Industrial Skills
Online Training

Safety, Health, and Plant Science
Mechanical Maintenance
Electrical Transmission and Distribution
Electrical Maintenance
Power Generating Systems and Operations
Instrumentation and Control
Process Systems and Operations
Industrial Machining and Welding
NERC Certification and Credential Maintenance

Making the workplace safer
and smarter because **Reliability Matters**

A Leader in Technical E-Learning

We offer animated and interactive technical e-learning which takes your team through the theoretical portion of their professional development before they experience hands-on training in a learning laboratory or on the job site.

The animation and graphic illustrations within our training enables us to display processes and complex internal components of equipment at a level of detail that would be impossible in a standardtextbook or traditional lecture format. Designed for minimal seat time and minimal staffoversight, our e-learning will make your staff leaner and more productive, offering you the greatest gains in efficiency and competency at the lowest possible cost.

Students learn at a distance and at their own pace – and because all students receive the same information throughout the life of the program, training remains consistent over time. With state-of-the-art technology, 3D animation, and a media library exceeding 300,000 images and videos, we'll engage and motivate your team as they learn and embrace your processes, procedures, and policies.

Our library includes more than 750 hours of customizable industrial training:

- Safety, Health, and Plant Science
- Mechanical Maintenance
- Instrumentation and Control
- Machining and Welding
- Electrical Maintenance
- Electrical Generation Operations
- Process Systems and Refining Operations
- NERC Regulatory Training

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

HSI and HSI_SOS_001 are recognized by the North American Electric Reliability Corporation as a continuing education provider who adheres to NERC Continuing Education Program Criteria.

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100

Safety, Health and Plant Science

101 Personal Protective Equipment (PPE)

101-01 Personal Protective Equipment

A personal protective program protects employees by ensuring personal protective equipment (PPE) is provided and used whenever workplace hazards deem it necessary. A personal protective program also requires all PPE be maintained in a sanitary and reliable condition. The Personal Protective Equipment training course describes employer and employee requirements for reducing risk and avoiding injury, illness, and death by properly selecting, using, and maintaining PPE. It discusses the types and use of PPE.

This lesson satisfies the required annual refresher training for OSHA standard 29 CFR 1910.132(f) (1) through (3).

101-02 Hearing and Noise Safety

Well established evidence shows that worker exposure to noise of sufficient intensity and duration can result in hearing damage. Noise-induced hearing loss rarely results from just one exposure. It progresses unnoticed over a period of years. The Hearing Noise and Safety training course identifies conditions that lead to hearing damage or loss. It shows how to use engineering controls and personal protective equipment to prevent such damage.

The 101 PPE lessons satisfy the training requirements and annual refresher requirements for OSHA standard 29 CFR 1910 section 95 (i) (4) (k) and (l).

101-03 Respiratory Protective Program

Policies, programs, and procedures exist in the workplace to provide employees with a safe and healthful working environment. Companies ensure worker safety by using facilities and equipment with feasible safeguards built into their designs to protect workers' respiratory health. When effective engineering controls are not available or being initiated, personal respiratory protection must be used to protect personnel. The Respiratory Protective Program training course identifies respiratory hazards. It explains how to use personal respiratory equipment to prevent injury or illness from poor breathing conditions.

The 101 PPE lessons satisfy the training requirements for OSHA 29 CFR 1910 section 134 (k) (1) through (6).

101-70 Introduction to OSHA (Occupational Safety and Health Administration)

The Introduction to OSHA (Occupational Safety and Health Administration) training course provides a general overview of basic topics related to OSHA and how it operates. It describes the large role OSHA plays in maintaining employee health and safety as they perform their daily work.

101-71 Introduction to Industrial Hygiene

Industrial Hygiene is the science of protecting the health and safety of workers and their families through the anticipation, recognition, evaluation, and control of worksite conditions. The Introduction to Industrial Hygiene training course discusses how to apply principles of industrial hygiene toward a safer working environment.

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102 Worksite Training

102-01 Slip, Trip, and Fall Prevention

Slips, trips, and falls are a frequent cause of accidents, both on and off the job. Slips, trips, and falls rank second only to automobile accidents as a cause of death or injury. Safety precautions to prevent these incidents include alertness, cleanliness, safety footwear, and compliance with safe practices when using stairs, ladders, and walkways. The Slip, Trip, and Fall Prevention training course describes safe practices for preventing these incidents in the workplace.

This lesson satisfies the training requirements for OSHA instructions 29 CFR 1910.30(a)(b)(c) and (d), 1926.21 (a) and (b), and 29 CFR 1926.20(b), (1), (2), and (4); (f) (2).

102-02 Ladder Safety

Ladders present unique opportunities for unsafe acts and unsafe conditions. Employees who use ladders must be trained in proper selection, inspection, use, and storage of this equipment. Improper ladder use causes most workplace accidents. The Ladder Safety training course identifies the specifications of several different ladder types. It explains how to adhere to standard safety precautions for ladder use, maintenance, and storage.

This lesson satisfies the requirements for OSHA standard 29 CFR 1926.1060 (a) (1) (i) through (v) and (b).

102-03 Portable Power and Hand Tool Safety

All tools are manufactured with safety in mind, but a serious accident often occurs before tool-related hazards are identified and eliminated. Workers must learn to recognize the hazard associated with the different tools they use. They also must learn the safety precautions necessary to avoid those hazards. Tool misuse is a source of worker injury. Often, Injuries happen because employers assume workers know how to use the tool or workers are distracted during their task. The Portable Power and Hand Tool Safety training course identifies hazards associated with hand and power tool use. It discusses how to prevent accidents and injury by following safety practices and requirements.

This course satisfies the training requirements for OSHA regulation 29 CFR 1910 (Subpart P) section 241 through 244.

102-04 Machine Hazards and Safety

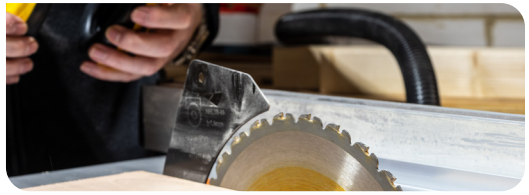
There are many different kinds of machinery and equipment, but they all have similar characteristics and hazards. People can be cut, crushed, or pulled into machines, or struck by objects thrown from them. Safety training, equipment, and practices are in place to prevent injury and death in the workplace. All employees must adhere to safety precautions and programs while operating machinery. The Machine Hazards and Safety training course identifies common workplace hazards associated with operating machinery. It explains how to apply safeguards to prevent injury and death in the workplace.

This lesson satisfies the training requirements for OSHA standard 29 CFR 1910.217, 29 CFR.218.

102-05 Machine Guarding

Placing and keeping guards on exposed machinery is a major step in preventing lacerations and amputations of body parts. It is also a requirement of OSHA standards. Several types of guards with a variety of functions are used in the workplace to prevent injury and illness. Guards must remain in place and function at all times. The Machine Guarding training course describes the characteristics of a machine guard and explains its functions.

This course satisfies the training requirements for OSHA standards 29 CFR 1910.212, 213, 215, 217, and 219.



102-06 Accident Causes, Prevention, and Investigation

The Accident Causes, Prevention, and Investigation training course discusses common causes of accidents and identifies ways to prevent accidents and control hazards. It identifies factors that cause accidents and methods to prevent them. It also explains how to investigate an accident.

102-07 Stationary Power Tool Safety

Stationary power tools can be helpful, but also present many hazards. Most power tools operate at high speeds and have numerous moving parts. Safety precautions can include engineering controls, such as machine guarding, and administrative controls, such as safe procedures. Additionally work area standards for cleanliness, organization, and personal protection equipment (PPE) can make operating stationary power tools safer. The Stationary Power Tool Safety training course explains how to safety operate a number of stationary power tools by identifying general work area safety requirements and tool-specific requirements.

This course satisfies the training requirements for OSHA regulation 29 CFR 1910 (Subpart O) section 211 through 219.

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102-08 **Laboratory Health and Safety**

A company's laboratory safety program depends on every employee's participation and cooperation. Noncompliance with safety precautions not only endangers the individual, but often compromises the health and safety of fellow workers and the surrounding community. The Laboratory Health and Safety training course discusses common safety practices and procedures in the laboratory. It also describe the proper disposal of laboratory waste.

This course may satisfy the training requirements for OSHA regulation 29 CFR 19190.1459.

102-09 **Operator Fatigue**

Operator fatigue has been found to play a role in many industrial accidents. Operator fatigue is often cited as ""unfitness for duty,"" meaning the operator was not physically or mentally ready to accomplish their tasks. Though usually not the only factor in industrial accidents, it has historically played a role in impairing judgement and compromising an operator's alertness.

The Operator Fatigue training course identifies the symptoms of operator fatigue and explains its:

- Causes
- Effects
- Indications
- Management

Operator Fatigue is part of the Worksite Safety training series.

102-10 **Hazard Identification and Assessment**

One of the root causes of workplace injuries, illnesses, and incidents is the failure to anticipate or identify recognized hazards. A critical element of any effective safety and health program is a proactive, ongoing process to identify and assess such hazards. The Hazard Identification and Assessment training course describes recommended practices for companywide safety and health programs regarding hazard identification and assessment.

103 **First Aid**

103-01 **First Aid**

First aid describes a number of procedures and techniques for treating minor injuries and illnesses and major medical emergencies. Minor injuries include cuts, scrapes, bruises, minor burns, and minor sprains. First aid may be required during major emergencies or accidents that could result in death. Applying first aid techniques to treat severe bleeding, heart attack, or choking can save the victim's life. The First Aid training course describes common injuries that require first aid treatment and how to provide aid for these injuries. It identifies major emergencies requiring emergency personnel and how to provide initial treatment for such injuries. It explains the importance of adhering to the universal precautions taken to prevent the transmission of bloodborne pathogens and prevent infections.

This course satisfies the training requirements for OSHA standard 29 CFR 1910.151 (a) (b).

103-02 **Bloodborne Pathogens**

Bloodborne pathogens are disease-causing microorganisms found in human blood. Occupational exposure to blood or other potentially infectious materials may put the employee at risk of infection by these microorganisms. The Bloodborne Pathogens training course identifies the diseases commonly caused by contact with bloodborne pathogens. It also describes safety measures and strategies to protect you from exposure to bloodborne pathogens.

This course satisfies the initial and annual training requirements for OSHA standard 29 CFR 1910.1030(g)(2), (h)(2), and (3).

103-03 **First Aid Resuscitation: Choking, CPR, and AED**

Responding quickly and correctly to a medical emergency greatly increases the victim's chances for survival. Effective bystander CPR and Heimlich Maneuver administration can double the survival rate. The First Aid Resuscitation: Choking, CPR, and AED training course demonstrates how to assist victims using appropriate first aid techniques, including the Heimlich Maneuver, CPR, and using an AED.

103-04 **Temperature Related Stress and Illnesses**

The Temperature-related Stress and Illness training course discusses the causes and effects of temperature-related stress. It identifies illnesses associated with this stress.

104 **Fire Prevention**

104-01 **Fire Prevention and Protection Program**

Fire in the workplace poses a constant danger, threatening property and workers' lives. Understanding the anatomy of fires, how to prevent fires, and how to properly extinguish small incipient fires will help provide the best protection against property loss, serious injury, and death. The Fire Prevention and Protection Program training course explains how to plan, practice, and apply fire protection program standards in the workplace.

This course satisfies the required initial and annual refresher training for OSHA standard CFR 1910.39(a) through (d) and CFR 1910.38 (a) through (f).

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104-02 **Fire Extinguisher Safety**

The proper use and handling of fire extinguishers can minimize the damage and threat of injury or death should a small fire ignite in the workplace. All employees must understand the types of fire extinguishers available in each work area. Fire extinguisher safety includes knowing which fires to fight, when to fight them, and what extinguishers and methods to use. The Fire Extinguisher Safety training course identifies the four fire fuel sources and the appropriate extinguisher to put out a small fire. It also demonstrates the safest procedures for extinguishing a fire in the workplace. It describes the maintenance, inspection, and documentation requirements for fire extinguishers.

This lesson satisfies the training requirements for OSHA standard 29 CFR 1910.155 (c) 41, 29 CFR 1910.157 (g) (1) thorough (4) and references NFPA 10 (13).

104-03 **Combustible Dusts**

Combustible dust is found in almost all lines of work. These dusts present explosion hazards if presented in the right mixture with air. It is important to recognize when a dust hazard is present and understand how to present a catastrophic explosion at your facility.

The Combustible Dusts training course identifies common combustible dusts and their associated workplace hazards. It also explains basic control measures to reduce combustible dust production. This online training course discusses:

- Hazard awareness
- Hazard communication standard
- Anatomy of a dust explosion
- Dust control and prevention
- Common combustible dusts

Combustible Dusts is part of the Fire Prevention training series.

105 **Lockout Tagout**

105-01 **Lockout/Tagout Safety Program**

To ensure workers' safety, all mechanical and electrical powered machinery must be secured and labeled to prevent inadvertent powering during repairs, installation, or maintenance. The Lockout/Tagout Safety Program explains the necessity of a lockout/tagout program and common procedures. It describes the importance of adhering to lockout/tagout safety procedures.

This lesson satisfies the training requirements for OSHA standard 29 CFR 1910.147.

106 **Confined Space Safety**

106-01 **Confined Spaces: Entrant and Attendant Duties**

Employees whose work requires them to enter a confined space or serve as a confined space attendant must be properly trained and qualified. Accidents occur within confined spaces because workers fail to recognize the potential hazards. Workers should always anticipate the most unfavorable situations and consider the danger of explosion, poisoning, and asphyxiation. The Confined Spaces: Entrant and Attendant Duties training course explains the role of the authorized attendant and the entrant working in confined spaces. it describes steps taken to safely enter and work within a confined space.

This course satisfies the training requirements for OSHA standard 29 CFR 1910.146 (g) and (k) (i) through (iv).

106-02 **Confined Spaces: Entry Supervisor Duties**

When workers enter confined spaces, the entry supervisor oversees all operations before entry as well as during and after all work has been completed. The entry supervisor must be familiar with all operations of confined spaces to ensure the safety of those performing the work. The Confined Spaces: Entry Supervisor Duties describes the role the entry supervisor plays in overseeing work and ensuring the safety of workers in confined spaces.

This lesson complies with OSHA Regulation 29 CFR 1910.146.

106-80 **Confined Spaces: Entrant and Attendant Duties (CAD)**

Employees whose work requires them to enter a confined space or serve as a confined space attendant must be properly trained and qualified. Accidents occur within confined spaces because workers fail to recognize the potential hazards. Workers should always anticipate the most unfavorable situations and consider the danger of explosion, poisoning, and asphyxiation. The Confined Spaces: Entrant and Attendant Duties training course explains the role of the authorized attendant and the entrant working in confined spaces. it describes steps taken to safely enter and work within a confined space.

107 **Electrical Safety**

107-01 **Electrical Safety**

One of the biggest misconceptions of electrical safety is high voltage kills people. Current, not voltage, causes electrical shock. Electrical shock occurs when current flows through a person's body. System voltages as low as 30 VAC can supply enough current to shock or even kill. The Electrical Safety training course describes the flow of electric current and common hazards of electricity. It explains safety procedures that prevent injury, damage, and death from electrical hazards.

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107-02 Energized Electrical Equipment Safety

Working on energized electrical circuits and equipment may be part of your job, or you may be an operator responsible for opening and closing breakers or switches. In either case, it's crucial for your safety and well-being to know how to use the right personal protective equipment to make your work as safe as possible. The Energized Electrical Equipment Safety training course identifies the industrial workplace safety authority and describes safe workplace practices. This course is part of the Electrical Safety training series.

107-03 Arc Flash Hazard Basics

An arc flash is one of the most catastrophic electric equipment hazards. This high-temperature electrical arc is devastating to personnel and equipment and can happen in an instant. The Arc Flash Hazard Basics training course focuses on defining arc flash terminology and identifying unsafe situations. It explains how to navigate the guidance of NFPA 70E and recognize when to reduce potential occurrences. Arc Flash Hazard Basics is part of the Electrical Safety training series.

108 Materials Handling

108-01 Materials Handling and Storing Safety

Material handling is the lifting, moving, and placing of anything used by people. Handling materials may be done manually or with lifting equipment such as hand trucks and fork trucks. Materials handling is one of the leading causes of disabling occupational injuries. Principle causes of injuries are the mishaps resulting from improper lifting, failing to use available equipment, and unsafe work practices. The Materials Handling and Storing Safety training course demonstrates how to minimize the risks of injury and illness by safe handling and storing of materials in the workplace.

This lesson satisfies the training requirements for OSHA regulation 29 CFR 1910.178 - .180, Subpart N.

109 Rigging Safety

109-01 Rigging Safety

Lifting heavy equipment, parts, or materials is hazardous work. Safety concerns must be taken seriously. In some circumstances, items should not, or cannot, be lifted by hand. In those situations, a rigging device is used. The Rigging Safety training course explains how to evaluate lifting tasks and make decisions that result in safe rigging use.

110 Scaffolding Safety

110-01 Scaffolding Safety

Scaffolding is a temporary, field-erected structure used for working aloft. Because it is temporary and field erected, it is subject to wear and abuse, improper assembly, and unauthorized changes. Construction standards require a "competent person" inspect scaffolds for defects before every work shift. Yet, in all industries, every employee who works on or around scaffolding should be aware of safety requirements. The Scaffolding Safety training course identifies the responsibilities of those employees who work on or near scaffolding to assemble, maintain, and operate all scaffolding systems. It also explains compliance with safety requirements.

This course satisfies the training requirements for OSHA standard 29 CFR 1926.454.

111 Scissor Lift Safety

111-01 Scissor Lift Operations and Safety

A scissor lift is a platform which can usually only move up and down. Many hazards are associated with using a scissor lift. Employees can overbalance while on the platform, or the scissor lift can tip over. The Scissor Lift Operations and Safety training course explains the importance of operating the lift according to step-by-step procedures. It explains the safety measures that must be followed in detail and the importance of thorough pre-operation inspections.

This course satisfies the training requirements for OSHA section 29 CFR 1926 (Subpart L) section 453 including appendices and the American National Standard Institute (ANSI) ANSI/SIA/A92.6-2006.

112 Crane and Hoist Safety

112-01 Crane and Hoist Safety

Many types of cranes, hoists, and rigging devices are used at facilities for lifting and moving materials. The company is responsible for maintaining a safe workplace for employees. Therefore, it is imperative only qualified and licensed individuals operate the devices. The Crane and Hoist Safety training course describes the rules and responsibilities for safe operation. It explains standard hand signals for equipment operation and how to perform a safety checklist before operation.

This course satisfies the required training for OSHA standard 29 CFR 1910.179 (n)(3)(ix) and (o)(3).

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113 Forklift Safety

113-01 Forklifts and Powered Industrial Trucks Safety

All company employees required to operate a powered industrial truck or forklift must be trained to operate the equipment. Almost 70,000 accidents occur each year resulting in more than 80 fatalities and 35,000 serious injuries when operating forklifts and other motorized trucks. Safety practices and procedures must be followed to ensure personnel safety. The Forklifts and Powered Industrial Trucks Safety training course explains the safe practices and procedures for minimizing the hazards of operating forklifts and other powered industrial trucks in the workplace.

This course satisfies the initial and refresher training requirements for OSHA standard 29 CFR 1910.178 (l)(1) through (7).

114 Fall Protection

114-01 Fall Protection

Employees must be protected from fall hazards when working on unguarded surfaces more than six feet above a lower level or working at any height above dangerous equipment. Employers must take all necessary steps to eliminate, prevent, and control fall hazards. They must comply fully with fall protection standards established for occupational safety. The Fall Protection training course explains how to avoid falls and injury due to falling objects in the workplace. It outlines how to follow safety precautions and use safety equipment.

This course satisfies the training requirements for OSHA standard 29 CFR 1926.503.

114-81 Fall Protection (CAD)

Employees must be protected from fall hazards when working on unguarded surfaces more than six feet above a lower level or working at any height above dangerous equipment. Employers must take all necessary steps to eliminate, prevent, and control fall hazards. They must comply fully with fall protection standards established for occupational safety. The Fall Protection training course explains how to avoid falls and injury due to falling objects in the workplace. It outlines how to follow safety precautions and use safety equipment.

115 Excavation and Trenching

115-01 Excavation and Trenching Safety

Excavation cave-ins cause serious and often fatal injuries. Cave-ins are a major cause of death in excavations. They account for nearly 1% of all workplace deaths. To prevent excavating accidents, injuries, and death, several safety precautions must be implemented. The Excavation and Trenching Safety training course identifies the safety procedures minimizing the hazards of working in or near excavation and trenching sites. It explains the safe practices that apply to the heavy equipment used in excavation.

