIS	ICS				RUT				
309: Basic Pneumatics	MST	MMT	MW	PF	LO		EST	EIS	ICS	FBM		HT	RUT				
310: Pneumatic Troubleshooting	MST	MMT	MW	PF				EIS	ICS	FBM		HT	RUT				

CURRICULUM WORKSHEET - CONT.

Recommended Curriculum by Job Title

MST	Mechanical Systems Technician	W	Welder	MTD	Machinist/Tool & Die Maker
MMT	Multi-Craft Maintenance Technician	EST	Electrical Systems Technician	HT	HVAC Technician
MW	Millwright	EIS	Electrical/Instrumentation Systems Technician	RUT	Refrigeration/Utilities Technician
PF	Pipefitter	ICS	Instrumentation/Control Systems Technician	MLS	Maintenance Lead/Supervisor
LO	Lubricator/Oiler	FBM	Facility/Building Maintenance Technician		

Customized Curriculum by Job Title

1. _____ 2. _____ 3. _____

Air Conditioning and Refrigeration

431: The Refrigeration Cycle		MMT								FBM		HT	RUT				
432: Refrigerants and Refrigerant Oils		MMT								FBM		HT	RUT				
433: Compressors		MMT								FBM		HT	RUT				
434: Evaporators and Metering Devices		MMT								FBM		HT	RUT				
435: Condensers and Cooling Towers		MMT								FBM		HT	RUT				
436: Piping		MMT								FBM		HT	RUT				
437: Control Systems		MMT								FBM		HT	RUT				
438: Air-Handling Systems		MMT								FBM		HT					
439: System Troubleshooting		MMT								FBM		HT	RUT				
440: Absorption Chillers		MMT								FBM		HT	RUT				
441: Heat Pumps		MMT								FBM		HT					
442: Heating System Basics		MMT								FBM		HT					
443: Heating System Equipment		MMT								FBM		HT					

Ammonia Refrigeration

461: Ammonia Refrigeration Basics													RUT				
462: Positive-Displacement Compressors	MST	MMT											RUT				
463: Evaporators, Condensers, and Controls													RUT				
464: Purging, Piping, and Safety													RUT				

Building and Grounds Maintenance

361: Introduction to Carpentry		MMT								FBM							
362: Constructing the Building Shell		MMT								FBM							
363: Finishing the Building Interior		MMT								FBM							
364: Structural Painting										FBM							
366: Flat Roof Maintenance		MMT								FBM							
367: Plumbing Systems Maintenance		MMT								FBM							
374: Locks and Key Systems		MMT								FBM							
375: Landscaping Maintenance										FBM							

Custodial Maintenance

451: Cleaning Chemicals										FBM							
452: Floors and Floor Care Equipment										FBM							
453: Maintaining Floors and Other Surfaces										FBM							
454: Rest Room Care										FBM							
455: Carpet and Upholstery Care										FBM							

CURRICULUM WORKSHEET - CONT.

Recommended Curriculum by Job Title

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Customized Curriculum by Job Title

1. _____ 2. _____ 3. _____

Electronics

251: Semiconductors							EST	EIS	ICS	FBM			RUT				
252: Power Supplies							EST	EIS	ICS	FBM			RUT				
253: Amplifiers							EST	EIS	ICS	FBM			RUT				
254: Oscillators							EST	EIS	ICS	FBM			RUT				
291: Digital Logic Systems							EST	EIS	ICS	FBM			RUT				

Energy Conservation

376: Energy Conservation Basics	MST	MMT	MW	PF			EST	EIS		FBM	MTD		RUT				
377: Energy Losses in Buildings	MST	MMT								FBM		HT	RUT				
378: Heating/Cooling System Efficiency	MST	MMT		PF			EST	EIS		FBM		HT	RUT				
379: Mechanical Energy Conservation	MST	MMT	MW							FBM			RUT				
380: Electrical Energy Conservation	MST	MMT					EST	EIS		FBM			RUT				

Foundations of Technology

391: Force and Motion	MST	MMT															

Industrial Hazard Control

151: Chemical Hazards	MST	MMT	MW	PF	LO	W	EST	EIS	ICS	FBM	MTD	HT	RUT				

Machine Shop Practices

315: Machine Shop Practice	MST	MMT	MW	PF		W				FBM	MTD						
316: Machine Shop Turning Operations	MST	MMT	MW								MTD						
317: Machine Shop Shaping Operations	MST	MMT	MW								MTD						
323: Machine Shop Job Analysis	MST	MMT	MW								MTD						
324: Lathe - Turning Work Between Centers	MST	MMT	MW								MTD						
325: Lathe - Machining Work in a Chuck	MST	MMT	MW								MTD						
326: Basic Milling Procedures	MST	MMT	MW								MTD						
327: Indexed Milling Procedures	MST	MMT	MW								MTD						
328: Multiple-Machine Procedures	MST	MMT	MW	PF		W					MTD						