116 Compressed Gas Cylinder Safety

116-01 Compressed Gas Cylinder Safety

Compressed gases in cylinders are hazardous because of the potential compression energy. In addition, the gases may be toxic, flammable, and act as asphyxiants if released in confined spaces. The Compressed Gas Cylinder Safety training course explains how to safely handle, store, and use gas cylinders. It discusses:

- Pressure regulator and needle valve safety
- Leak testing and connections
- Inspection checklists

This lesson satisfies the training requirements for OSHA standards 29 CFR 1910.253 and 29 CFR 1910.252.

117 Hazardous Materials Safety

117-01 Hazardous Materials Safety

Governmental health, safety, and environmental laws dictate the specific handling and disposal methods of hazardous materials. Failure to comply with these laws can be costly as well as environmentally negligent. Companies must fully comply with all laws and regulations. They must train employees in the proper procedures to follow when they encounter a hazardous material spill or leak. The Hazardous Materials Safety training course identities hazardous materials common to industrial and commercial workplaces. It discusses how to appropriately respond to spills, leaks, or other types of contamination to protect personnel and the environment.

This course satisfies the requirements for OSHA standard 29 CFR 1910.1200 (h) (1) through (3).

117-02 Acid and Caustic Awareness

Acids and caustics are commonly used chemicals that violently react with each other. To use them safely, workers must understand how to properly handle and store these incompatible chemicals. They also must know how to protect themselves from the dangers the chemicals present. The Acid and Caustic Awareness training course explains how substances are ranked on the pH scale. It describes general safety precautions and emergency actions used when working with acids and caustics. This course is part of the Hazardous Materials Safety training series.

117-03 Asbestos and Silica Awareness

General industry employees may be exposed to asbestos and silica during manufacturing processes, cleanup operations, or while repairing equipment. Awareness of the hazards associated with these materials can help prevent serious illness or disease. The Asbestos and Silica Awareness training course describes the health risks associated with both materials. it identifies ways to prevent exposure in the workplace.

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117-04 **Ammonia Awareness**

Exposure to ammonia can be hazardous to your health. Awareness of potential health hazards can help prevent serious injury or death due to overexposure to this harmful, but widely used chemical. The Ammonia Awareness training course explains the health risks associated with working around ammonia. It identifies how workers should protect themselves during general maintenance or emergency activities.

117-05 **Hydrogen Sulfide Awareness**

Hydrogen sulfide occurs naturally in the environment. It is found in petroleum products such as natural gas and crude oil. Exposure levels to hydrogen sulfide must be closely monitored to protect those who work around the toxic and flammable gas. Workers must understand emergency procedures to follow if hydrogen sulfide is released. The Hydrogen Sulfide Awareness training course describes common warning signs, health effects, and personal protection requirements related to hydrogen sulfide exposure. It explains hydrogen sulfide properties and permissible exposure limits.

117-06 **Chlorine Awareness**

Chlorine is widely used in industry and found in many household products. It is one of the most commonly manufactured chemicals in the U.S. Being aware of the health risks it poses can help prevent hazardous exposure. The Chlorine Awareness training course explains the occupational hazards and potential health effects of chlorine exposure. It discusses proper storage and handling and first aid.

117-07 **Radiation Awareness**

Radiation sources can be found in a variety of occupational settings. Understanding the health risks of radiation and taking proper precautions to prevent exposure can help maintain a healthy work environment. The Radiation Awareness training series provides a basic overview of radiation. It also describes health risks commonly associated with radiation and identifies methods to protect yourself and others from exposure.

117-08 **Hazardous Gases - Methane, Carbon Monoxide and Carbon Dioxide**

Methane, carbon monoxide, and carbon dioxide are all found around and within coal mines and coal handling facilities. Understanding where these hazardous gases occur in the workplace is important to worker health and safety. The Hazardous Gases - Methane, Carbon Monoxide, and Carbon Dioxide explains the common health and safety hazards associated with these gases. It discusses where they can be found in the workplace and describes procedures and devices to protect employees from exposure.

117-09 **Lead Awareness**

General industry employees may be exposed to lead during manufacturing and recycling processes, cleanup and renovation operations, or while performing facility and equipment maintenance and repair. When someone is exposed to lead, it enters the bloodstream, eventually accumulating in bones and tissue. Understanding lead exposure hazards can help prevent serious illness. Knowing how exposure occurs helps reduce the risk of lead poisoning. The Lead Awareness training course explains the risks associated with lead, where it might be encountered, and the negative health effective it can cause. It also identifies prevention measures, such as personal protective equipment and good housekeeping practices.

117-20 **Gas Monitoring Basics**

Gas monitoring instruments are designed to protect personnel from unseen hazards that may exist in workplace environments, including confined spaces and underground mines. These instruments must be maintained and properly calibrated to ensure worker health and safety. The Gas Monitoring Basics training series describes the basic design and operation of a gas monitor. It also discusses sampling techniques.

117-83 **Asbestos Awareness (CAD)**

General industry employees may be exposed to asbestos during manufacturing processes, cleanup operations, or equipment repair. Understanding the hazards associated with this material can help prevent serious illness. The Asbestos Awareness (CAD) training course explains the health risks associated with asbestos. It identifies ways to prevent exposure to this material in the workplace.

117-85 **Hydrogen Sulfide Awareness (CAD)**

Hydrogen sulfide occurs naturally in the environment. It is found in petroleum products such as natural gas and crude oil. Exposure levels to hydrogen sulfide must be closely monitored to protect those who work around the toxic and flammable gas. Workers must understand emergency procedures to follow if hydrogen sulfide is released. The Hydrogen Sulfide Awareness training course describes common warning signs, health effects, and personal protection requirements related to hydrogen sulfide exposure. It explains hydrogen sulfide properties and permissible exposure limits.

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118 HAZWOPER

118-01 HAZWOPER Regulation Overview

Hazardous materials are all around us. They are found in almost all workplaces. To help protect workers from injury due to contact with these materials, the Hazardous Waste Operations and Emergency Response (HAZWOPER) regulations aim at maintaining safe and healthy workplaces. The HAZWOPER Regulation Overview training course discusses an overview of federal acts and regulatory bodies that protect workers who deal with hazardous materials. It also provides an understanding of terminology and numbering used to outline a typical regulation.

118-02 Site Characterization and Analysis

Each facility comes with its own hazards and risks. Those containing hazardous substances or hazardous wastes employ site characterization and analysis to identify hazards and determine appropriate safety and health control procedures to protect employees. As companies grow and change, new and unknown hazards may arise. Workers must be able to correctly monitor and evaluate the changes they encounter during a normal workday. The Site Characterization and Analysis training course describes how to use this process to protect the lives of employees and ensure a safe working environment at sites with hazardous substances.

118-03 Toxicology

When responding to a hazardous material spill, your risk of harmful exposure is high. Toxic chemicals can have immediate effects. They can also have delayed effects that could go unnoticed for years. Understanding these effects is critical to protecting workers from toxic levels of hazardous materials. The Toxicology training course explains the potential health effects of exposure to various toxic substances. It discusses chemical classification and exposure limits.

118-04 Medical Surveillance

Workers handling hazardous waste can experience high levels of stress. Their daily tasks may expose them to toxic chemicals, safety hazards, biological hazards, and radiation. A medical program is essential to assess and monitor workers' health and fitness, prior to and during employment. It must also provide emergency and other treatment as needed and keep accurate records for future reference. The Medical Surveillance training course describes the design and function of a medical surveillance program. It outlines employee medical rights and responsibilities. It also explains record-keeping needs.

118-05 Decontamination

Decontamination prevents the spread of contamination and ensures the safety of individuals affected by harmful or dangerous materials. Decontamination procedures outline the specific tasks needed to properly carry out decontamination techniques. The Decontamination training course discusses principles of decontamination and describes activities performed in a standard decontamination corridor.

118-06 Emergency Procedures

Proper emergency planning and response are important elements of a health and safety program. They help minimize employee injury and exposure. Before performing hazardous waste operations, employers must develop and implement a written response plan to handle possible emergencies. The Emergency Procedures training course discusses the purpose and scope of an emergency response plan. It also explains the roles and responsibilities of those individuals responding to a hazardous materials release.

119 Hazard Communication

119-03 Hazardous Communications Employee Training Program, Part 1

Manufacturers and users of hazardous materials take many actions to maintain a safe and healthy workplace. By law, employees have the right to know any areas in their work space where hazardous chemicals are present. Employers must provide employees with effective information and training on hazardous chemicals in those spaces. The Hazardous Communications Employee Training Program, Part 1 discusses the Hazardous Communication Program. It describes the training provided under this program for every employee.

119-04 Hazardous Communications Employee Training Program, Part 2

Personal protective equipment (PPE) refers to the respiratory equipment, garments, and barrier materials used to protect workers, rescuers, and medical personnel from exposure to biological, chemical, and radioactive hazards. Various types of PPE may be used, depending on the hazard present. The Hazardous Communications Employee Training Program, Part 2 describes how exposure to hazardous materials occurs. It also explains how to choose and use equipment for personal protection

119-06 Hazard Communication Programs in the Workplace

Manufacturers and users of hazardous materials take many actions to maintain a safe and healthy workplace. By law, employees have the right to know any areas in their work space where hazardous materials are present. Employers must provide effective information and training on these hazards as part of a hazardous communications program. The Hazard Communication Programs in the Workplace training course discusses the program and describes the training and information provided under this program for every employee.

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119-07 Exposure to and Detection of Hazardous Chemicals

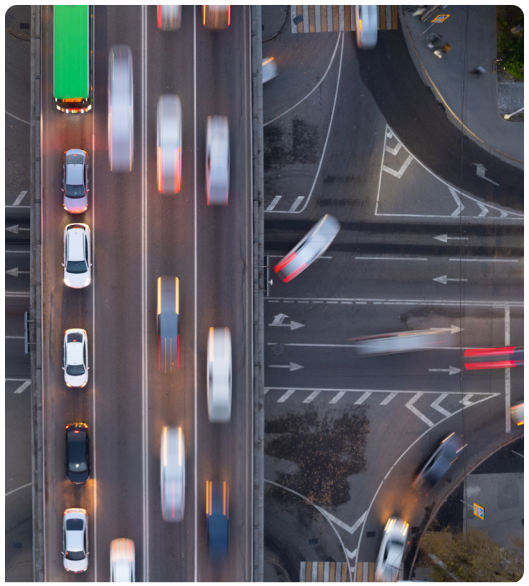
Manufacturers and users of hazards materials take many actions to maintain a safe and healthy workplace. As part of these efforts, employers must provide employees with effective information and training on hazardous chemicals in their work area. The Exposure to and Detection of Hazardous Chemicals training course describes how exposure to hazardous materials occurs and what can influence the severity of the hazard's effects. It also describes ways a hazardous release can be detected.

119-08 Physical, Health, and Environmental Hazard Classes

The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) defines and classifies hazardous substances according to their physical, health, and environmental effect. The Physical, Health, and Environmental Hazard Classes training course discusses the GHS hazard classifications. It also describes the effects of the various hazard classifications.

119-09 Labeling and SDS for Hazardous Chemicals

The United Nations developed the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). The Labeling and SDS for Hazardous Chemicals training course explains proper labeling requirements according to the GHS. It also describes pictograms for GHS hazard classifications and discusses the contents of the standardized, 16 sections of the SDS.



122 Transportation

122-01 Safe Driving Practices

Despite all the communication and shipping technologies today, vehicular travel is still often necessary to conduct business. Whether driving a truck, car, or something with a trailer, there is no way to control all aspects of a road trip. However, driving can be made as safe and uneventful as possible, no matter what vehicle is used. The Safe Driving Practices training course explains the requirements for driving Department of Transportation (DOT) Class 1-6 light or medium duty vehicles. It also describes defensive driving techniques, hazard perception, and driving attitude.

122-02 Drug and Alcohol Awareness

Driving while impaired by any substance - alcohol or drugs, whether legal or illegal - is against the law in all 50 states and the District of Columbia. Law enforcement officers are trained to observe drivers' behavior and identify impaired drivers. Even in states where marijuana use is legal, driving under the influence of the drug is still illegal. The Drug and Alcohol Awareness training course explains the effects of drugs and alcohol. It explains the DOT required testing process and the result-based consequences.

130 Behavior Based Safety Training

130-01 Behavior Based Safety Programs Basic Design

Behavior based safety programs are employee owned. They are designed to reinforce safe working attitudes and behaviors among individual employees. Understanding the basic design of these programs is necessary to effectively participate in safety programs. The Behavior Based Safety Programs Design training course describes the basic design of a program. It explains how employees can participate in safety committees and safety inspection teams to positively influence a plant's safety program.

130-02 Behavior Based Safety Program Concepts

A safe working attitude is one of the best qualities a competent plant operator can have. Understanding key factors affecting safety in the workplace is necessary to develop and participate in effective safety programs. The Behavior Based Safety Program Concepts training course describes the factors affecting personal safety on the job including capabilities, work environment, attitude toward safety, and exhibited behaviors. It also explains the difference between a positive safety attitude and safe working behaviors.

130-03 Hazardous Material Procedures

Power plants use many products which can be hazardous to workers' health and the environment if not used, stored, and disposed of properly. Understanding hazardous materials and the procedures for their use is necessary to ensure safety while working in a power plant. The Hazardous Material Procedures training course describes some of the basic hazardous materials found in a power plant. It also discusses some procedures used while working with these products.

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130-04 Confined Space Procedures

Facilities can require a great deal of maintenance which often occurs inside confined spaces such as tanks, vessels, boilers, or ductwork. Knowing confined space procedures is necessary to safely work in and around these spaces. The Confined Space Procedures training course discusses the reason for a confined space procedure and the basic information found on a confined space permit. It also explains the difference between a non-permit required confined space and a permit required confined space.

130-05 Hot Work Procedures

Power plants need a lot of maintenance, often requiring the use of equipment that generates sparks, such as welding machines, cutting torches, and grinders. Understanding hot work procedures is necessary to prevent and respond to power plant fires. The Hot Work Procedures training course describes the purpose of a hot work permit procedure. It also discusses the basic information that can be found on most hot work permits.

130-06 Root Cause Analysis

Root cause analysis is a means of analyzing data to properly determine an event's true cause. The Root Cause Analysis training course explains the process and how to properly identify a root cause. It also describes the common tools used in determining root cause.

130-07 Safety and Health Programs

Policies, programs, and procedures exist in the workplace to provide employees with a safe and healthy working environment. How does the company get the procedures and programs to ensure worker safety? The Safety and Health Programs training course outlines the true cost of workplace accidents. It illustrates the critical elements of an effective health and safety program and explains how to identify and prevent most workplace hazards. Safety and Health Programs is part of the Behavior Based Safety Training series.

131 Ergonomics

131-01 Ergonomics in an Office Environment

The Ergonomics in an Office Environment training course explains ergonomics and the disorders related to it. It also describes ergonomic hazards in an office environment and describes ways to mitigate these hazards. This course emphasizes computer workstations.

131-02 Ergonomics in an Industrial Environment

Ergonomics in an Industrial Environment explains ergonomics and the disorders related to it. It also describes ergonomic hazards in an industrial environment and determines ways to mitigate these hazards.

131-03 Proper Lifting Techniques

The Proper Lifting Techniques training course explains proper lifting techniques when performing manual material handling tasks. It also explains methods to help prevent back injuries.

140 Qualified Electric Worker

140-01 General Concepts and Job Briefings

For safety and efficiency, most electrical work is done by a team or at least two people. However, in some circumstances, a technician may end up working on electrical lines or equipment on their own. Regardless of the job size, familiarity with general safety concepts for power generation, transmission, and generation can help technicians complete their work safely.

The General Concepts and Job Briefings training course discusses general safety concepts while performing electrical work. It also highlights job briefings and how they can help a worker avoid accidents.

This online training course is part of the Qualified Electric Worker training series.

140-04 Enclosed Spaces

Enclosed spaces have many similarities to confined spaces. However the term ""enclosed spaces"" is specific to the electric power generation industry. Enclosed spaces have environments which can contain hazardous atmospheres. Familiarity with the regulations for working in enclosed spaces creates safer working conditions.

The Enclosed Spaces training course identifies the conditions of an enclosed space. It also explains how to eliminate or reduce the hazards associated with working in an enclosed space. This course discusses:

- Enclosed space definition
- Accessing an enclosed space
- Testing enclosed space atmosphere

Enclosed Spaces is part of the Qualified Electric Worker training series.

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140-09 **Electrical Clearances**

Working on energized lines and equipment can be dangerous. When done correctly, de-energizing creates a safer environment to work in. The Electrical Clearances training course provides an overview of de-energizing transmission and distribution lines and equipment to protect workers. It also discusses the requirements for controlling hazardous energy sources used in power generation, transmission, and distribution. This online course covers:

- General requirements
- De-energizing lines and equipment
- Transferring and releasing clearances

Electrical Clearances is part of the Qualified Electric Worker training series.

140-11 **Mechanical Equipment**

Electrical work may require using mechanical equipment for lifting or rotating components. Utility workers must be prepared to operate this equipment safely and effectively on the worksite.

The Mechanical Equipment training course explains the basic requirements for using mechanical equipment during electrical work. This online course discusses:

- Mechanical equipment regulation
- Mechanical equipment types
- Additional requirements

Mechanical Equipment is part of the Qualified Electric Worker training series.

140-18 **Dog Bite Prevention**

For some jobs, like meter reader, interactions with dogs are a common occurrence. Often, these encounters happen without incident. But they can be a serious hazard to the employee. Employees may encounter all types of dogs on the job. They should be prepared for a worst case scenario.

The Dog Bite Prevention training course details techniques for preventing a dog attack. If an attack cannot be prevented, it discusses ways to minimize the severity. This online course covers:

- Dog encounter dangers
- Prevention, actions, and defense
- Injury types
- Manager responsibilities

Dog Bite Prevention is part of the Qualified Electric Worker training series.

150 **Environmental Awareness**

150-01 **Environmental Awareness**

Our understanding of the natural world has come a long way. Maintaining a thriving livable planet has become everyone's responsibility. This responsibility is especially true for individuals employed in planning, managing, and implementing industrial processes. These processes include diverse activities such as construction, mining, refining, manufacturing, and power, food, and essential services production. Understanding how individual actions impact the environment is critical to achieving the necessary balance between harvesting earth's resources and protecting its ecosystem.

The Environmental Awareness training course identifies ways awareness can reduce the environmental impact of various processes and tasks. It also describes how to design and implement an environmental management system (EMS). It discuss the overall goals of waste minimization and pollution prevention programs.

150-02 **Stormwater Regulations and Pollution Prevention Plans**

Stormwater runoff is generated when precipitation from rain and snowmelt flows over the ground or other surfaces such as paved streets, parking lots, and building rooftops, and does not immediately sink into the soil. As the runoff flows over the ground, it accumulates debris, chemicals, sediment, and other pollutants that could adversely affect water quality. The Stormwater Regulations and Pollution Prevention Plans training course describes ways stormwater runoff can impact the environment. It also discusses stormwater regulations and explain how to effectively develop a stormwater pollution prevention plan.

150-03 **Spill Prevention, Control, and Countermeasures**

Although most spills are accidental, they happen too often. Preventing spills is the best way to protect our health and the environment from exposure to oil. Spill prevention, control, and countermeasures (SPCC) plans are written and implemented by oil storage facility owners and operators to help them prevent spills from their facilities. The Spill Prevention, Control, and Countermeasures training course describes the use of these plans. It also discusses common practices for preventing, responding to, and reporting spills.

160 **Construction Safety**

160-01 **Health Hazards in Construction**

Industrial hygiene is the science of protecting the health and safety of workers and their families through the anticipation, recognitions, evaluation, and control of worksite conditions. The Health Hazards in Construction training course discusses principles of industrial hygiene toward a safer working environment.

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160-02 Scaffolding Safety for Construction

Scaffolding is a temporary field-erected structure used for working aloft. It is subject to wear and abuse, improper assembly, and unauthorized changes. Construction standards require a "competent person" to inspect scaffolds for defects before every work shift. However, every employee who works on or around scaffolding must be aware of the safety requirements. The Scaffolding Safety for Construction training course distinguishes the responsibilities of those employees who work on or near scaffolding to assemble, maintain, and operate all scaffolding systems and adhere to safety requirements.

160-03 Portable Power and Hand Tool Safety for Construction

Hand and power tools are part of everyday life. These tools help people perform tasks otherwise difficult or impossible. However, even simple tools can be hazardous and can cause severe injuries when used or maintained improperly. Special attention to hand and power tool safety is necessary to reduce or eliminate these hazards. The Portable Power and Hand Tool Safety for construction training course identifies hazards associated with the use of hand and power tools. It explains how to prevent accidents and injury in the workplace by adhering to safety practices and requirements. It also describes the employer requirements put in place to protect construction workers.

160-04 Materials Handling and Storing Safety for Construction

Materials handling is the lifting, moving, and placing of anything used by people. Handling materials may be done manually or with lifting equipment such as a hand truck or forklift. Materials handling is one of the leading causes of disabling occupational injuries such as strains, sprains, and contusions. The principle cause of injuries is mishaps from improper lifting, not using available equipment, and unsafe work practices. The Materials Handling and Storing Safety for Construction training course explains how to minimize the risks of injury and illness by safely handling and storing materials. It also identifies potential hazards when handling materials and ways to prevent those hazards. Finally, it describes an employer's responsibilities for safe materials handling.

160-05 Personal Protective Equipment for Construction, Part 1

A personal protection program protects employees by ensuring personal protective equipment (PPE) is used whenever necessary. It assures PPE is maintained in a sanitary and reliable condition. The Personal Protective Equipment for Construction Part 1 training course describes the hierarchy of control for reducing risk and avoiding injury, illness, and death by properly selecting, using, and maintaining PPE.

160-06 Personal Protective Equipment for Construction, Part 2

A personal protective program protects employees by ensuring personal protective equipment (PPE) is provided and used when necessary. It also makes sure the equipment is maintained in a sanitary and reliable condition. The Personal Protective Equipment for Construction, Part 2 training course describes some of the employer and employee requirements for reducing risk and avoiding injury, illness, and death by properly selecting, using, and maintaining PPE.

160-07 Excavation and Trenching Safety for Construction

Excavation cave-ins cause serious and often fatal injuries. Excavation incidents are a major cause of death, accounting for almost 1% of all annual workplace deaths. To prevent accidents, injuries and death in these situations, a number of safety precautions must be implemented. The Excavation and Trenching Safety for Construction training course identifies hazards and methods of protecting workers from hazards during excavation and trenching operations. It describes the role of a competent person and the responsibilities of the employer and employee during these operations.

170 Industrial Mathematics

170-01 Introduction to Industrial Math

The Introduction to Industrial Math training course lays a foundation for developing and interpreting data in technical and industrial applications. It explains the mathematical order of operations, exponents, and square roots.

This online training course includes:

- Rounding numbers
- Mathematical order of operations
- Working with exponents
- Working with roots
- Using a calculator for exponents and roots

This course is part of the Industrial Mathematics training series.

170-02 Industrial Math Measurements and Calculations

Industrial Math Measurements and Calculations explains the use of conversion tables and how to solve problems using length, height, flow, and temperature conversions. It introduces you to solving mathematical problems using formulas for volume, velocity, area, and flow. This online course also provides an overview of charts and tables that present information graphically.

This course includes:

- Conversions
- Using area formulas
- Using volumetric formulas
- Density and specific gravity
- Using velocity formulas
- Using flow formulas
- Interpreting graphs
- Interpreting charts and tables

Industrial Math Measurements and Calculations is part of the Industrial Mathematics training series.

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170-03 **Industrial Math: Fractions, Percentages, and Ratios**

The Industrial Math: Fractions, Percentages, and Ratios training course introduces the basics of working with fractions, decimals, percentages, ratios, and proportions. It demonstrates how to interpret and solve problems using these elements. This course covers:

- Proper, improper, and equivalent fractions
- Fraction addition and subtraction
- Fraction multiplication and division
- Converting between fractions, decimals, and percents
- Solving basic percent problems
- Percent differential and percent tolerance
- Ratio and proportion

This course is part of the Industrial Mathematics training course.

171 Industrial Sciences

171-01 **Atomic Structure and Chemical Bonding**

This chemistry lesson examines an atom's structure. It also explains how atoms combine in different chemical bonds to form molecules, compounds, and mixtures.

The Atomic Structure and Chemical Bonding training course describes an atom's various components and discusses atomic theory. It also explores how chemical bonds are formed and describes the two most common types of chemical bonding.

This online training course is part of the Industrial Sciences training series.

171-02 **Introduction to the Periodic Table of Elements**

Industrial facilities work with a variety of chemical elements when producing products. Understanding these elements and their interactions increases the ability to understand the various chemical processes used in a facility.

Introduction to the Periodic Table of Elements presents the periodic table of elements, explains how it is arranged, and introduces how electrons control an element's chemical behavior and reactions. This online training course explains:

- History of the periodic table of elements
- Elements and classifications
- Periodic table layout

This course is part of the Industrial Sciences training series. Note: course content is the same as 559-02.

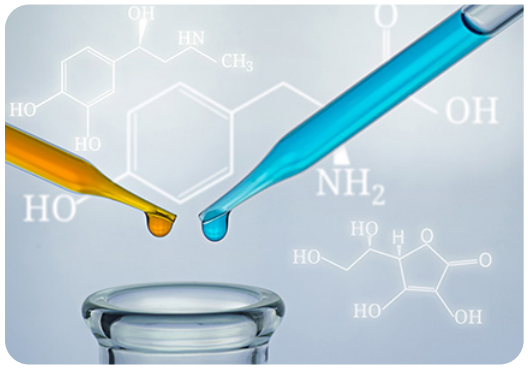
171-03 **Chemical Formulas, Reactions, and Solubility**

The Chemical formulas, Reactions, and Solubility training course describes different ways of writing chemical formulas. It also examines the four parts of a chemical reaction. This online course explains the components and characteristics of solubility.

This course covers:

- Chemical formulas
- Chemical reactions
- Solutions, solubility, and saturation

Chemical Formulas, Reactions, and Solubility is part of the Industrial Sciences training series.



171-04 **Introduction to Hydrocarbon Chemistry**

The Introduction to Hydrocarbon Chemistry training course focuses on hydrocarbon chemistry basics. It examines properties associated with various hydrocarbon molecules found in petroleum products. This online training course discusses the molecular structure, physical properties, naming conventions, and commercial use of several common hydrocarbons. It focuses on:

- Crude oil chemistry
- Hydrocarbon covalent bonding
- Hydrocarbon naming conventions
- Hydrocarbon families: paraffins, napthenes, aromatics
- Hydrocarbon families: olefins and alkynes
- Physical properties and molecular structure
- Crude oil contaminants

Introduction to Hydrocarbon Chemistry is part of the Industrial Sciences training series.

171-05 **Chemical Equations**

When working with chemicals and chemical processes, it may be necessary to read and correctly balance chemical equations. The Chemical Equation training course identifies the components in a chemical equation. It then explains the process of balancing chemical formulas.

Chemical Equations is part of the Industrial Sciences training series.

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171-10 Introduction to Physics: Force and Motion

Physics is the science of matter, energy, and interactions between the two. Physics can be categorized into fields such as acoustics, optics, mechanics, electronics, thermodynamics, and electromagnetism.

The Introduction to Physics: Force and Motion training course examines fundamental laws of physics involving force and motion. It discusses their real world applications in industrial facilities. This online course describes terms and types of force as they apply to classical physics. It explains Newton's laws involving motion and how to perform basic calculations using these laws. This course incudes:

- Vectors
- Laws of motion
- Momentum
- Relating force and weight
- Types of force

Introduction to Physics: Force and Motion is part of the Industrial Sciences training series.

171-11 Introduction to Physics: Energy, Work, and Power

Physics is the science of matter, energy, and interactions between the two. Physics can be categorized into fields such as acoustics, optics, mechanics, electronics, thermodynamics, and electromagnetism.

The Introduction to Physics: Energy, Work, and Power training course examines the fundamental laws of physics involving energy, work, and power. It discusses their real-world application in industrial facilities. It also demonstrates how to use formulas to calculate:

- Potential energy
- Kinetic energy
- Work done
- Power used

Introduction to Physics: Energy, Work, and Power is part of the Industrial Sciences training series.

180 Human Performance

180-01 Fundamentals of Human Performance Improvement

Human Performance Improvement (HPI) is a continual process by which organizations are making revolutionary changes. HPI program implementation requires leaders to recognize how latent conditions impact decisions made by workers in various tasks.

The Fundamentals of Human Performance Improvement training course explains how to recognize and address the factors necessary for lasting organizational culture change. This online course covers:

- Human performance overview
- Types of human error
- Origins of human error
- Changing views of human error

This course is part of the Human Performance training series.

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200

Mechanical Maintenance

201 Introduction to Industrial Maintenance and the Tools of the Trade

201-01 Working Principles of Simple Machines

Simple machines make work easier by providing a trade-off between the force applied and the distance over which the force is applied. The Working Principles of Simple Machines course explains the operating principles of several simple machines.

This online training course covers the:

- Inclined plane
- Wedge
- Level
- Screw
- Pulley
- Wheel and axle
- Gears

The Working Principles of Simple Machines course is part of the Introduction to Industrial Maintenance and the Tools of the Trade series.

201-02 Hand Tools, Part 1

In modern industrial facilities, equipment maintenance and repair still relies on hand tools. Because the people who maintain and repair equipment use these tools daily, they must learn the proper use and function.

The Hand Tools, Part 1 training course explains safety precautions for working with hand tools. It identifies and describes types of wrenches, hammers, screwdrivers, and pliers used in industrial facilities.

This online training course is part of the Introduction to Industrial Maintenance and the Tools of the Trade series.

201-03 Hand Tools, Part 2

In industrial facilities, equipment maintenance and repair relies largely on hand tools. Because these hand tools are used every day by the people responsible for maintaining and repairing equipment, it is important to learn their proper use and function.

The Hand Tools, Part 2 training course explains the types of hand tools used in industrial facilities, including:

- Saws
- Files
- Levels
- Chisels and Punches
- Vises and Clamps

This online course is part of the Introduction to Industrial Maintenance and the Tools of the Trade training series.

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201-04 Portable Power Tools

In modern industrial facilities, equipment maintenance and repair rely on many types of portable power tools. Because these tools are used every day by maintenance workers, it is important to learn their proper use and function.

The Portable Power Tools training course explains safety precautions to follow when working with these tools. It identifies and describes the various types of portable power tools used in industrial facilities, including:

- Grinders
- Impact wrenches
- Power drills
- Power screwdrivers
- Power saws

This course is part of the Introduction to Industrial Maintenance and the Tools of the Trade training series.

201-05 Torque Wrenches

Each bolt has a specified torque value, indicating the level to which it should be tightened. Using a torque wrench provides accurate torque application. Properly selecting and using torque wrenches can mean the difference between a safe and reliable installation and one that fails prematurely.

The Torque Wrenches training course explains the need for torque wrenches in machining and machine operations. This online course describes:

- Need for torque wrenches
- Torque wrench types
- Proper torque wrench use

Torque Wrenches is part of the Introduction to Industrial Maintenance and the Tools of the Trade training series.

202 Belt Drive Maintenance

202-01 Introduction to Belt Drive Maintenance

Belt drives are found in many power transmission applications in industrial facilities. The Introduction to Belt Drive Maintenance course introduces the terminology used when discussing belt drives.

This online course reviews the advantages and disadvantages of belt drives. It also explains belt tensioning and the arc of belt contact.

Introduction to Belt Drive Maintenance is part of the Bearing Maintenance training series.

202-02 V-belts

V-belts are a type of belt named for their distinctive ""V"" shaped cross-section. They transfer power to fans, air compressors, pumps, and other types of rotating equipment in industrial facilities. The V-belts training course explains the design and use of the most common V-belts.

This online course focuses on common and specialized v-belts. It also discusses v-bolt design.

This course is part of the Introduction to Belt Drive Maintenance series.

202-03 Positive Traction Belt Drives

Positive traction belt drives are used in industrial facilities where maintaining a constant speed ratio and a permanent relative position are extremely important. The positive, or nonslip, nature of these belt drives means they can transmit large torques and withstand large accelerations.

The Positive Traction Belt Drives training course describes the major components and proper operation of positive traction belt drive systems used in an industrial facility. It also covers positive drive sheaves and belts.

This online course is part of the Introduction to Belt Drive Maintenance training series.

202-04 Sheave Maintenance

A sheave is a wheel with a grove along its edge for holding a rope, cable, or belt. Sheaves are used in industrial facilities that need to send power from one source to another. Sheaves can change the direction of an applied force, transmit rotational motion, or realize a mechanical advantage in either a linear or rotational system of motion.

The Sheave Maintenance course describes sheaves commonly used on belt drives in industrial facilities, including operation and design. It also explains basic techniques used to maintain them. This course focuses on:

- V-belts and positive traction belt sheaves
- Variable speed sheaves
- Sheave alignment and maintenance

Sheave Maintenance is part of the Introduction to Belt Drive Maintenance training series.

202-05 Introduction to Conveyor Systems

Conveyors move bulk products and materials from one point to another in many types of industrial facilities. Conveyor training provides knowledge of basic conveyor design and operation to safely work around them.

This conveyor training course will help you identify basic conveyor designs and explain how various general configurations are used to move different products and materials from point to point.

This lesson is part of the Belt Drive Maintenance training series.

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202-06 Conveyor System Designs

Conveyor systems vary from small, simple conveyors to massive, industrial conveying systems. To operating and maintain these systems, technicians need a working knowledge of the basic components used in a typical conveyor. They also need to understand the equipment making up an industrial conveyor system.

The Introduction to Conveyor Systems training course describes the components of a typical belt conveyor used in an industrial setting. It identifies equipment found in large-scale, industrial conveying systems. It also describes the purpose of each piece of equipment. This online training course highlights:

- Basic conveyor principles
- Industrial belt conveyor components
- Industrial conveying systems

Introduction to Conveyor Systems is part of the Belt Drive Maintenance series.

202-07 Conveyor Belt System Inspection and Operation

Conveyor belts are often the lifeblood of industrial and manufacturing plant operations. Conveyor belt inspections and protective equipment help ensure the conveyor system life and plant personnel safety. Understanding conveyor belt system inspections and protective equipment is necessary for anyone working with conveyor systems.

The Conveyor Belt System Inspection and Operation training course describes the equipment used to protect plant personnel and conveying system equipment. It lists the inspections that should be conducted on the systems and equipment. This online course discusses:

- Conveyor belt safety devices
- Conveyor belt inspections
- Conveyor belt maintenance

Conveyor Belt System Inspection and Operation is part of the Best Drive Maintenance series.

202-08 Conveyor Belt Installation and Repair

As discussed in previous courses, belt conveyors are often the heart of an industrial plant. They are expensive, and downtime can cost a company a lot of money. To ensure safe and reliable operation, anyone working with belt conveyors must understand basic conveyor belt installation, adjustment, and repair techniques.

The Conveyor Belt Installation and Repair training course describes the basic technique used to install and adjust new belting on a large industrial conveyor. This online course focuses on:

- Conveyor belt installation
- Common splicing techniques
- Belt training techniques

Conveyor Belt Installation and Repair is part of the Belt Drive Maintenance series.

203 Bearing Maintenance

203-01 Introduction to Bearings

Bearings are found in every type of moving machinery. This bearings training introduces two distinct categories of bearings, describes the types of operating forces they are subjected to, and reviews common lubricants used in bearings.

This bearings course trains students in the basic concepts behind the use of bearings and describes their mechanical functions, loading forces, common lubricants, main classifications, and the types of friction they encounter.

After completing this lesson, your worker will understand the basic mechanical functions of two main categories of bearings and the types of loading and friction forces they experience.

This lesson is part of the Bearing Maintenance training series.

203-02 Rolling Contact Bearings

The Rolling Contact Bearings training course examines the different types and designs of rolling contact bearings. These bearings are also known as anti-friction bearings. It discusses their components, operating principles, and the load types they support.

This online training covers ball bearings and roller bearings. It also reviews rolling contact bearing variations.

This course is part of the Bearing maintenance training series.

203-03 Sliding Surface Bearings

The Sliding Surface Bearings training course examines various types of sliding surface bearings and their components. It discusses their operating principles and the types of load they support.

This online course reviews sliding surface bearing categories and explains their advantages.

Sliding Surface Bearings is part of the Bearing Maintenance training series.

203-04 Bearing Installation and Removal

When bearings fail, they must be removed and replaced with new ones. Applying the correct techniques to install and remove rolling contact and sliding surface bearings prevents damage to the bearings, shafts, and housings. Using the correct techniques extends bearing life and reduces expensive downtime.

The Bearing Installation and Removal online training course explains basic techniques to install and replace rolling contact and sliding surface bearings.

This online course is part of the Bearing Maintenance training series.

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203-05 **Bearing Seals**

Bearings need seals to keep them operating properly over an extended period of time. Seals keep out contaminants while keeping lubricating fluid in.

The Bearing Seals training course identifies basic bearing seal components and materials used to produce them. It examines seal designs and discusses the preferred application for each. This online course covers:

- Bearing seal functions
- Bearing oil seals
- Bearing oil seal classifications
- Bearing labyrinth seals

This course is part of the Bearing Maintenance training series.

203-06 **Troubleshooting Bearing Failures**

The Troubleshooting Bearing Failures training course identifies symptoms indicating failing bearings. It explains how to troubleshoot bearing failure and prevent a recurrence. This online training course focuses on:

- Bearing failure symptoms
- Bearing failure causes
- Troubleshooting the failure

Troubleshooting Bearing Failures is part of the Bearing Maintenance training series.

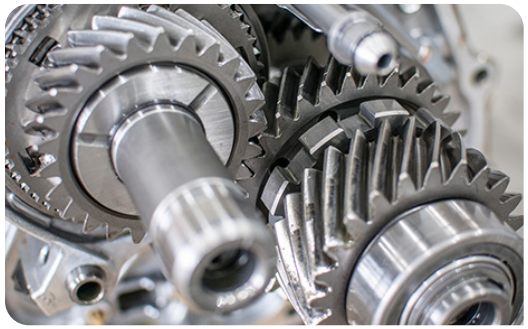
205 **Gear Maintenance**

205-01 **Introduction to Gear Drives**

A gear is a main component of a gear drive system. The Introduction to Gear Drives training course explains a gear and the common terms associated with different gear designs.

This online course describes the function of a gear and defines common terms used. It also covers gear hardiness.

This course is part of the Gear Maintenance training series.



205-02 **Types of Gears**

Different gearing arrangements are used for many diverse power transmission applications in industrial facilities. Each gear type has advantages and disadvantages. The Types of Gears training course explains the gears and their uses.

This online course describes six common types of gears, including:

- Spur
- Helical
- Bevel
- Hypoid
- Worm
- Non-circular

Types of Gears is part of the Gear Maintenance training series.

205-03 **Maintaining Gear Drives**

Many applications in industrial facilities use gear drives. Techniques to help provide longer service life for gear drive systems include maintaining the gears, ensuring proper backlash, employing proper lubrication, and analyzing prior gear failures.

The Maintaining Gear Drives training course describes how to analyze and troubleshoot common gear drive problems. It explains factors affecting gear backlash and proper gear lubrication. This online training course focuses on:

- Gear maintenance
- Gear backlash
- Backlash measurement and control
- Gear lubrication
- Methods of lubricant application
- Gear failure analysis

This course is part of the Gear Maintenance training series.

205-04 **Clutches**

After taking the HSI clutch training, you will be able to explain the purpose of clutches and identify the operating principles of common industrial clutch designs.

This clutch training discusses the three main types of clutches in industrial applications – mechanical, electric, and fluid – and covers clutch breaks which are used to facilitate actions such as deceleration, positioning, increasing cycle rates, and applying tension.

This course is part of the Gear Maintenance training series.

207 **Lubrication of Rotating Machinery**

207-01 **Lubrication Selection and Sampling in Rotating Machinery**

Lubrication is essential to the life of rotating machinery. Selecting a lubricant with properties appropriate for application and operating conditions is critical. The Lubrication Selection and Sampling in Rotating Machinery training course describes the factors that influence lubricant selection. It also explains how to monitor the lubricant condition.

This online training course discusses lubricant additives, lubricant film protection, and bearing lubrication. It also covers oil sampling.

This course is part of the Lubrication of Rotating Machinery training series.

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207-02 Lubrication Failures and Management in Rotating Machinery

Employing good lubrication management techniques is important in maintaining lubrication oil systems and preventing failures. The Lubrication Failures and Management in Rotating Machinery training course describes the importance and process of good lubrication management.

This online training course explains:

- Lubrication failure
- Lubricating oil systems operation
- Lubrication management basics
- Lubrication management solutions

This course is part of the Lubrication of Rotating Machinery training series.

207-03 Lubrication Analysis in Rotating Machinery

Oil and grease have evolved as the demands on them have grown. Today, they are available in many types, providing protection for a wide range of operations.

The Lubrication Analysis in Rotating Machinery training course discusses the characteristics of lubricants and describes how they influence use. This online training course covers:

- Lubrication composition
- Friction effects
- Lubrication characteristics
- Grease and oil characteristics
- Lubrication selection

This course is part of the Lubrication of Rotating Machinery training series.