Machine Tool Workbooks

161: Measurements	MST	MMT	MW								MTD						
162: Basic Hand Tools	MST	MMT	MW								MTD						
163: Work Planning and Setup	MST	MMT	MW								MTD						
164: Metal Cutting Fundamentals	MST	MMT	MW								MTD						
165: Cutting Tools I	MST	MMT	MW								MTD						
166: Cutting Tools II	MST	MMT	MW								MTD						

CURRICULUM WORKSHEET - CONT.

Recommended Curriculum by Job Title

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Customized Curriculum by Job Title

1. _____ 2. _____ 3. _____

Material Handling Systems

331: Bulk-Handling Conveyors	MST	MMT								FBM							

Mechanical Maintenance Applications

341: Mechanical Drive Maintenance	MST	MMT	MW		LO					FBM			RUT				
342: Mechanical and Fluid Drive Systems	MST	MMT	MW							FBM			RUT				
343: Bearing and Shaft Seal Maintenance	MST	MMT	MW							FBM		HT	RUT				
344: Pump Installation and Maintenance	MST	MMT	MW	PF						FBM			RUT				
345: Maintenance Pipefitting	MST	MMT	MW	PF		W				FBM		HT	RUT				
346: Tubing and Hose System Maintenance	MST	MMT	MW	PF				EIS	ICS	FBM		HT	RUT				
347: Valve Maintenance and Piping System Protection	MST	MMT	MW	PF			EST	EIS	ICS	FBM		HT	RUT				

Packaging Machinery

311: Introduction to Packaging	MST	MMT															
312: Packaging Machinery	MST	MMT															
313: Casing Machinery	MST	MMT															

Power Plant Operations

111: How Power Plants Work							EST	EIS		FBM							
112: Generating Steam in the Power Plant										FBM			RUT				
113: Using Steam in the Power Plant							EST	EIS		FBM							
114: Waste-to-Energy Fundamentals										FBM							

Process Control Instrumentation

271: Introduction to Process Measurement and Control		MMT						EIS	ICS			HT	RUT				
273: Pressure Measurement								EIS	ICS	FBM							
274: Force, Weight, and Motion Measurement								EIS	ICS								
275: Flow Measurement								EIS	ICS	FBM							
276: Level Measurement								EIS	ICS	FBM							
277: Temperature Measurement								EIS	ICS			HT	RUT				
278: Analytical Instrumentation								EIS	ICS								
279: Final Control Elements								EIS	ICS								
280: Safety, Calibration, and Testing								EIS	ICS								

CURRICULUM WORKSHEET - CONT.

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Customized Curriculum by Job Title

1. _____ 2. _____ 3. _____

Process Control Systems

281: Working with Controllers								EIS	ICS								
282: How Control Loops Operate								EIS	ICS								
283: Data Transmission								EIS	ICS								
284: Computers in Process Control								EIS	ICS								

Programmable Logic Controllers

298: Programmable Logic Controllers							EST	EIS	ICS	FBM		HT	RUT				

Rigging and Equipment Installation

318: Industrial Rigging Principles and Practices	MST	MMT	MW	PF		W	EST	EIS		FBM	MTD	HT	RUT				
319: Equipment Installation	MST	MMT	MW							FBM		HT	RUT				

Robotics

501: Introduction to Robotics	MST	MMT															

Water / Wastewater Treatment

381: Introduction to Water Technology		MMT								FBM			RUT				
382: Wastewater Treatment Processes		MMT								FBM							
383: Maintaining Wastewater Equipment		MMT															

Welding

416: Blueprint Reading for Welders	MST	MMT	MW	PF		W	EST	EIS		FBM		HT	RUT				
417: Welding Principles	MST	MMT	MW	PF		W	EST	EIS		FBM		HT	RUT				
418: Oxyfuel Operations	MST	MMT	MW	PF		W				FBM		HT	RUT				
419: Arc Welding Operations	MST	MMT	MW	PF		W	EST	EIS		FBM			RUT				

Maintenance Management

901: Maintenance Organization														MLS			
902: Implementing Preventive Maintenance														MLS			
903: Controlling Maintenance Resources														MLS			
904: Improving Performance in Maintenance														MLS			
905: Effective Communication for Supervisors														MLS			
906: Employee Relations														MLS			
907: Managing a Training Program														MLS			