208 Piping and Tubing

208-01 Pipe Connections and Symbols

Pipes must be securely fastened to ensure safe transport of materials in industrial facilities. Three connection methods are commonly used when constructing piping systems – threaded, flanged, and welded. Also, knowing piping symbols to read and interpret drawings and plans is necessary when working in an industrial facility. The Piping Connections and Symbols training course will introduce pipes and pipe-fitting symbols.

This online training course describes the methods used to connect lengths of piping and identifies advantages and disadvantages of each. It also explains the symbols used to indicated pipe types, pipe fittings, and welding connections.

Piping Connections and Symbols covers threaded connections and fittings, flanged connections, and welded connections. It also includes gaskets.

This course is part of the Piping and Tubing training series.

208-03 Piping Construction and Sizing

The first lesson in this series covers how pipes are essential for transporting materials from one point to another. These pipes are available in several materials, sizes, and thickness. The Piping Construction and Sizing training course discusses how they are measured and used.

This online training course explains:

- Pipe materials
- Industrial pipe sizes
- Piping measurements
- Pipe construction techniques

The Piping Constructing and Sizing course is part of the Piping and Tubing training series.

208-04 Piping Expansion, Support, and Insulation

Temperature changes cause piping material to expand and contract. If allowance is not made for this effect, excessive stress could be exerted on piping, supports, and connected equipment. Pipe supports must allow the pipe to move freely to account for expansion and contraction, but still prevent excessive sagging. If the piping's operating temperature differs much from ambient temperature, insulation may be required.

The Piping Expansion, Support, and Insulation training course explores these conditions and outlines some of the ways plants manage them. It explains the effects of changing temperature on industrial piping and describes how to allow for those effects. This online training course includes:

- Piping expansion
- Piping supports
- Piping insulation
- Insulation materials and installation

Piping Expansion, Support and Insulation is part of the Piping and Tubing training series.

208-05 Piping Auxiliaries

Industrial facilities must constantly drain any condensate from the piping. Otherwise, the condensate is carried with the steam and may produce water hammer. This situation could rupture pipes or fittings. It is also important to avoid admitting moisture-carrying steam to turbines or engines.

The Piping Auxiliaries training course discusses various devices used to remove condensate and moisture from lines. It describes the design and function of steam separators and traps used in piping systems. This course focuses on:

- Introduction to steam separators and steam traps
- Mechanical steam traps
- Thermostatic steam traps
- Thermodynamic steam traps
- Steam trap installation and inspection
- Water hammer

Piping Auxiliaries is part of the Piping and Tubing training series.

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208-06 **Tubing Types and Applications**

Tubing is used in a variety of industries and tasks. To help ensure a tubing system has a long and trouble-free service life, it is important to select the proper tubing for an application. It is also important to handle it correctly during installation and use.

The Tubing Types and Applications training course describes tubing's design and function. It demonstrates criteria to select tubing for common applications. This online course covers:

- Tubing basics
- Copper tubing
- Steel and stainless steel tubing
- Other types of tubing
- Handling tubing

Tubing Types and Applications is part of the Piping and Tubing training series.

208-07 **Tube Fittings and Connection Methods**

As discussed in previous courses, many industries use tubing to aid different tasks. Since a variety of fittings are available for connecting tubing, several methods are used to make the connections that play a large role in ensuring tubing system reliability.

The Tube Fittings and Connection Methods training course describes various methods to properly cut and join tubing segments. This online course discusses:

- Tube cutting
- Tube fittings
- Tube flare method
- Compression fittings method
- Tube soldering
- Tube beading

Tube Fittings and Connection Methods is part of the Piping and Tubing training series.

208-08 **Tube and Conduit Bending**

When installing tubing and conduit, you need to make bends so the material can travel around obstacles and turns. To help ensure a tubing system has a long and trouble-free service life, tubing must be handled correctly during this process.

The Tube and Conduit Bending training course describes how to properly bend tubing and conduit into a variety of angles and offsets. This online course explains:

- Tube bending
- Conduit bending terminology
- Conduit bending tools
- Conduit bending techniques
- Stub-up bends
- Back-to-back bends
- Offset bends
- Three-point saddle bends
- Four-point saddle bends

This course is part of the Piping and Tubing training series.

209 **Shaft Alignment**

209-01 **Couplings**

Couplings are the most important aspect of the shaft alignment process. Understanding basic coupling design and maintenance procedures is critical for safe and reliable equipment. The Couplings training course identifies different styles of couplings and how to maintain them.

This course introduces couplings, including mechanical and non-mechanical couplings.

Couplings is part of the Shaft Alignment training series.

209-03 **Pre-alignment Procedures**

Shaft misalignment is a contributor to rotating equipment mechanical failures. Bearing, coupling, mechanical seat, and packing failures are usually a direct result of shaft misalignment. To connect shafts of independent units, the centerlines of the shaft must be colinear. Understanding couplings, misalignment types, and industry pre-checks are a must to get two independent units aligned.

The Pre-alignment Procedures training course identifies industry standard pre-checks, coupling types, and misalignment types.

This course is part of the Shaft Alignment training series.

209-04 **Rough Alignment**

Shaft alignment is a critical part of component reliability and longevity. It must not be over-looked.

The Rough Alignment training course identifies the planes, tools, and criteria necessary to perform a rough alignment. This online course focuses on:

- Rough alignment basics
- Rough alignment definitions and terms
- Horizontal plane
- Vertical plane

This course is part of the Shaft Alignment training series.

209-05 **Mathematical Rim-and-Face Alignment**

Shaft misalignment is one of the major contributors to rotating equipment mechanical failure. Bearings, couplings, mechanical seals, and packing failure are usually an indirect result of shaft misalignment. The rim-and-face alignment method can help reduce premature equipment failure.

The Mathematical Rim-and-Face Alignment training course identifies how to perform an alignment. It also discusses the types of misalignment identifiable and correctable by the rim-and-face alignment method.

This online training course is part of the Shaft Alignment training series.

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209-06 **Graphical Rim-and-Face Alignment**

Shaft misalignment is one of the major contributors to rotating equipment mechanical failure. Bearings, couplings, mechanical seals, and packing failure are usually an indirect result of shaft misalignment. The graphical rim-and-face alignment method can help reduce premature equipment failure.

The Graphical Rim-and-Face Alignment training course explains the graphical method of performing rim-and-face alignment. It describes the types of misalignment this method can identify and correct. This online course focuses on:

- Misalignment types
- Graphical rim-and-face alignment
- Vertical angular misalignment
- Vertical parallel misalignment
- Horizontal angular misalignment
- Horizontal parallel misalignment

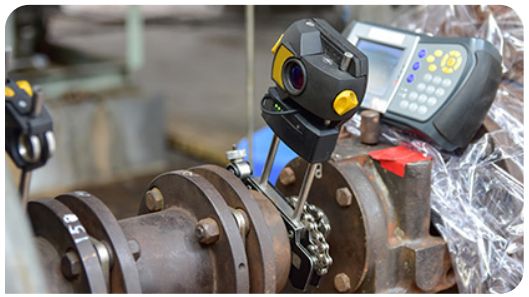
This course is part of the Shaft Alignment training series.

209-07 **Reverse Dial Alignment**

Reverse Dial Alignment training focuses on the theories and type of equipment associated with a reverse dial alignment. This alignment is necessary for rotating equipment in a driver/driven relationship. Rotating equipment must be in a precise state of alignment for safety, reliability, and smooth operation.

This Reverse Dial Alignment training covers fundamentals, reverse dial equipment, reverse dial preparation, and alignment.

This lesson is part of the Shaft Alignment training series.



209-09 **Laser Alignment**

Rotating equipment in a driver/driven relationship is common. Having driver/driven equipment in a precise state of alignment is critical for safety, reliability, and smooth operation. Aligning equipment using a laser is a safe and easy way to provide efficient operation and long equipment life.

The Laser Alignment training course explains the theory and equipment associated with laser alignment. It discusses:

- Laser alignment theory
- Mounting the sensors
- Operating the laser alignment system
- Laser beam adjustment
- Taking measurements
- Correcting misalignment

Laser Alignment is part of the Shaft Alignment training series.

211 **Chain Drive Maintenance**

211-01 **Introduction to Chain Drives**

Chain drives are an important part of mechanical power transmission systems in industrial facilities. They send needed power from the drive unit to other equipment. The Introduction to Chain Drives training course covers the principles of chain systems and common terminology used when working with them.

This online course describes the design and function of typical chain drives. It also reviews chain drive advantages and disadvantages. It includes power transmission chain types and sprockets.

Introduction to Chain Drives is part of the Chain Drive Maintenance training series.

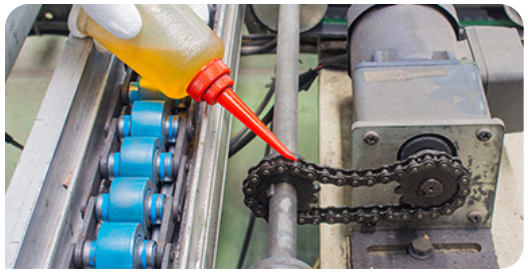
211-02 **Chain Drive Maintenance and Troubleshooting**

Maintaining chain drive systems and troubleshooting failures can save valuable equipment downtime in industrial facilities. Proper installation of new chains and sprockets, inspection of old chains and sprockets, and understanding chain drive lubrication systems facilitates trouble-free system operation.

The Chain Drive Maintenance and Troubleshooting training course describes techniques for maintaining and troubleshooting chain drive systems including:

- Chain length
- Chain and sprocket installation
- Lubrication methods
- Chain and sprocket inspection
- Chain drive troubleshooting

This online course is part of the Chain Drive Maintenance training series.



213 **Lubrication**

213-01 **Lubrication Basics**

Lubricants reduce the harmful effects of friction in operating machinery. Knowing the types of friction helps workers understand the kinds of lubrication used. The Lubrication Basics training course outlines how lubrication is used in machinery to reduce friction. It also discusses why certain types of equipment need lubrication with specific viscosity.

This online training course explains friction. It covers the role of lubricants, including liquid lubricants and viscosity.

Lubrication Basics is part of the Lubrication training series.

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213-02 Types of Lubricants

All operating equipment requires lubricants to reduce friction and wear on moving parts. Understanding lubricant types and uses helps better maintain operating equipment.

The Types of Lubrications training course describes what to consider when selecting a lubricant for specific equipment. It also identifies different viscosity grades and what each grade represents. This online training course covers:

- Grease
- Industrial lubricating oils
- Lubricating oil systems

This course is part of the Lubrication training series.

213-03 Lubrication Sampling and Analysis

Lubrication is the lifeblood of operating machinery. Understanding lubrication sampling procedures and scheduling is important for a long service life.

The Lubrication Sampling and Analysis training course explains the importance of lubrication sampling. It describes basic techniques used to collect lubricant samples. This online training course focuses on how to use lubrication schedules to ensure proper preventative maintenance. It also discusses lubrication contamination and analysis.

Lubrication Sampling and Analysis is part of the Lubrication training series.

213-04 Lubricant Filtration and Purification

A contaminant-free lubricant provides the best protection for equipment. Understanding lubrication filtration and purification is important to ensure a lubricant retains its quality and continues to protect the equipment it serves.

The Lubricant Filtration and Purification training course explains how to use mechanical filters and lube oil purifiers to keep lubrication oil contaminant free. It also describes methods to filter and purify lubricating oil in a power plant. This online training course includes:

- Water and solids contamination
- Mechanical filtration
- Oil purification

Lubricant Filtration and Purification is part of the Lubrication training series.

213-05 Lubrication Delivery Systems and Methods

The Lubrication Delivery Systems and Methods training course focuses on various delivery methods used to lubricate industrial machinery. It describes common lubricant delivery methods and systems, including:

- Manually applied lubrication
- Automatic feed lubrication
- Controlled feed lubrication

Lubrication Delivery Systems and Methods is part of the Lubrication training series.

215 Valve Selection and Maintenance

215-01 Introduction to Valves and Their Components

Valves are the single most common piece of equipment in industrial facilities. This online training covers valve fundamentals, including the major components common to most valves and the basic types of flow control elements used in valve design.

This training explains the basic design and function of valves, major valve components, and flow control elements. Using 3D animation, the training examines valve functions, body and bonnet, trim, actuators and packing, types, and markings.

This lesson is part of the Valve Selection and Maintenance series.

215-02 Valve Actuators

As discussed in Introduction to Valves and Their Components, an actuator is needed to position a valve's stem and disk assembly. The Valve Actuators training course discusses the use, selection, and design of various actuators, from simple handwheels to relatively complex electrical and hydraulic manipulators.

This online course covers actuator types, including:

- Fixed and hammer actuators (manual)
- Gear and electric motor actuators
- Pneumatic and hydraulic actuators
- Self-actuated and solenoid actuated valves

The Valve Actuators course discusses power actuators speed and valve position indication.

Valve Actuators is part of the Valve Selection and Maintenance training series.

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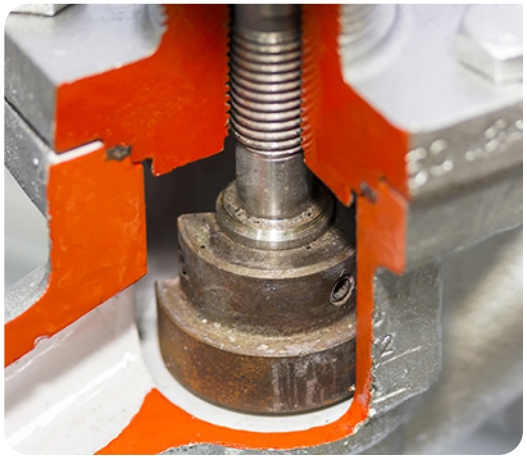
215-03 **Gate Valves**

Gate valves have a simple design and function. They are used for zero flow and full flow services and flow isolation. Normally, gate valves are placed where straight free flow is required and an immediate flow shut-off may be needed.

The Gate Valves training course explains the use, selection, and design of a gate valve. It also describes how different service conditions affect gate valve configuration. This online course covers gate valve:

- Operation
- Disk design
- Stem designs
- Seat designs

Gate Valves is part of the Valve Selection and Maintenance training series.



215-04 **Globe Valves**

Most control valves found in industrial facilities are globe valves. They are primarily used for controlling, or throttling, flows in pump systems. The seating surfaces, body designs, and disk arrangements in globe valves differ according to the design and intended application.

The Globe Valves course describes the use, selection, and design of globe valves. This online training course focuses on globe valve:

- Operation
- Body designs
- Disks
- Seats and direction of flow

Globe Valves is part of the Valve Selection and Maintenance training series.

215-05 **Butterfly Valves**

Many industrial facility applications use butterfly valves. They range in size from 2 to 72 inches. They can handle fluid pressure up to 2500 psi and temperatures over 1000 degrees F. A butterfly valve can be used as a stop valve. However, it is primarily used in high flow and low pressure situations.

The Butterfly Valves training course explains the use, selection, and design of typical butterfly valves found in industrial applications. This course covers:

- Butterfly valve operation
- Butterfly valve seat and body construction
- Butterfly valve disk and stem assemblies

Butterfly Valves is part of the Valve Selection and Maintenance training series.

215-06 **Ball Valves**

The ball valve, like the butterfly valve, belongs to the valve family called quarter turn valves. To operate it, you turn a handle attached to a ball inside the valve. The ball has a hold, or port, through the middle. When the port is in line with both ends of the valve, flow occurs. When the hold is perpendicular to the valve ends, flow is blocked.

Ball valves are excellent for shut-off applications. They don't offer the fine control necessary for throttling applications, but are sometimes used for this purpose. Ball valves can be made from materials that withstand corrosion and caustics. They are low cost and easy to install, so they are dominant in chemical uses with low pressure.

The Ball Valves training course explains the use, selection, and design of ball valves found in industrial applications. This online course focuses on:

- Ball valve operation
- Ball valve design
- Ball valve, body, ball, and seat construction
- Ball valve stem and bonnet design

Ball Valves is part of the Valve Selection and Maintenance training series.

215-07 **Check Valves**

Check valves are designed to prevent flow reversal in a fluid carrying system. Flow reversal can be controlled by a disk, flapper, or plate rotating into or out of the fluid flow path. An alternate method uses a disk, piston, or circular object (ball) moving along the fluid's flowline.

The Check Valves training course explains the use, selection, and design of check valves found in industrial applications. This online course includes:

- Check valve operation
- Swing check valves
- Tilting disk check valves
- Lift check valves
- Ball check valves
- Piston check valves
- Butterfly (water) check valves
- Stop check valves

Check Valves is part of the Valve Selection and Maintenance training series.

215-08 **Needle Valves**

A needle valve uses a small orifice and a threaded, needle-like plunger to precisely regulate flow. It offers fine control, but can only handle applications with a small flow.

The Needle Valves training course describe the use, selection, and design of a needle valve.

This online course is part of the Valve Selection and Maintenance training series.

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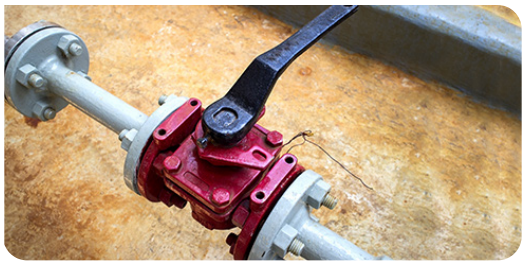
215-09 **Plug Valves**

The plug valve is commonly used in industrial facilities because of its simplicity and compact design. It is easy to operate, offers positive closure and can be used for automatic control. The plug valve functions under a range of temperatures and pressures. it can safely and efficiently handle gas and liquid fuel, boiler feedwater, condensate, and many other fluids.

The Plug Valves training course describes the use, selection, and design of plug valves found in industrial settings. This online course covers:

- Plug valve operation
- Plug valve disks and ports
- Multi-port plug valves
- Lubricated plug valve design
- Non-lubricated plug valve design

Plug Valves is part of the Valve Selection and Maintenance training series.



215-10 **Diaphragm Valves**

A diaphragm valve has disk and seating surfaces made of flexible materials. Diaphragm valves are used in many industrial applications. They are particularly suited for systems carrying chemicals, harmful gases, and corrosive materials.

The Diaphragm Valve training course describes the use, selection, and design of two basic diaphragm valve types. This online course includes:

- Diaphragm valve operation
- Diaphragm construction
- Diaphragm valve stem assemblies
- Diaphragm valve bonnet assemblies

Diaphragm Valves is part of the Valve Selection and Maintenance training series.

215-11 **Pinch Valves**

Pinch valves are used in many industrial applications where the corrosiveness of the fluid handled or the amount of solids present in the fluid flow prevent other valve types from working. Pinch valves isolate the operating mechanism from the process fluid.

The Pinch Valves training course describes their use, selection, and design. It discusses pinch valve construction and operation.

Pinch Valves is part of the Valve Selection and Maintenance training series.

215-12 **Safety and Relief Valves**

Valves are used as safety devices to relieve excess pressures in process piping and equipment. Safety valves and relief valves are two types of specialized valves which serve this purpose.

The Safety and Relief Valves training course describes the use, selection, and design of these valves.

This online course is part of the Valves Selection and Maintenance Training series.

215-13 **Solenoid Valves**

Solenoid valves are electromechanical devices that employ a solenoid to control fluid flows in pneumatic and hydraulic systems. A solenoid valve is typically either all the way open or all the way closed, so it is not used for modulating control.

The Solenoid Valves training course describes the overall design and function of these valves. It covers:

- Solenoid valve operation
- Solenoid valve coils
- Solenoid valve types

This online course is part of the Valves Selection and Maintenance training series.

215-14 **Valve Positioners**

A valve positioner is a type of relay used between the valve's controller output and the valve diaphragm. The positioner increases or decreases the signal operating the valve actuator, helping the valve's final control element more accurately reach the desired position.

The Valve Positioner training course describes the basic design and function of valve positioners used in industrial facilities. This online course discusses:

- Valve positioner basics
- Valve positioner types
- Valve positioner operation

Valve Positioners is part of the Valve Selection and Maintenance training series.

215-15 **Pressure Regulator Valves**

In industrial operations, gases and fluids must be regulated for safe and effective plant operations. The Pressure Regulator Valves training course describes the design and function of these valves as used in industrial facilities. This online course focuses on:

- Self-operated/pilot-operated valve
- Direct control valve
- Fluid overpressure relief valve

Pressure Regulator Valves is part of the Valve Selection and Maintenance training series.

219 **Centrifugal Pumps**

219-01 **Introduction to Centrifugal Pumps**

Pumps are used extensively in industrial facilities to move fluids through system equipment. The Introduction to Centrifugal Pumps training course introduces various centrifugal pump designs. It explains the common operational procedures of each type.

Introduction to Centrifugal Pumps describes the principals behind centrifugal pump construction. It reviews the basic design and function of single-stage and multi-stage centrifugal pumps.

This online training course is part of the Centrifugal Pump training series.

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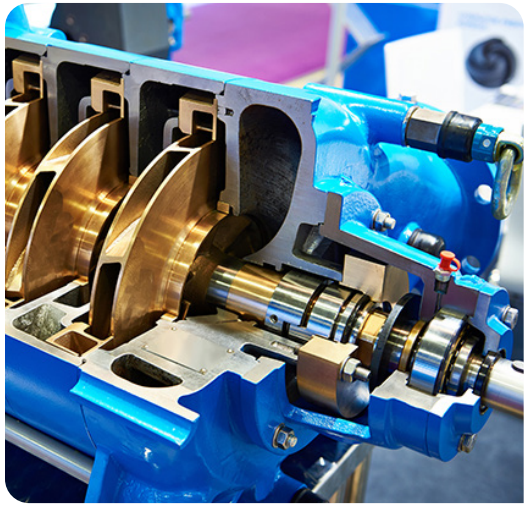

219-02 Centrifugal Pump Design

Centrifugal pumps are used extensively in industrial system processes. The Centrifugal Pump Design online training course builds on the knowledge learned in Introduction to Centrifugal Pumps by providing a more in-depth look at centrifugal pump design.

This course explains the role design plays in matching a pump to a process application. It discusses casing function and options, impeller function and options, and bearings, couplings, and seals.

This course is part of the Centrifugal Pump series.

219-03 Centrifugal Pump Fundamentals

Centrifugal pumps move liquids through system processes under various operating conditions. Understanding centrifugal pump terminology in relation to operational considerations is important in working with associated system process.

The Centrifugal Pump Fundamentals training course uses appropriate terminology to discuss centrifugal pump selection and operation. It explains head pressure and pump capacity. It also explores pump cavitation and net positive suction head.

This online course is part of the Centrifugal Pump training series.

219-04 Centrifugal Pump Operation and Maintenance, Part 1

Centrifugal pumps are used throughout industrial facilities. To ensure they operate reliably and effectively, operators must understand and use proper operating and maintenance procedures.

The Centrifugal Pump Operation and Maintenance, Part 1 training course describes the basic startup procedures used on single and multi-stage centrifugal pumps. It also explains the basic inspections to complete on operating centrifugal pumps during each shift. This online course covers:

- Centrifugal pump startup
- Normal pump operations, inspections, and maintenance
- Centrifugal pump troubleshooting

This course is part of the Centrifugal Pump training series.

219-05 Centrifugal Pump Operation and Maintenance, Part 2

Industrial work often requires quickly moving large amounts of fluids using centrifugal pumps. Being able to operate, troubleshoot, and maintain these pumps is critical to operational success.

The Centrifugal Pump Operation and Maintenance, Part 2 training course identifies different pump types. It explains pump operations and maintenance terms and discusses best practices. This online course identifies predictive and preventative maintenance concepts. It also explores common pump operating problems.

This course is part of the Centrifugal Pump training series.

219-08 Impellers and Wear Rings

Industrial facilities use pumps extensively to move fluids through system equipment. The Impellers and Wear Rings training course introduces various impeller designs and applications for common centrifugal-style pumps which move the majority of fluids in industrial settings. This online course describes the principles behind centrifugal pump mechanical impellers, pump stages, and fluid flow paths. It provides basic information about wear rings. This course focuses on:

- Fundamentals
- Pump stages
- Mechanical impeller types
- Impeller flow modes
- Wear rings
- Wear ring types

Impellers and Wear Rings is part of the Centrifugal Pump training series.

219-10 Pump Troubleshooting

Pump and motor combinations are common in industrial plants. Identifying malfunctioning equipment symptoms and taking action or assisting in the troubleshooting process is critical to plant success.

The Pump Troubleshooting training course describes basic troubleshooting steps. It identifies visual, audible, and tangible equipment malfunction symptoms.

Pump Troubleshooting is part of the Centrifugal Pump training series.

219-12 Pump Internal Inspection and Troubleshooting

Pump and motor combinations are common in modern industry. The ability to quickly troubleshoot and repair them while producing lasting repairs and performing internal inspections is critical to plant success.

The Pump Internal Inspection and Troubleshooting training course describes an internal inspection of a centrifugal pump. It also identifies unsatisfactory component conditions.

This online course is part of the Centrifugal Pump training series.

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223 Heat Exchangers

223-01 Heat Exchanger Theory

In modern industry, cooling equipment and machinery is critical to safe and profitable operations. For cooling to occur, heat transfer must take place from one substance to another. This transfer often occurs in heat exchangers.

The Heat Exchanger training course explains how heat is transferred from one substance to another through heat exchangers. It describes the basic differences between heat exchangers and their supporting equipment.

This online training course covers the purpose and types of heat exchangers. It identifies heat exchanger support components and covers troubleshooting and maintenance.

The Heat Exchanger Theory course is part of the Heat Exchangers training series.

223-02 Open Heat Exchanger Design and Operation

Open heat exchangers increase a boiler's efficiency and remove non-condensable gases from the condensate. Familiarity with open heat exchanger design and characteristics can help during operations and maintenance.

The Open Heat Exchanger Design and Operation training course explains how open heat exchangers use direct contact to heat condensate and remove non-condensable gases from the condensate. It also describes the three basic types of open heat exchangers and their operational characteristics.

This course covers:

- Open heat exchanger purpose
- Deaerator types
- Deaerator operation

Open Heat Exchanger Design and Operation is part of the Heat Exchangers training series.

223-03 Closed Heat Exchangers

Closed heat exchangers are one of the most common types of heat exchanger. Understanding their operation and maintenance helps provide years of trouble-free operation.

The Closed Heat Exchangers training course identifies:

- The difference between single- and multi-pass heat exchangers
- Typical heat exchanger components
- Flow types
- Common maintenance and trouble-shooting procedures.

This online course also focuses on shell-and-tuber heat exchanger design.

Closed Heat Exchangers is part of the Heat Exchangers training series.

225 Compressors

225-01 Plant Compressed Air Systems

Air compressors are used extensively in industrial facilities to operate and control equipment. They are also used to operate pneumatic power tools that maintain plant equipment. Understanding compressed air systems and basic compressor designs is necessary to operate and maintain plant systems.

The Plant Compressed Air Systems training course describes the basic classifications of air compressors used in industrial facilities. It also explains service air and control system operation.

This online training course covers compressor basics, systems, and characteristics.

This course is part of the Plant Compressed Air Systems training series.

225-02 Compressed Air System Components

Compressed air systems supply the air needed to operate plant equipment. Understanding compressed air system components is necessary to effectively operate and maintain plant equipment. The air compressor is one component in a compressed air system. Most systems have several compressors and many auxiliary components.

The Compressed Air System Components training course focuses on the design and operation of the auxiliary equipment. It describes the basic components of a compressed air system. It also explains basic troubleshooting techniques used to detect problems in the system. This online training course reviews:

- Intercoolers and aftercoolers
- Air purification
- Lubrication and maintenance

This course is part of the Plant Compressed Air Systems training series.

225-03 Positive Displacement Compressors

Air compressors are essential to industrial facilities. They provide compressed air to operating instrument/control air systems, pneumatic power tools, and equipment. Knowledge of their design and operations is needed to effectively operate and maintain plant air systems. The two most common types of air compressors in industrial facilities are positive displacement and centrifugal/dynamic air compressors.

The Positive Displacement Compressors training course explains the basic design and operation of positive air displacement compressors. It includes both reciprocating and rotary air compressors.

This course is part of the Plant Compressed Air Systems training series.

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225-04 **Dynamic Compressors**

Dynamic air compressors are used in industrial plant applications requiring high volume airflow. Understanding dynamic air compressors is necessary to operate and maintain plant air systems and equipment.

The Dynamic Compressors training course describes the basic design and operation of dynamic air compressors, including centrifugal and axial types.

This online course is part of the Plant Compressed Air Systems training series.

225-06 **Axial Compressor Control Schemes**

Axial compressors are essential to many industries. They provide fluid compression for various processes. Understanding their control and protection is necessary to effectively operate and maintain the production process.

The Axial Compressor Control Schemes training course describes:

- Control fundamentals
- Control system selection
- Surge control components
- Surge control
- Surge avoidance

Axial Compressor Control Schemes is part of the Plant Compressed Air Systems training series.

229 Fasteners and Seals

229-01 **Bolted Joints**

Bolted joints are used in hundreds of applications in modern industrial facilities. Understanding the proper torque techniques, available bolt types, common bolt locking mechanisms, and preloading bolt methods is necessary for tight, long-lasting joints. The Bolted Joints training course describes commonly used bolt types and grades and discusses their proper use. It also lists common modes of joint failure and identifies preventive measures.

This online course covers:

- Bolts and nuts and their grades
- Flange bolt tightening
- Bolt preload and torque basics
- Torque settings
- Preload methods
- Joint failure
- Locking mechanisms

The Bolted Joints course is part of the Fasteners and Seals training series.

229-02 **O-Rings**

O-rings are used in many sealing applications in an industrial facility. They ensure light seals and prevent fluid leaking from different plant equipment. Understanding O-ring sealing characteristics and the different materials used in production helps in selecting the proper O-ring for any application. Proper installation techniques and troubleshooting procedures prevent future problems with the sealing application.

The O-rings training course describes its design and purpose. This online course explains:

- O-ring basics
- O-ring scaling
- Static O-ring seals
- Dynamic O-ring seals
- Other O-ring applications
- O-ring materials
- O-ring failure analysis
- O-ring assembly, care, and treatment

O-rings is part of the Fasteners and Seals training series.

229-03 **Making Gaskets**

Gaskets are used in industrial facilities to ensure leak-free seals between piping and equipment connections. New gaskets should be used whenever connections have been taken apart and are ready to be put back together. Pre-made gaskets are often available; however making new gaskets from bulk stock is a valuable and necessary additional to a maintenance technician's skills.

The Making Gaskets training course describes different types of gaskets. It explains common methods for making gaskets from stock materials. This online training course includes:

- Gasket types
- Trace and cut method
- Layout and cut method
- Trace and tap method
- Using a gasket cutter

Making Gaskets is part of the Fasteners and Seals training series.

229-04 **Fasteners**

A fastener is a piece of hardware that mechanically holds or joins two or more objects together. Workers use a variety of fasteners in hundreds of industrial facility applications.

The Fasteners training course examines several commonly encountered fasteners. It describes their design and identifies their purpose. These fasteners include:

- Screws
- Bolts
- Nuts
- Washers
- Nails
- Retaining rings
- Rivets

This online course is part of the Fasteners and Seals training series.

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229-05 Packing Material Use and Installation

Packing is a flexible, rope-like material used to seal pump shafts and valve stems. It prevents process fluid from leaking out and/or air from leaking in. Understanding how pump and valve packing works helps technicians perform effectively.

The Packing Material Use and Installation training course describes what packing is. It identifies common packing designs, components, and construction. This online course explains general procedures for installing and removing packing from pumps and valves. It covers:

- Packing basics
- Packing material selection
- Packing glands
- Removing packing
- Installing packing in a pump
- Installing packing in a valve

Packing Material Use and Installation is part of the Fasteners and Seals training series.

229-06 Mechanical Seals Use and Installation

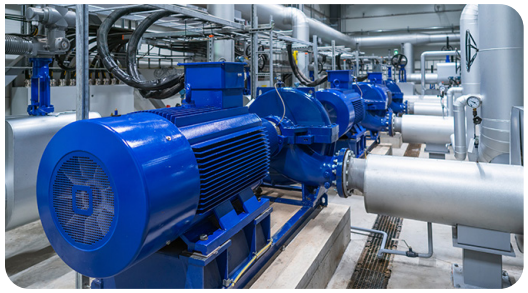
Mechanical seals are used in installations where leakage from packing type seals is not safe or allowed. For example, mechanical seals are the preferred choice for sealing applications where the process contains hazardous substances such as hydrocarbons, caustics, or acids.

Mechanical seals are also used in high pressure and temperature applications, such as high pressure or temperature pumps, where stuffing boxes and packing cannot offer adequate leak protection. Understand the ways mechanical seals are used and maintained helps a technician more effectively perform their duties.

The Mechanical Seals Use and installation training course describes how mechanical seals work. It identifies the features of commonly used seal types. It also explains proper seal care. This online course focuses on:

- How mechanical seals work
- Stationary and rotating mechanical seals
- Balanced and unbalanced mechanical seals
- Care and troubleshooting of mechanical seals
- Mechanical seal removal
- Mechanical seal installation

Mechanical Seals Use and Installation is part of the Fasteners and Seals training series.



231 Positive Displacement Pumps

231-01 Introduction to Positive Displacement Pumps

Industrial facility operations rely on many pump types and sizes to move fluids through equipment. Positive displacement pumps are suitable for use with a variety of industrial system processes. Introduction to Positive Displacement Pumps training identifies the pumps' principle designs and common operational processes. It also identifies the operating conditions in which positive displacement pumps are commonly used.

This online course also discusses the operational differences between the two main pump types - reciprocating and rotary. Introduction to Positive Displacement Pumps includes operation principles and reciprocating and rotary pump design.

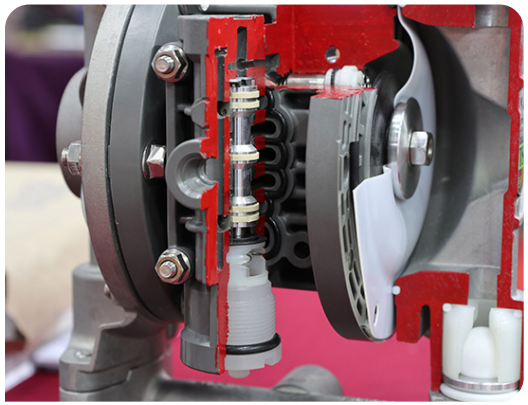
This course is part of the Positive Displacement Pumps Series.

231-02 Reciprocating Positive Displacement Pumps

Positive displacement pumps move fluid from one system process or location to another. The Reciprocating Positive Displacement Pumps training course focuses on the design and operation of these pumps, with an emphasis on safe and reliable operation. This course describes the design and function of reciprocating positive displacement pumps.

Building on the information learned in Introductive to Positive Displacement Pumps, this online training course discusses pump applications and classifications. It covers two types of pumps: piston and plunger reciprocating pumps and diaphragm reciprocating positive displacement pumps.

This course is part of the Positive Displacement Pumps series.



231-03 Rotary Positive Displacement Pumps

As discussed in previous lessons, positive displacement pumps are commonly used to move working fluid from one industrial location or system process to another. The Rotary Positive Displacement Pump training course focuses on the design and operation of these pumps.

This online course covers:

- Internal and external gear pump designs
- Screw and vane pump design
- Lobe and metering pump design

This course is part of the Positive Displacement Pumps series.

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243 Hydraulics

243-01 Introduction to Hydraulics

Hydraulic systems are used extensively in the utility, construction, and manufacturing industries. Understanding basic hydraulic principles is necessary to operate, maintain, and repair hydraulic equipment. The Introduction to Hydraulics course describes the basic components and functions of a typical hydraulic circuit. It also explains using hydraulic multiplication to increase the hydraulic system's capacity.

This online training course covers simple hydraulic systems and their basic components. It also includes hydraulic manipulation. Introduction to Hydraulics is part of the Hydraulics training series.

243-02 Hydraulic Systems

Hydraulic systems are used to operate heavy equipment, machinery, and tools. Understanding the hydraulic system's operation is key to safely operate, maintain, and repair equipment and systems.

The Hydraulic Systems training course identifies and describes the purposes of various components used in hydraulic systems. It also describes the parts used to control flow through a hydraulic circuit. This online training course covers:

- Hydraulic system components
- Flow control
- Auxiliary components

This course is part of the Hydraulics training series.

243-03 Hydraulic Fluids

Hydraulic fluids are non-compressible fluids that help energy move through a hydraulic circuit to perform work through motion. Knowing the different types and characteristics of available hydraulic fluid is necessary to select the appropriate fluid for a specific hydraulic circuit.

The Hydraulic Fluids training course identifies the three basic types of hydraulic fluids. It also explains what to consider when selecting the hydraulic fluid for a specific hydraulic circuit. This online course also covers hydraulic fluid contamination.

This course is part of the Hydraulics training series.

271 Vibration

271-01 Vibration Introduction

Many parameters are measured for information about systems and components. But, vibration is the best parameter for measuring operating equipment. Vibration helps you understand when equipment is not operating correctly. It can also help diagnose and troubleshoot problems. The Vibration Introduction course defines basic terms and measurement units for vibration. It also describes the relationship between a machine's operating speed and vibration problems.

This online course explains vibration and excitation. It reviews amplitude units, including displacement, velocity, and acceleration, and their mathematical relationships. It details time and frequency domains and covers revolutions, cycles, and orders.

Vibration Introduction is part of the Vibration training series.

271-02 Vibration Causes and Characteristics

All operating machines exhibit some vibration. No matter how well designed, manufactured, installed, and operated, they all experience excitation forces, which cause some vibration and noise. While this vibration is expected, excessive amounts can damage a machine, create noise, and even be dangerous. Many things can cause vibration. Understanding these causes helps troubleshoot machine vibration problems.

The Vibration Causes and Characteristics training course describes the characteristics of vibration-causing mechanical faults. This online course explains:

- Unbalance
- Misalignment
- Mechanical looseness
- Bearings
- Belts
- Gears
- Electrical faults

Vibration Causes and Characteristics is part of the Vibration training course.

271-04 Plant Vibration Program

All operating machines vibrate. Due to many factors, vibration gets worse with time. Unless it is controlled, vibration causes bearings, and the machines they are part of, to fail. A well-planned vibration program is a vital element of a plant's operational readiness. A plant's vibration program can minimize downtime and repair costs while making the plant safer and more reliable.

The Plant Vibration Program training course explains the roles of vibration program components. It describes a typical plant program and discusses how it contributes to operational readiness. This online training course includes:

- Vibration data collection equipment
- Computer-related tools
- Workgroup roles and responsibilities

This course is part of the Vibration training series.

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273 Boiler Repair

273-01 Boiler Tube Repair

Boiler tubes function in extreme pressure and experience wear and periodic failure. Corrosion, erosion, and temperature- and pressure-related stresses wear or weaken the tubes. When boiler tubes leak, those tubes and any affected surrounding ones must be repaired or replaced. The Boiler Tube Repair training course describes different tube assemblies that may need repair. It lists common leak causes and procedures for repair.

This online course discusses boiler tube assemblies. It also highlights leak or rupture causes and explains repair methods.

The Boiler Tube Repair course is part of the Boiler Repair training series.

273-02 Inspecting the Fireside of a Boiler, Part 1

Most companies mandate boiler inspections to ensure boilers are maintained in safe operating condition. The Inspecting the Fireside of a Boiler, Part 1 training course focuses on techniques and procedures for inspecting the fireside waterwalls for problem areas. This course covers burner openings, air ports, and inspection doors. It also explains inspecting for tube thickness.

This online training course describes specific things to look for when doing a fireside inspection on a large boiler's watertubes, including

- Support failures
- Refractory failures
- Clunker damage
- Tube erosion and corrosion
- Tube overheating
- Ash accumulations
- Weld failures

Inspecting the Fireside of a Boiler, Part 1 is part of the Boiler Repair training series.

273-03 Inspecting the Fireside of a Boiler, Part 2

Boiler inspections can be broken into three broad categories: fireside inspections, waterside inspections, and exterior inspections. Most companies mandate routine inspections to ensure boilers are maintained in safe operating condition.

The Inspecting the Fireside of a Boiler, Part 2 training course explains specific things to look for when doing a fireside inspection. It includes techniques and procedures for inspecting:

- Superheaters and reheaters
- Soot blowers
- Bottom ash hoppers
- Economizers
- Baffles
- Boiler bottom seals

This online course is part of the Boiler Repair training series.

273-04 Inspecting the Water Side of a Boiler

The Inspecting the Water Side of a Boiler training course focuses on techniques and procedures for inspecting the water side of a large watertube boiler for problem areas. Most companies mandate routine inspections to ensure boilers are maintained in safe operation condition.

This online training course identifies unacceptable conditions when performing a water side inspection on:

- Steam drums
- Moister separators
- Headers
- Tubes

Inspecting the Water Side of a Boiler is part of the Boiler Repair training series.

273-05 Inspecting a Boiler's Exterior

The Inspecting a Boiler's Exterior training course examines some specific areas to focus on when inspecting the exterior of a large boiler. This online training course highlights:

- Boiler casing
- Steam drum
- Safety valves
- Downcomers and pumps
- Casing stiffeners and intrusions

Inspecting a Boiler's Exterior is part of the Boiler Repair training series.

273-06 Waterside and Fireside Cleaning of a Boiler

If the boiler water in a large watertube boiler has been properly treated, chemical cleaning is not usually necessary. If, however, the boiler chemistry causes deposits to form on the boiler's waterside, it may need to be chemically cleaned.

The Waterside and Fireside Cleaning of a Boiler explains some methods and procedures for cleaning and testing a large watertube boiler's waterside and fireside. This online training discusses:

- Chemical cleaning
- Hydrostatic testing
- Air testing
- Fireside cleaning
- Closing and firing the boiler

Waterside and Fireside Cleaning of a Boiler is part of the Boiler Repair training series.

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Electrical Transmission and Distribution

301 Distribution Systems

301-02 Electrical Distribution System Fundamentals*

Electrical distribution system design is an intricate and involved process requiring consideration of many factors before completing. The Electrical Distribution System Fundamentals training course describes the process and purpose of designing an electrical power distribution system.

This online course introduces:

- Principles of electrical power distribution systems
- Modern technology in distribution design
- Electrical power distribution design goals
- Common voltage classes and levels
- Common system types and configurations

Electrical Distribution System Fundamentals is part of the Distribution Systems training series.

301-03 Primary and Secondary Distribution Systems

The distribution process is the final step in providing energy to customers. After transmission has carried the energy to the load area, a distribution system modifies the voltage to a useable level. It then distributes it to consumers evenly, reliably, and economically.

The Primary and Secondary Distribution Systems training course describes these network systems. It discusses the benefits of primary and secondary distribution systems. It also explains how to create a riser diagram. This online course explores:

- History of network distribution systems
- Functions of primary distribution systems
- Properties of secondary distribution systems
- Common system designs
- Benefits of a network system

This course is part of the Distribution Systems training series.

301-04 Distribution System Components and Application

A distribution system's complexity seems overwhelming even to the most experienced personnel. This complexity comes from how the components can be modified and manipulated to convert energy into usable levels for consumers. Regardless of a component's design, it fulfills the same function universally.

The Distribution System Components and Application training course introduces configuration fundamentals, identifies the most common components, and clarifies the role a substation fills in a power system.

This course is part of the Distribution Systems training series.

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301-05 Characteristics of Distribution Switchgear

Switchgear is a term used to cover the various switching devices used to protect transmission and distribution systems. Switchgear devices also apply to power system regulation, control, and metering.

The Characteristics of Distribution Switchgear training course covers switchgear types and applications which make these devices an integral component from generation to distribution. This online course explains how to modify system designs by combining and replacing switchgear applications. It focuses on

- Basic function of switching devices
- Simple switchgear applications
- Combining switchgear applications
- Circuit breakers as switchgear

Characteristics of Distribution Switchgear is part of the Distribution System training series.

301-06 Load Characteristics and Management*

As distribution and transmission technologies improve, load area construction complexity increases. Many components contribute to understanding how to properly manage load area balance and interchange.

The Load Characteristics and Management training course discusses characteristics common to load area demand. It also demonstrates how to use load and load-duration curves to help balance interchange scheduling and conduct time error correction. This online training course covers:

- Load characteristic terminology
- Common demand characteristics
- Load and load-duration curve understanding
- Load forecasting and power factor corrections
- Time error correction
- Inadvertent interchange

Load Characteristics and Management is part of the Distribution Systems training series.

301-08 Single- and Poly-phase Metering*

Single- and poly-phase metering are the two types of revenue data meters used in the modern world. Technology advances change the designs of meters that may be applied at the service entrance. Still, the purpose, data, and terminology data remain the same. Understanding this information better prepares a technician to service meters today and tomorrow.

The Single- and Poly-phase Metering training course describes the process for meter reading, testing, and calibration. This online course discusses:

- Watt-hour meter purpose and operation
- Meter types
- Understanding meter constants
- Poly-phase circuit metering
- Meter reading, testing, and calibration
- Rotating standard guidelines

Single- and Poly-phase Metering is part of the Distribution Systems training series.

301-09 Introduction to Distribution Systems

This course describes basic terminology and fundamental concepts relating to electrical energy production and delivery in large power systems. It discusses how the Real-time electrical power system generates, transports, distributes, and delivers electrical energy to consumers. Topics include basic electrical terminology, electrical load characteristics, and an overview of the bulk electric power system.

301-10 Distribution Design and Resource Planning

This course describes the different federal, state, and local regulatory compliance issues electric power companies must adhere to when planning for their distribution system. It discusses the methods used to forecast demand, analyze needed distribution system improvements, and successfully transfer load during emergency situations. Students who take this class will understand the information contained on electrical drawings, including standard types, labeling conventions, and basic symbols needed to perform most job-related activities.

301-11 Distribution Substation Equipment

This course describes how key distribution substation equipment works and is used to serve load. It also covers how distribution feeders are configured to provide customer service voltage and equipment used in overhead and underground power distribution systems.

301-12 Distribution Protection

This course describes the common overhead and underground faults encountered in distribution systems and discusses the benefits of using instrument transformers. It reviews different equipment used to protect machinery and minimize outages.

301-13 Overvoltage Protection

This course explains different transient overvoltage events, defines Basic Insulation Level (BIL) and lightning protection schemes, and describes protection margins with respect to overvoltage protection on distribution systems.

301-14 SCADA and EMS

This course explains how SCADA, RTUs, and communication systems provide the electronic means for control centers to monitor the state of the power system, selectively control equipment in remote locations, and feed application programs used in EMS.

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* NERC CEHs are available for qualified operators. Courses taken to fulfill NERC CEH requirements must be indicated at time of purchase.

301-15 **Service Entrance Equipment**

This course discusses overhead and underground single-phase residential electrical service entrance equipment, breaker panels, and basic wiring of receptacles, switches, Ground Fault Circuit Interrupters (GFCI), 240 V connections, and other special considerations imposed by the National Electric Code. It also describes how electric utilities serve commercial and industrial customers.

301-16 **Normal Operations**

This course explains the purpose and basic operation of key distribution equipment and reviews key equipment for controlling voltage on distribution feeders. It shows distribution operators how to ensure normal distribution system operations are happening in Real-time and watch for signs of reliability threats.

301-17 **Emergency Operations**

This course explains how to capably manage distribution operations during abnormal conditions by having an in-depth understanding and grasp of important situational awareness indicators surrounding critical situations, events, workforce placement, standard operating procedures, system tools, and safety awareness. This course also discusses how to properly sectionalize distribution feeders to transfer load and restore service to as many customers as possible in a timely manner, following a systematic process.

301-18 **Regulatory Overview and Electrical Safety Equipment**

This course describes how regulatory agencies use basic electrical principals to develop safe working environments and work procedures. It explains how substation ground grids, multi-grounded neutrals on distribution lines, shield wires on transmission lines, and grounding electrodes on other electrical facilities provide benefits to system operations and personnel safety. It discusses how faults are created, how resulting current flows through various grounding locations, and where the hazardous electrical potentials appear.

301-19 **Safe Working Practices**

This course discusses safety procedures, methods to work on energized and de-energized equipment, and various accidental energization scenarios. It explains ground potential rise, Zone of Influence, human vulnerability, and personal protective equipment.

301-20 **Arc Flash Analysis and Safety Equipment**

This course discusses arc flash concepts, regulatory requirements, and industry standards when working around energized electrical equipment. It covers the methods used to determine arc flash boundaries, approach distances, required PPE, and labeling requirements.

301-21 **Switching Practices**

This course explains how utilities perform maintenance activities on high voltage power lines and substation equipment through switching and tagging procedures. It presents how electrical utilities write and process switching orders to remove equipment from service. This course reviews lockout-tagout devices and summarizes steps involved in an effective switching order.

301-22 **Post-Storm Electrical Safety**

This course includes an electrical review and discusses line identification. It addresses post-storm electrical hazards such as identifying downed wires and safety precautions, listing safety precautions associated with damaged overhead, underground, and substation facilities, and understanding the risks associated with accidental energization.

301-23 **Distribution Reliability**

This course discusses the various reliability indices used to measure distribution system performance and methods utilities use to improve service reliability. It explains how smart meters and communication networks are used to improve service reliability by enhancing or automating the way feeder problems are quickly identified, isolated, and corrected. This course also discusses how dense distribution systems and critical load customers are connected to grid, secondary and spot networks, and auto transfer switches to improve service reliability.

301-24 **Power Quality**

This course describes common power quality issues and the means to resolve those issues. It discusses installation variances that can cause power quality issues, primarily with transformers. It explains how ferroresonance and radio-television interference affect power quality and outlines viable solutions essential to providing reliable and safe electric service.

301-25 **Planned Maintenance and Test Equipment**

This course covers the importance of an adequate facility inspection, inspections within a facility substation and outside equipment, perimeter inspection, and remote equipment inspections. It discusses manufacturer-recommended maintenance programs and routine, thorough entity maintenance programs. It highlights the types of test equipment used on power system equipment during maintenance and troubleshooting activities.

301-26 **Smart Grid Systems**

This course provides an overview of how smart grid technologies play a prominent role in transitioning the various organization sectors to modern smart grid enhancements. It describes the new smart electronic equipment and information technology interfaces used in substation protection and switchyard equipment control. It focuses on how the growing use of distributed generation and distributed energy resources is changing the way electric power systems balance generation and demand from large, remotely located plants to multiple,';[smaller distribution-based plants. With the new communication systems used for smart grid, this course describes the various cyber and physical threats that plague the modern smart grid. It shows how smart grid systems can help manage energy consumption and integrate technology to improve distribution system performance and reliability.

- **100** Safety, Health, and Plant Science
- **200** Mechanical Maintenance
- **300** Electrical Transmission and Distribution
- **400** Electrical Maintenance
- **500** Power Generating Systems and Operations
- **600** Instrumentation and Control
- **700** Process Systems and Operations
- **800** Industrial Machining and Welding
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301-37 Introduction to Distribution Systems

This course provides a working knowledge of the technical concepts associated with modern electric power distribution systems design, equipment, and operations. It introduces distribution systems and identifies the major components of a distribution system. It also explains how distribution systems are configured to serve load.

301-38 Overhead and Underground Facilities

This course focuses on overhead and underground facilities, identifying the physical and electrical characteristics of equipment used in those facilities. It also outlines how household wiring enables electrical appliances to be powered by the BES.

301-39 System Protection and Coordination

This course details system protection, various protection equipment and coordination between protection devices. It specifies how solid state and electromechanical relays are used to protect distribution equipment from faults. After finishing this course, students will be able to identify how the various overcurrent protection devices are coordinated to minimize customer outages. Finally, it explains how lightning arresters are used to protect distribution systems from overvoltage conditions.

301-40 Distribution Operations

This course details system reliability and power quality and specifies how reliability indices are used to measure performance. It also identifies the basic types of power disturbance monitoring equipment for power quality problems. After finishing this course, students will understand how stray voltages and currents are created and their ability to mitigate undesirable effects.

301-41 Safety for Distribution Systems

This course details safety for distribution systems by identifying the root causes for electrical safety. It explains how to recognize human vulnerability regarding touch and step potentials. It also specifies how to use personal protective equipment and grounding to safety work around distribution equipment.

301-42 Distribution Control Center and Smart Devices

This course explains the operation of distribution control centers and smart devices, including specifying how control centers are used to remotely operate distribution system. It identifies the various communication systems used by utility SCADA systems to remotely monitor, control, and support electrical distribution operations. Students learn how the distribution system is rapidly changing, including the use of modern smart electronic devices and other new technology enhancements to improve distribution reliability and customer service.

312 Basic Electricity Fundamentals

312-01 Basic Electricity*

Understanding the concepts that govern the use of electricity is important to workers in the power, manufacturing construction, and many other industries. The Basic Electricity training course looks at these concepts, focusing on:

- Atomic structure
- Electric charges
- Electricity carriers
- Compounds
- Conductors and insulators
- Voltage, current, and resistance
- Separating charges
- Chemical reaction
- Magnetism

Basic Electricity is part of the Basic Electricity Fundamentals training series.

312-02 Laws of Electricity*

The Laws of Electricity training course explores the consistent relationship between various properties of electrical circuits. This online training course covers:

- Electrical circuits
- Coulomb's Law
- Ohm's Law
- Kirchoff's Law

Laws of Electricity is part of the Basic Electricity Fundamentals training series.

312-03 AC, DC, and Circuit Interactions*

The AC, DC, and Circuit Interactions course explains common properties of electrical circuits. These circuits are encountered throughout the study of electrical systems and operations. This online training course discusses:

- Series circuit
- Parallel circuits
- AC polarity changes
- Faraday's Law
- Power formula
- Inductance
- Capacitors in AC circuits

AC, DC, and Circuit Interactions is part of the Basic Electricity Fundamentals training series.

312-04 Three Phase AC Connections and Effects*

The Three Phase AC Connections and Effects training course looks at common electrical circuit properties encountered in the study of electrical systems and operations. This online training course features:

- Three-phase system characteristics
- Wye and delta connections
- Inductance and capacitance
- Power factor
- Countering inductance
- Excess capacitance

Three Phase AC Connections and Effects is part of the Basic Electricity Fundamentals training series.

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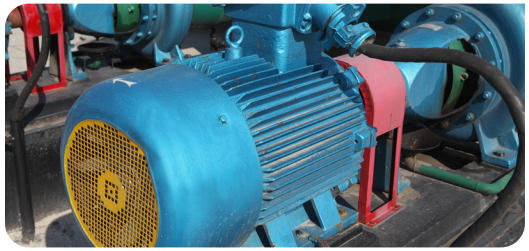
312-05 **Electric Devices***

Electromagnetism is at the heart of all major electrical system devices. The Electrical Devices training course discusses these power system components, including:

- Solenoids
- Relays
- Circuit breakers
- Motors
- Generators
- Transformers

Electric Devices is part of the Basic Electricity Fundamentals training series.



312-06 **Ohm's Law, Energy Formulas, Basic Concepts, Circuits***

Electric charge has its roots in the atomic level of substances. Understanding electric charge and basic electric principles is necessary for anyone working in the power industry. These principles include how atoms work, formulas and equations to understand current and voltage flow, and the laws that explain how electricity works.

The Ohm's Law, Power & Energy Formulas, and Basic Concepts of Series and Parallel Circuits training course explores electric charge, potential, Ohm's Law, and power and energy. It discusses series and parallel circuits. It also explains equations for series and parallel resistive circuits. This online course focuses on:

- Electric charge
- Conductors and insulators
- Resistance/Ohm's Law
- Power and energy
- Series and parallel circuits
- Kirchhoff's Voltage Law
- Kirchhoff's Current Law

This course is part of the Basic Electricity Fundamentals Training Series.

312-07 **Formulas for Voltage and Current Division***

Voltage and current division are methods used in circuit analysis to quickly find the necessary voltage or current. The formulas are derived from Kirchhoff's Voltage and Current Law equations. Knowing these formulas is important for power industry employees to perform their jobs safely and effectively.

The Formulas for Voltage and Current Division training course uses concrete examples to explore those formulas, using. It demonstrates how to calculate voltage and current given specific data.

The Formulas for Voltage and Current Division is part of the Basic Electricity Fundamentals Training Series.

312-08 **Inductance, Capacitance, and Phase and Power Angles***

Inductors and capacitors are important circuit elements. An inductor opposes any change of current through it. A capacitor opposes any change in voltage across it. Phase angles are also important elements. They show the phase shift as inductance and capacitance impact whether current waves lead or lag voltage waves. Understanding how these elements affect the flow of electricity is important for workers responsible for system reliability.

The Inductance, Capacitance, and Phase and Power Angles training course differentiates between inductance and capacitance. It explains the difference between current leading and lagging voltage. It also explains the difference between real (active) and reactive power. This online course covers:

- Inductive circuit behavior
- Capacitive circuit behavior
- Lagging and leading current waveforms
- Phase angle
- Power wave
- Power triangle

Inductance, Capacitance, and Phase and Power Angles is part of the Basic Electricity Fundamentals training series.

312-09 **Phasors, Capacitance, Inductance, and Symmetrical Components***

Resistance, capacitance, and inductance must be considered when analyzing AC circuits. Just as resistances oppose power flow in DC circuits, they also oppose current flow in AC circuits. Capacitors and inductors also oppose current flow in AC circuits and cause current to be out of phase with voltage. A simple mathematical description explains these effects without getting involved in wave forms.

The Phasors, Capacitance, Inductance, and Symmetrical Components training course explains how to convert data, using formulas, to improve power flow and efficiency. This course is useful for entry-level employees. It is also helpful for personnel who support system operations. This online course discusses:

- Phasors
- Phasor conversion
- Complex number arithmetic rules
- Load impendence
- Symmetrical components
- Resonance

Phasors, Capacitance, Inductance, and Symmetrical Components is part of the Basic Electricity Fundamentals training.

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312-10 **Electromagnetism, Induction, Transformers, and Conductors***

Understanding electromagnetism is critical to understanding how electric power is generated. Electromagnets produce a magnetic field which in turn, produces flux. Inductance and flux work together in a transformer to induce voltage, which can supply a load. Power transformers step up and step down voltage to transfer it from generation to load.

The Electromagnetism, Induction, Transformers, and Conductors training course discusses the relationship between electromagnetism and flux. It explains how power transformers are used for all voltage level changes. This online course focuses on:

- Electromagnetic force
- Inductance
- Voltage and turns ratio relationship
- Current and turns ratio relationship

Electromagnetism, Induction, Transformers, and Conductors is part of the Basic Electricity Fundamentals training.

312-11 **Generators, Torque Angle, and Synchronizing***

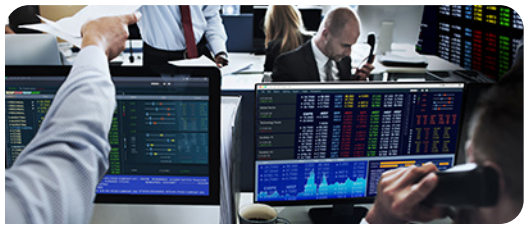
A power plant generator consists of a rotating magnetic field on a rotor inside armature windings on the generator's stator. The turning electromagnetic rotor causes lines of flux to cut through the coils in the stator. Voltage is induced in these coils, with current flowing to any load connected to the terminal of the generator.

In the generator, the magnetic fields of the rotor and stator rotate at the same speed. The angle between the rotor and stator is the torque angle. Torque is the rotational force applied to the rotor. The torque angle is the generator's rotor position with respect to the phasor. For a generator to provide power to the system, it must be synchronized. Specific conditions must match between the generator and the system for synchronization to happen.

The Generators, Torque Angle, and Synchronizing training course explores how generator components work together to create power. It discusses single- and three-phase systems. It discusses how torque angle impacts a generator's output. Finally, it explains the conditions necessary to synchronize a generator to the system. This online course highlights:

- Pole and speed relationship
- Balanced three-phase systems
- Reactive and real power output control
- Checking equal voltage condition

The Generator, Torque Angle, and Synchronization is part of the Basic Electricity Fundamentals training course.



320 **Power Markets**

320-01 **Market Concepts***

Through the years, wholesale quantities of electricity have been bought and sold in various ways. Electric power has been transacted between entities since they connected their systems early in the 20th century. The power markets operate in much the same way today.

How much does it cost? The price is typically negotiated at a fixed $/MWh rate or at some pre-agreed upon rate, similar to the current generation cost.

The seller exports the energy and the buyer imports it. The power is normally delivered in hourly blocks, which could be pre-scheduled hours, days, or months ahead. Many transactions still operate this way. However, with deregulation in the 1990s, generating companies became more prevalent. These generators began competing with each other to supply electric load. These new operating conditions allowed market-based pricing to become the rule. A clearing house, such as an ISO, receives offers from generators for the minimum amount they would charge for energy and other services.

The Market Concepts training course discusses the sale and purchase of bulk power. It explains the difference between cost-based and market-based transactions. It also describes the sellers and buyers roles. This online course covers:

- Bilateral contracts
- Market clearing price
- Power market buyers
- Bids and offers
- Locational margin price

Market Concepts is part of the Power Markets training series.

320-02 **Regulators, RTOs, ISOs, Long Term Power Supply***

The electric utility industry has evolved over the years. From its beginning as fragmented utilities providing power locally, to vertically integrated utilities regulated by federal and state commissions, to the partial deregulation we see today, the power industry has continuously changed to meet the national's electrical demands.

One area that illustrates this illusion is the buying and selling of electricity, or the power markets. Independent System Operators (ISOs) and Regional Transmission Operators (RTOs) manage the sale of generation on the power market. These organizations work to ensure reliability of the grid in their region, manage and settle the financial transactions, and schedule power transfers, among other responsibilities.

To measure generation capacity on a long-term (monthly , seasonal, or annual) basis, many ISOs use installed capacity, or ICAP. It's a way of assuring capacity is available on an ongoing basis to serve load during a period.

The Regulators, RTOS, ISOs, and Long Term Power Supply training course provides an overview of the power system history and how its regulation has evolved. It identifies factors that affect energy costs. It also discusses the various generation capacity types involved in the power marketplace. This online training course focuses on:

- Day-ahead markets
- Capacity
- Transmission congestion
- Market mechanics
- Energy legislation

Regulators, RTOs, ISOs, and Long Term Power Supply is part of the Power Markets training series.

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320-03 **Near Term, Day Ahead, Hour Ahead, Real Time Power Supply***

Day-Ahead Markets and Real-Time Markets are critical power market components. The Day-Ahead Market is an ISO-controlled market for trading services for the next 24 hours. Day-Ahead Markets allow loads to plan their generation coverage a day in advance. Generators know what equipment needs to be running to provide the generation they've scheduled.

Real-Time Markets are hourly. They enable loads to access additional power as needed when demand is higher than anticipated. Generators sell excess generation they either didn't sell or didn't offer in the Day-Ahead Market. These two markets help the ISO ensure reliability across its system.

The Near Term, Day Ahead, Hour Ahead, Real Time Power Supply training course builds on the information provided in the previous course. It discusses how short-term and day-ahead capability is applied within the ISO's environment. It describes the benefits and characteristics of the Day-Ahead Market. It identifies hour-ahead processes and explains the difference between Day-Ahead Market and Real-Time Market pricing. This online training course includes:

- Day-Ahead Market scenarios
- Day-Ahead Market versus Real-Time Market
- Generator and load perspectives

Near Term, Day Ahead, Hour Ahead, Real Time Power Supply is part of the Power Market training series.

320-04 **Ancillary Services***

Ancillary Services are transmission system services that support the transmission system. These services move electricity from generating sources to ultimate consumers. They support the transmission system in times of system stress or in the event of a system blackout and restoration.

The typical ISO operates several markets for Ancillary Services including:

- Voltage support
- Regulation
- Energy imbalance
- System blackstart
- Operating reserve (synchronized and non-synchronized)

The Ancillary Services training course identifies and describes the typical services an ISO provides. It explains the differences between cost-based and market-based Ancillary Services. It also discusses how generation impacts the power grid's frequency. This online training course explores:

- Reactive power and voltage support
- Regulation service
- Committing and scheduling resources
- The need for blackstart service

Ancillary Services is part of the Power Market training series.

320-05 **Risk Protection**

Sometimes, the wholesale electricity market's complexity can cause prices to vary significantly, especially with high demand or low supply. Many factors contribute to this volatility, including generation type and weather events. Knowing why wholesale prices change is vital to safeguard the interests of present and future customers.

The Risk Protection training course describes the risk-based pricing model and differences. It explores how world events influence electricity prices while comparing the relationship between fuel and electricity costs. It also identifies renewable energy effects on the price of wholesale electricity. This online course discusses:

- Price volatility and volume risk
- Wholesale market costs
- Levelized energy costs

Risk Protection is part of the Power Marketing training series.

345 Introduction to NERC

345-01 **NERC Overview and Application for Generator Operators**

The North American Reliability Corporation (NERC) is the only Electrical Reliability Organization (ERO) in the U.S. authorized by the Federal Energy Regulatory Commission (FERC) to oversee reliability operations of the national power grid. Not all power generation, transmission, and distribution facilities are reportable to NERC, but those who are must follow strict guidelines to ensure they contribute to the stability of the Bulk Power System.

The NERC Overview and Application for Generators training course focuses on the roles and responsibilities of Generator Operators. This course identifies the standards and requirements for NERC registered Generation Operators, including:

- History, structure of NERC, and the Generator Operator role
- Resource and Demand Balancing (BAL) requirements
- Communication (COM) requirements
- Critical Infrastructure Protection (CIP) requirements
- Emergency Preparedness and Operations (EOP) requirements
- Interchange Reliability Operations and Coordination (IRO) requirements
- Protection and Control (PRC) requirements
- Transmission Operations (TOP) requirements
- Voltage and Reactive Power (VAR) requirements

This course is part of the Introduction to NERC training series.

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345-02 **NERC Overview**

The North American Reliability Corporation (NERC) is the only Electrical Reliability Organization (ERO) in the U.S. authorized by the Federal Energy Regulatory Commission (FERC) to oversee reliability operations of the national power grid. Not all power generation, transmission, and distribution facilities are reportable to NERC, but those who are must follow strict guidelines to ensure they contribute to the stability of the Bulk Power System.

The NERC Overview training course explains NERC's history and purpose. It also highlight the key roles in the NERC System Operator realm. This online training course focuses on:

- NERC history and general structure
- Real-time functional entity tasks and responsibilities
- Prominent NERC real-time operating standards

NERC Overview is part of the Introduction to NERC training series.

345-03 **PER-006 for Generator Operators**

Generators are critical components of the Bulk Electric System. They are the power source for the various loads on the system. When their output is affected, it can result in instability or System Operating Limits violations. For this reason, NERC issued PER-006 which requires training for generation plant personnel. This training must cover the operational functionality of Protection Systems and Remedial Action Schemes that affect the output of the generating facilities they operate.

The PER-006 for Generator Operators training course explains the operational functionality of Protection Schemes and Remedial Action Schemes. This online course covers:

- Relay protection fundamentals
- Breaker and relay basics
- Zones of protection and relay identification
- Relay control circuits
- Generator fault characteristics and device coordination
- Generator system protection
- Generator backup protection
- Remedial action schemes

PER-006 for Generator Operators is part of the Introduction to NERC training series.

345-10 **FERC Standards of Conduct (SOC)***

A Transmission Provider's employees must function independently from not only the company's marketing affiliates, but also its energy affiliates. Transmission Providers may not treat either their energy affiliates or their marketing affiliates on a preferential basis. The Standards are applicable to both the electric and gas industries. The FERC Standards of Conduct (SOC) was created to ensure this practice is followed.

The FERC Standards of Conduct training course provides the background and guiding principles of the FERC SOC. It discusses how employees in the transmission and marketing areas of a public utility or interstate natural gas pipeline should apply them in day-to-day activities. This online course includes:

- The overall functions of FERC
- FERC SOC expectations
- Rules and requirements
- Independent Functioning Rule
- Transparency Rule
- Implementation requirements

FERC Standards of Conduct (SOC) is part of the Introduction to NERC training series.

350 **System Protection**

350-01 **Elements of System Protection***

System protection is monitoring system parameters to identify abnormal and unacceptable conditions, taking appropriate action, and assessing the action's effectiveness. Monitoring system parameters, identifying abnormalities, and isolating portions of the system under fault conditions requires specialized equipment. Depending on the fault type, the system uses different identification and isolation methods.

The Elements of System Protection training course explains the fundamental principles of system protection. It discusses basic equipment and methods deployed to meet protection principles. This online course covers:

- Protection device and scheme application
- Breaker and relay basics
- Zones of protection and relay identification
- Relay control circuits
- Testing and coordination

This course is part of the Elements of System Protection training series. This course is applicable to NERC standard PRC-001.

350-02 **Types of Protective Relays***

Relay protection technology has changed over the years, but the underlying operating principles are mostly the same. While many makes and models of relays are used, they generally fall into a handful of categories geared toward a specific purpose. Most relays are used in generation and transmission applications. NERC standards PRC-023-04 and PRC-026-2 direct how each relay is applied.

The Types of Protective Relays training course explains the basic operating principles of common protective relays. It describes how they are used in protection systems. This online training course focuses on:

- Protective relay application
- Relay construction basics
- Instantaneous relays
- Time delay relays
- Directional relays
- Differential relays
- Impedance relays

This course is part of the Elements of System Protection training series.

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350-03 **Monitoring System Conditions***

Obtaining raw data about system parameters and making proper decisions from that data requires understanding the methodologies and limitations of the equipment used. Quick and successful system parameter evaluation needs procedures to conveniently compare the parameters to a reference standard. These procedures are directed by NERC standard PRC-002 to ensure availability of adequate disturbance data to analyze BES events.

The Monitoring System Conditions training course explains the purpose of PRC-002. It discusses how system conditions are monitored through the application of per-unit measurement, AC polarity, and basic potential transformer and current transformer construction and operation. This online course highlights:

- Monitoring system conditions in compliance with PRC-002
- Units and phasors
- Transformers and polarity
- Potential transformers
- Current transformers

Monitoring System Conditions is part of the System Protection training series.

350-04 **Disturbance Monitoring Equipment***

Generation, transmission, and distribution systems contain vital components requiring constant monitoring. The North American Electrical Reliability Corporation (NERC) is the agency that defines how those items are monitored. To ensure compliance with NERC standards, all owners and operators must be familiar with Protection and Control requirements as they relate to Distribution Monitoring Equipment (DME) and data reporting.

The Disturbance Monitoring Equipment training course explains why DME is required. It identifies and applies guidelines of applicable NERC standards. It also identifies types and applications of common DME and conducts accurate DME data reporting. This online training course focuses on:

- DME principles
- Major categories of DME
- Operator adherence to NERC guidelines
- Requirements for data reporting and analysis

Disturbance Monitoring Equipment is part of the System Protection training series.

350-05 **Line Protection***

Without reliable transmission capability, generation units throughout the BPS are useless. Transmission lines are highways allowing energy to travel from source to load to support customer demand. As such, protecting these lines is as critical as protecting systems that generate and distribute energy. Protecting these lines depends on:

- Properly loading transmission line relays
- Identifying the characteristics of overcurrent and ground faults
- Recognizing zone of protection and voltage instability protection

The Line Protection training course explains basic power system line relay loadability. It also discusses how to apply various protection methods to isolate faults on those lines. This online course includes:

- Transmission relay loadability
- Overcurrent protection
- Ground fault protection
- Distance relaying
- Voltage instability protection

This course is part of the System Protection training series.

350-06 **Transformer Protection***

Transformers are integral to the transportation of electrical energy through power systems. They can be found at almost every generation facility and transmission substation. Because transformers play an integral role, protection is necessary. Transformer protection can address multiples fault types. Each fault type is protected against with various relaying methods.

The Transformer Protection training course explains the basic construction and protection methods used in transformer protection. This online course focuses on:

- Transformer construction and fault categories
- Thermal and pressure protection
- Overcurrent and ground fault protection
- Differential protection
- Other transformer and shunt connected devices

Transformer Protection is part of the System Protection training series.

350-07 **Pilot Protection***

System protection monitors system parameters to identify abnormal and unacceptable conditions. If one of those conditions occurs, system protection takes appropriate action to avoid any system damage. Time delays are used to ensure coordination between all system elements when a fault occurs. Pilot protection is used to avoid extended system damage by quickly identifying the fault, taking appropriate action, and bypassing the time delay.

The Pilot Protection training course explains the major communication channels used by this protection. It also describes the basic functions of the common pilot protection schemes deployed in power system protection. This online course covers:

- Pilot protection introduction
- Communication channels
- Pilot schemes

Pilot Protection is part of the System Protection training series.

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350-09 **Bus Protection***

Buses provide a connecting backbone for multiple power sources and loads. Almost every major junction in an electrical transmission and distribution system employs a bus to connect multiple lines, feeders, power sources, and loads. Bus protection is crucial.

The Bus Protection training course introduces the six basic substation bus configurations. It also explains the various relaying systems used to protect them. This online course discusses:

- Bus construction and overview
- Bus configuration and zones of protection
- Backup, directional comparison, and fault bus protection relaying
- Current differential bus protection
- High impedance differential bus protection
- Voltage differential bus protection

Bus Protection is part of the System Protection training series.

350-10 **Generator Protection***

Generators are susceptible to a variety of vaults which require different methods of detecting and clearing. Because of the complex nature of generation protection, this course covers six NERC standards. These standards all address fault detection and clearance in frequency, voltage, and composite systems. The six standards are:

- PRC-001-1.1(ii)
- PRC-006-03
- PRC-019-2
- PRC-024-2
- PRC-025-2
- PER-006-1

The Generator Protection training course explains generator protection schemes and NERC standards as they apply to protection methods and requirements. This online course covers:

- Generator fault characteristics and device coordination
- Generator system protection
- Generator backup protection
- Generator relay settings and loadability
- Generator protection relay loadability schemes
- Remedial action scheme simulation

Generator Protection is part of the System Protection training series.

350-11 **System Protection Misoperation***

The stability of the North American Bulk Electric System (BES) relies on protection system performance. From time to time, misoperations occur across the BES and are negated by protection systems of all types. To maintain system stability, technicians and NERC system operators must be familiar with standards relating to misoperation identification and correction.

The System Protection Misoperation training course defines the term misoperation and identifies misoperation conditions. It focuses on:

- Characteristics of system protection design
- Transmission protection system misoperation analysis
- Importance of NERC Standard PRC-004-5(i)
- Protection system misoperation identification and correction

This online course is part of the System Protection training series.

350-12 **Protection Systems Maintenance Programs***

Protection systems serving generation assets, transmission equipment, and applicable distribution circuits must be periodically tested and maintained. This practice ensures the protected assets continually receive the most effective protection. When assets are protected, the Bulk Electric System maintains peak stability. Maintaining protection systems requires technicians to understand terminology, standard compliance, and affected protective equipment.

The Protection Systems Maintenance Program training course identifies system terminology and assets. It discusses how to comply with applicable NERC standards. This online training course explores protection system maintenance:

- Terminology
- Technology
- Fundamentals
- Program types

It also introduces maintenance program practices.

Protection System Maintenance Programs is part of the System Protection training series.

350-14 **General Relay Operations and Categories and Input***

Many different types of events can impact and damage the power system and its equipment. These events often cause the power system to short-circuit or fault. Faults lower or raise voltage beyond acceptable limits and block power flow. Protective relays protect power system equipment from the damage caused by faulted conditions. They also indicate the type of failure that occurred and the location.

The General Relay Operations, Categories, and Input training course explains what protective relays do. It also discusses how the relays operate and defines their unique attributes. This online course covers:

- Protection zones
- Relay sensitivity
- Relay types
- NERC Standards PER-006 and PRC-001

General Relay Operations, Categories, and Input is part of the System Protection training series.

350-15 **Auxiliary Relays***

Auxiliary relays are secondary relays assisting the protection relay. They are used for many purposes. They are often used in parallel with the sensitive primary protection relay to interrupt heavy fault current of long duration. They are also used for:

- Intentional time delays
- Alarm functions
- SCADA communication
- Tripping and reclosing
- Lockout functions
- Triggering communication schemes

The Auxiliary Relays training course names and describes the different types of auxiliary relays. It explains how to interpret the meaning of relay flags and indications. This online training course discusses:

- Purpose of relays
- Relay types
- Alarms and CIP

Auxiliary Relays is part of the System Protection training series.

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› **700** Process Systems and Operations
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350-16 **Fault Analysis, Relay Coordination, and Back-up Protection***

Faults can cause damage to the power system in many ways. The transmission system is constructed to withstand severe faults even when some faculties have been removed for maintenance. The transmission system is resiliently designed to withstand the loss of any single component and some specific multiple components.

The Fault Analysis, Relay Coordination, and Back-up Protection training course focuses on the elements used to identify and analyze system faults. It demonstrates how to interpret the graphic representation of voltage, current, and power vectors and phases. This online training course includes:

- Fault categories
- Fault damage
- Wye and delta configuration
- Neutral fault current
- Communication mediums and schemes
- Relay coordination

Fault Analysis, Relay Coordination, and Back-up Protection is part of the System Protection training series.

350-17 **Breaker Operations***

A well-designed transmission and distribution system uses circuit breakers to protect transmission lines, buses, transformers, and other equipment. Circuit breakers are an integral part of all protection systems. Their correct operation is vital to the reliable delivery of electric power

to homes and businesses world-wide. The rapid interruption of electrical power circuits is an essential function, especially in cases of overloads or short circuits when immediate current flow interruption becomes necessary. Circuit breakers perform this function repeatedly, reliably, and quickly.

The Breaker Operation training course describes circuit breaker components and features. It explains how they operate. It also discusses close and trip functions on a breaker control schematic. This online course focuses on:

- Why a breaker may fail during service and operation
- Various protection schemes used on circuit breakers
- Precautions to take when operating breakers during abnormal events

Breaker Operations is part of the System Protection training series.

350-18 **Protection & Control***

Transmission and distribution systems are safe and reliable. They deliver a great product to homes, industries, and businesses throughout North America. However, these power systems are susceptible to adverse weather conditions, animals, and the general public. When some of these events or conditions infringe on the system, injury to people or damage to property can occur. Protective relaying helps prevent damage and keep the system stable by isolating problems during fault conditions.

The Protection and Control training course describes how operating entities coordinate system protection. It explains different types of protection schemes, including zone configuration, differential, and distance relay. This online training course discusses:

- Protective and auxiliary relays
- IEEE relay numbering system
- Differential protection
- Distance relays
- Overcurrent relays
- Circuit breaker failure
- Communication

Protection and Control is part of the System Protection training series.

350-19 **Protection and Switching**

Faults or fault currents in electric power systems are any abnormal electric current scenario other than serving load. For example, a short circuit is a fault in which current bypasses normal load. An open-circuit fault occurs when a circuit is interrupted by some component failure, opening the normal current flow. In three-phase power systems, a fault may involve one or more phase and ground or may occur between phases.

Voltages that exceed the nominal operating voltage on the system, regardless of cause, are considered overvoltages. Overvoltage conditions can affect the operation of many types of electronic and electrical power equipment, including destruction or catastrophic failures.

The highest priority for electric utilities is personnel and public safety. These entities use switching and tagging to establish safe working conditions. Careful work procedures, including switching orders, are used to perform all work activities in a coordinated manner. Switching orders is a method where all substation and line activities or procedures are carefully written down, approved and implemented.

The Protection and Switching training course is designed for system operators and support personnel. It explains how abnormal power flows may occur on the power system. It also describes how system protection minimizes the impact from these abnormal power flows. This course defines how protective relays are used. It also outlines industry standards associated with basic switching practices. This online training focuses on:

- Power system faults
- Underfrequency relays
- Overvoltage effects
- Overcurrent conditions
- Switching and tagging procedures

Protection and Switching is part of the System Protection training series.

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350-20 Remedial Action Schemes*

Almost all protection and control schemes on the grid today are local. The sensing and tripping takes place in one substation with some schemes using telecommunications between adjacent substations to coordinate the protection. However, as power systems have become more interconnected, more sophisticated schemes are needed. Remedial Action Schemes (RAS) are wide-area schemes that provide automatic actions based on certain pre-set criteria. RAS are designed to detect predetermined conditions and automatically take corrective actions. They are used to help maintain system stability, acceptable voltages, and equipment loading.

The Remedial Action Schemes training course discusses RAS actions and categories. It identifies RAS trigger categories and its limitations. It also compares RAS to synchrophasor-based systems. This online training course covers:

- Underfrequency and undervoltage load shedding
- Automatic corrective actions
- RAS triggers
- Synchrophasor technologies and monitoring

Remedial Action Schemes is part of the System Protection training series.

375 Resource and Demand Balancing

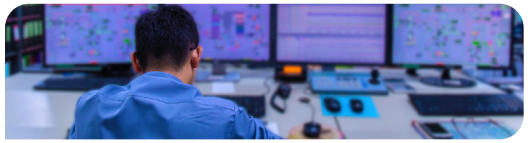
375-01 Real Power Balancing Control Performance

The electric power industry is like no other when it comes to supply and demand. AC electrical power must be produced as it is consumed. The Balancing Authority is responsible for ensuring their area's supply, or generation, matches demand, or load. This lesson explores this balancing concept and the NERC Standard that governs the process. It describes BAL-001, demonstrates calculations using the ACE equation, discussing the Control Performance Standard (CPS1), and explains the function of the Balancing Authority ACE Limit (BAAL).

375-02 Disturbance Control Performance

Within a NERC interconnection, each Balancing Authority, Reserve Sharing Group, and Regional Entity is required to return affected systems to stable levels following disturbance events. Limits are established by a Disturbance Control Standard. Compliance with this standard relies on understanding the terms associated with task performance and the six requirements in the standard.

The Disturbance Control Standard training course explains the requirements for disturbance recovery, what is deemed a Reportable Disturbance. and how Contingency Reserves play a role in disturbance recovery.



375-03 Frequency Response and Bias

One constant in all power systems is the consistent change in loads. From the operation of all laundry equipment in a residential area to machinery in a paper mill, all actions on the customer end result in a change to power system load. Meeting the constantly changing demand requires compliance with the assigned Area Control Error (ACE) through a variety of measures. NERC Reliability Standard BAL-003-1.1 provides a reliable process for delivering the Frequency Bias component used in the ACE equation.

Understanding the Frequency Bias is key to fulfilling generation and load obligations. The Frequency Response and Bias training course explains the basics of Frequency Bias, frequency deviation, and response terminology. It also describes how frequency recovers after a disturbance.

375-05 Automatic Generation Control

After governor systems have arrested and stabilized declining system frequency, the Automatic Generation Control (AGC) system serves to restore frequency to its pre-disturbance scheduled value. System operating personnel must be familiar with NERC's Balancing Authority Control standard which defines requirements for Balancing Authority AGC systems necessary to calculate Area Control Error (ACE) and routinely deploy the Regulating Reserve. Personnel must also be familiar with how AGC systems impact the various system operating positions and the tasks each must perform to ensure ACE is maintained at all levels.

The Automatic Generation Control training course focuses on the requirements necessary for a Balancing Authority to calculate ACE and have AGC ready to dispatch Regulating Reserves as needed.

375-12 Real Power Control Balancing Performance (BAL-001)*

A Balancing Authority Area is part of an Interconnection. There are four Interconnections in North America. Every Balancing Authority Area in the U.S. and parts of Canada are in an Interconnection.

Each generator, every MW of load, and every transmission system operating in an Interconnection must be included in the metered boundaries of a Balancing Authority. A Balancing Authority's goal is to serve energy to homes and businesses within their boundaries in a reliable and safe manner.

NERC reliability standard BAL-001 directs Balancing Authorities to maintain Interconnection steady-state frequency with defined limits by balancing power demand and supply in real time. To maintain this balance, system operators must understand how to calculate the ACE equation and identify the impacts of each component. They must also understand the purpose of Control Performance Standard 1 (CPS1) and Balancing Authority ACE Limit (BAAL).

The Real Power Control Balancing Performance training course discusses the BAL-001 requirements. It outline the components of the ACE equation and its impact on reliability. It also addresses compliance with CPS1 and BAAL. This online course includes:

- ACE fluctuation
- CPS1 calculation data
- BAAL equations

Real Power Control Balancing Performance is part of the Resource and Demand Balancing training series.

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375-13 **Disturbance Control Performance (BAL-002)***

A Balancing Authority works to maintain balance of generation, load, and interchange as calculated by the ACE equation. A Balancing Authority must also be prepared to handle a disturbance which produces an abnormal system condition of under-generation. A disturbance is an unplanned and unexpected generation failure.

The NERC BAL-002 reliability standard ensures the Balancing Authority or Reserve Sharing Group balances resources and demand and returns its ACE to defined values following a Reportable Balancing Contingency Event.

The Disturbance Control Performance training course addresses the BAL-002 standard, Disturbance Control Standard - Contingency Reserve for Recover from a Balancing Contingency Event. It explains the standard and addresses why Balancing Authorities need access to reserve power. This online course covers:

- Most severe single contingency
- Reportable Balancing Contingency Event
- Multiple contingencies
- Reporting requirements

Disturbance Control Performance is part of the Resource and Demand Balancing training series.

375-14 **Inadvertent Interchange (BAL-003/BAL-005)***

Changes in Interconnection generation-to-load balance result in frequency change. If generation exceeds load, frequency will increase. If load exceeds generation, frequency will decrease. Load in the Interconnection is continuously changing. Generation control systems maintain balance in response to these load changes.

Occasionally, generation trips off-line, and Interconnection frequency drops quickly. When this happens, power system reliability depends on quick and automatic response actions. These actions are called Frequency Response.

The Frequency Response, Bias Setting, and Balancing Authority Control training course addresses NERC standards developed to maintain Interconnection frequency within predetermined boundaries. It discusses requirements for acquiring data necessary to calculate Reporting Area Control Error (ACE). It also explains the importance of tracking and maintaining Inadvertent Interchange. This online course includes:

- Governor droop
- Frequency response
- Frequency bias
- ACE data accuracy
- Tie-line metering and flows
- Automatic generation control systems
- Factors causing Inadvertent Interchange

Frequency Response, Bias Setting, and Balancing Authority Control is part of the Resource and Demand Balancing training series.

375-15 **Area Control Error Equation***

One of a Balancing Authority's primary functions is to balance its load and schedule while supporting Interconnection frequency. Area Control Error or ACE is the value a system operator uses to maintain interconnection steady state frequency within defined limits by balancing real power demand and supply in Real-time.

The Area Control Error Equation training course introduces the ACE equation, its various components, and how it is calculated. This online training course discusses:

- How to define, describe, and properly calculate the ACE equation
- Calculating Net Interchange Actual and Net Interchange Scheduled
- Understanding and calculating Actual and Scheduled Frequency
- Causes of Inadvertent Interchange
- Generator reaction due to loss or increase of load within the ACE equation

Area Control Equation is part of the Resource and Demand Balancing training series.

375-16 **Evaluation and Implementation of Interchange Transaction***

Interchange is energy, in MW, that crosses Balancing Authority boundaries. A Balancing Authority must maintain generation-load-interchange balance. A Balancing Authority who generates just enough real power to meet its load will not have interchange. However, if the Balancing Authority overgenerates, MW flow out of its area. If the Balancing Authority undergenerates, MW flow into its area. INT

standards govern the process of buying and selling power within energy markets.

The Interchange Scheduling and Coordination training course explains how responsible entities must conduct a reliability assessment of each Arranged Interchange before it is implemented. It identifies the assessment requirements of each entity involved in an Interchange Transaction. It also describes activities associated with interchange. This online course focuses on:

- Interchange transaction evaluation
- Interchange implementation
- Dynamic transfers
- Interchange initiation and modification for reliability
- Intra-Balancing Authority transaction identification

Interchange Scheduling and Coordination is part of the Resource and Demand Balancing training series.

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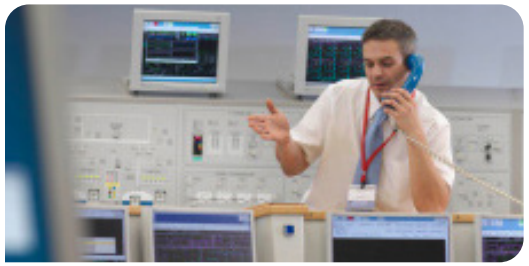
375-17 **Generation***

The key to understanding electric power generation lies in understanding the relationship between electricity and magnetism. Generators work on the principle that by spinning or rotating a magnet in a coil, they can produce a voltage in that coil of wire. Most electric generators depend on spinning turbines to generate electricity.

The Generation training course explains the fundamentals of generation and power plant characteristics. It explores how voltage is produced in a conductor and identifies the role of a turbine in generating electricity. It also discusses the different generation types. This online training course focuses on:

- Active and reactive power
- Governor control
- Types of generation plants

Generation is part of the Resource and Demand Balancing training series.



376 **Communication**

376-01 **Bulk Power System Communication Basics**

Communication is an essential function of maintaining the stability of the Bulk Power System (BPS). One of the most reliable methods of passing information between responsible entities, telecommunications between system operators, is guided by NERC standard COM-001-3. Understanding the 11 requirements of this standard assists system operators in mitigating violation risk factors and applying the basics of how communication affects BPS stability. The Bulk Power System Communication Basics training course explains the three levels of BPS communication as they relate to the system operator.

376-02 **Bulk Power System Communications and Coordination**

The NERC Operating Personnel Protocol Standard (COM-002-4) standardizes the way Operating Instructions are relayed to responsible parties to reduce the opportunity for miscommunication. Miscommunication can cause action or inaction that could be harmful to the reliability of the Bulk Electric System (BES). Communication must be clear, concise, and adheres to documented protocols. The Bulk Power System Communications and Coordination training course describes how to communicate clearly and concisely according to documented protocols using three-part communication and the phonetic alphabet.

376-04 **Communication (COM-001/COM-002)***

System operators must be able to communicate clearly and quickly with field workers and other functional entities. This communication is essential in emergency conditions. To ensure clear and effective information transfer, utilities use three-part communication.

The Communication training course focuses on the typical methods of interpersonal communication. It also discusses the importance of three-part communication in relation to COM-001 and COM-002. This online training course explores:

- Interpersonal communication
- Communication contingency plan
- Communication standards
- Three-part communication

Communication (COM-001/COM-002) is part of the Communication training series.

376-05 **Principles of Synchrophasors***

Modern power system control units use the traditional Supervisory Control and Data Acquisition (SCADA) system to remotely monitor and control grid operations in Real-time. SCADA systems use a centralized control center computer that connects to various remote unit terminals, or RTUs, throughout the power grid control area. A highly reliable telecommunications network interconnects the central computer with each RTU. The RTUs acquire digital and analog information from local sensors, protective relays, equipment status points, and equipment control schemes. This information provides operators with Real-time situational awareness of normal and emergency operating conditions.

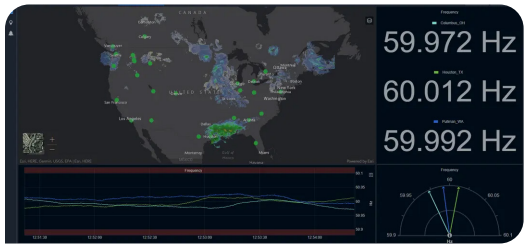
Unfortunately, the information provided by the RTUs is displayed to system operators in a relatively slow asynchronous manner. However, the syncrophasor-based wide area monitoring system (WAMS) technology adds a new dimension to system monitoring, control, and grid stability.

Synchrophasor describes a device or set of devices used to communicate measured substation bus voltage or current magnitudes to the control center in a precise time reference. The synchrophasor is also called a Phasor Measuring Unit (PMU).

The Principles of Synchrophasors training course explains why synchrophasors are an essential asset in several sectors of the electric power industry. It introduces Wide-Area Monitoring concepts. It also describes network infrastructure and operations. This online training course discusses:

- Frequency measurements
- PMU components
- Vectors, phasors, and synchrophasors
- Voltage phase angles and power angles

Principles of Synchrophasors is part of the Communication training series.



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376-06 **Application of Synchrophasors***

Power systems receive many benefits when they use a network of synchrophasors or Phasor Measuring Units (PMUs), phasor data concentrators, and the associated software programs. The main benefit is improved:

- Transmission grid reliability
- Economic dispatch
- Tie-line control
- Automatic generating control
- State estimation
- Distribution automation

These wide area monitoring systems, or WAMS, enhance power system operations and control through modern high speed computer networks that can process detailed and time-tagged senor data. These computers apply robust software analysis tools to recognize undesirable patterns that could lead to system instability. Modern WAMS can process this amount of data much faster, with better results than traditional SCADA systems.

The Application of Synchrophasors training course explains how WAMS use PMU data to provide valuable services to transmission system operators, protective relaying, generation control, distribution automation, and engineering and planning studies. It identifies the various benefits from using synchrophasor technology. This online course covers:

- PMU voltage phase angles
- WAMS protection architecture
- Dispatcher situational awareness
- State estimator and the phasor measurement system
- Wide-area frequency monitoring
- North America synchrophasor initiative

Application of Synchrophasors is part of the Communication training series.

376-07 **Effective Communication Overview***

Understanding effective communication and best practices helps utility personnel prevent possible communication errors. Communication means transmitting a message so the receiver understands exactly what the sender intended. It conveys an image or idea from one mind and develops that identical image or understanding in another. The benefits of an effective communication plan in the power industry are incalculable. 70 to 90% of mistakes are attributed to human error. Many of these errors are communication related.

The Effective Communication Overview training course shows how to develop effective verbal and written communications, practices, and procedures to support the reliability of the bulk power system. It introduces practical methods that can help power professionals improve company safety, reliability, efficiency, and personal potential. It also assists in error prevention through improved communication skills. This online course covers:

- Obstacles to communication
- Three categories of listening
- Barriers to effective communication
- Three-part communication

Effective Communication Overview is part of the Communication training series.

376-08 **Effective Verbal Communication***

Everyone depends on verbal communication to exchange information or instructions. An individual may be responsible for transmitting or receiving information in the form of operating instructions, feedback on operation results, or emergency warnings or instructions. To communicate effectively, sender and receiver must understand the same information.

The Effective Verbal Communication training course discusses effective verbal communication, practices, and procedures across the industry to support reliability. It explains the principles of effective verbal communication to prevent possible loss and errors within the power industry. This online course focuses on:

- Effective face-to-face communication
- Active, passive, and competitive listening
- Communication tools
- Phonetic alphabet
- Three-part communication

Effective Verbal Communication is part of the Communication training series.

376-09 **Effective Written Communication***

Written communication is an important tool in the precise sharing of information. Clearly outlining relative information is an important skills for operators and other personnel.

The Effective Written Communication training course develops effective written communication, practices, and procedures to support BPS reliability. It demonstrates how using the principles of effective written communication helps prevent possible communication errors. This online course discusses:

- The five W's
- Task previews
- Place-keeping technique

Effective Written Communication is part of the Communication training series.

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376-10 **Effective Communication Strategies and Best Practices***

When an organization's leaders, peers, and subordinates reinforce good communication practices through proper feedback and training, employees achieve higher levels of performance. In the power industry, the consequences from poor communication could have costly results and inflict physical harm to both humans and equipment. Every employee plays a critical role in reducing errors in the electric power industry. Yet best practices cannot be developed or followed without the support of their organization. Each organization must support their employees' performance through communication strategies and best practices.

The Effective Communication Strategies and Best Practices training course provides specific techniques employees can use every day. These techniques will help effectively communicate critical information within the work environment. This online course explores:

- Pre-job briefing
- Self-checking
- Shift turnover
- Event analysis
- Communication etiquette

Effective Communication Strategies and Best Practices is part of the Communication training series.

377 Critical Infrastructure Protection

377-01 **CIP Personnel Responsibilities**

Responsible entities and their system operating personnel are tasked with continuous Real-time protection of Cyber Systems. To maximize effectiveness, interconnected systems are expected to follow NERC requirements standardizing Cyber System security plans and training. The CIP Personnel Responsibilities training course explains Critical Infrastructure Protection (CIP) training and planning requirements, and the applicable NERC CIP standards as they apply to maintaining the stability of the BES.

377-02 **CIP Perimeters and Configurations**

Cyber Systems are critical to the reliable operation of the Bulk Electric System (BES), impact the delivery of electricity to end users, and must be protected against a variety of threats. Electronic Security Perimeters manage electronic access to the systems. Specifying configuration change management and vulnerability assessment requirements prevents and detects unauthorized changes that could lead to misoperation and instability.

377-03 **CIP Controls and Management**

Security management controls and how those controls affect system security are regulated by NERC's Critical Infrastructure Protection (CIP) standards, CIP-003-8 and CIP-007-6. The standards require all responsible authorities to adopt methods to protect critical cyber assets (CCA) and devices. The CIP Controls and Management training course discusses how to adhere to NERC compliance measures, identify specific information required by NERC CIP standards, and ensure the protection of critical cyber assets and devices.

377-04 **CIP Related BES Recovery Plans**

While the loss, compromise, or misuse of BES Cyber Systems can be mitigated, it is impossible to ensure 100% reliability. As such, registered entities must be prepared for recovering stability and operability if such an event occurs. Categorizing BES Cyber Systems, then developing and implementing recovery plans helps maintain reliability. The CIP Related BES Recovery Plans training course describes how to categorize BES Cyber Systems according to CIP-002-5 requirements and implement a Recovery Plan meeting the requirements of CIP-009-5.

377-05 **CIP Physical Security**

While protection from cyber attacks has become an increasing concern, there is no substitute for physical security of BES assets and equipment. NERC standards CIP-006-6 and CIP-014-2 are the foundations on which physical security policies and programs are built. These standards address physical security plans for BES Cyber Assets and transmission systems which face constant threat both physically and electronically. The CIP Physical Security training course explains how to comply with the requirements of NERC standards regarding CIP physical security measures.

377-06 **Critical Infrastructure Protection Overview***

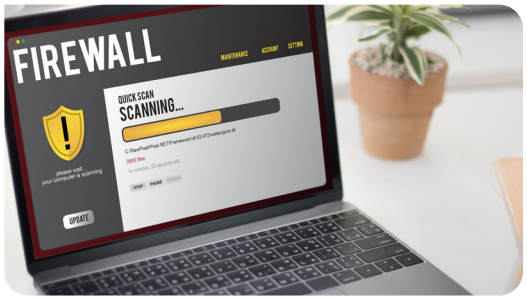
Protecting the BES from cyber attacks is critical to Bulk Electric System reliability. All power industry employees must understand and follow their organization's CIP policies.

The Critical Infrastructure Protection Overview training course introduces students to the security measures established to protect facilities, equipment, and data. These measures help prevent compromise that could lead to misoperation and instability in the BES. This online course discusses:

- Employee expectations
- BES Cyber Assets
- Strategies - Protect, Detect, Defend, and Recover

This course meets the CIP-004 training requirements for staff with CIP unescorted physical and/or cyber access when combined with the other Critical Infrastructure Protection courses.

Critical Infrastructure Protection Overview is part of the Critical Infrastructure Protection training series.



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377-07 CIP Physical and Electronic Access*

The Physical and Electronic Access training course continues the Critical Infrastructure Protection training series. It is mandatory for all power company staff, contractors, and service vendors requiring unescorted physical access to applicable BES Cyber Assets. This online training focuses on:

- Applicable NERC CIP standards
- Physical security plan and physical access control
- Security control methods
- Protection strategy
- Transient Cyber Assets and removable media

This course meets the CIP-004 training requirements for staff with unescorted physical and/or cyber access.

377-08 CIP Incident Response & Recovery, Data Protection, and Risk Management*

The CIP Incident Response and Recovery, Data Protection, and Risk Management training course continues the Critical Infrastructure Protection training series. It is mandatory for all power company staff, contractors, and service vendors requiring unescorted physical access to applicable BES Cyber Assets. This online training includes:

- Applicable NERC CIP standards
- Recovery procedures
- Information protection controls
- BES Cyber Assets reuse and disposal

This course meets the CIP-004 training requirements for staff with unescorted physical and/or cyber access.

378 Emergency Operations Planning

378-01 Emergency Policies and Procedures

NERC's role following a blackout or other major BES disturbance is to provide leadership, coordination, technical expertise, and assistance to the industry in responding to critical disturbance emergencies. Working closely with Regional Entities and Reliability Coordinators, NERC coordinates efforts among industry participants and between, state, federal, and provincial governments across the U.S. and Canada to support a uniform industry response. The Emergency Policies and Procedures training course identifies the actions, processes, and procedures instituted by different levels of NERC system operators to improve emergency response during widespread electric system disruptions.

378-09 Event Reporting and Emergency Operations (EOP-004/EOP-011)*

The power system consists of generation resources and transmission elements which deliver power to the end user. All parameters must be planned and monitored for reliable operations. However, the power system is constantly changing. Change in one element is reflected in other elements or equipment. Emergency conditions can happen suddenly. Entities must monitor critical equipment to ensure reliable operations if a single component fails.

Operating Plans are key to reliable operations. These plans direct system operators on when to issue emergency alerts and potentially shed load in case of a component failure. To prevent future incidents, entities must report events for study and analysis.

The Emergency Operations and Event Reporting training course explains how Transmission Operator and Balancing Authorities develop and coordinate Operating Plans to mitigate operating emergencies. It describes the requirements for reporting events to improve system reliability. It also discusses the related NERC Reliability Standards. This online training course focuses on:

- Operating plans and operating instructions
- Energy Emergency Alerts
- Load shedding plans
- Reportable events
- NERC Standards EOP-004 and EOP-011

Emergency Operations and Event Reporting is part of the Emergency Operations Preparedness training series.

378-10 System Restart from Blackstart and System Restoration Coordination (EOP-005/EOP-006)*

System restoration must be coordinated between entities. Reliability Coordinators are required to have a restoration plan that directs activities among the registered entities in its area. Amon other requirements, this plan must include:

- Strategies for system restoration
- Procedures for restoring interconnections between Transmission Operators
- Identification of blackstart resources

Reliability Coordinators must coordinate efforts to restore the system during a blackout.

The System Restoration Coordination and System Restoration from Blackstart training course explains how to establish plans and prepare personnel to effectively coordinate the system restoration process. It focuses on maintaining reliability during restoration and placing priority on restoring the interconnection. This online course also helps ensure plans, facilities, and personnel are ready to restore the system using blackstart resources. It includes:

- Restoration plans
- Plan review and distribution
- Synchronizing
- System restoration training
- Blackstart resources

System Restoration Coordination and System Restoration from Blackstart is part of the Emergency Operations Preparation training series.

› 100 Safety, Health, and Plant Science
› 200 Mechanical Maintenance
› 300 Electrical Transmission and Distribution
› 400 Electrical Maintenance
› 500 Power Generating Systems and Operations
› 600 Instrumentation and Control
› 700 Process Systems and Operations
› 800 Industrial Machining and Welding
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378-11 Loss of Control Center and Geomagnetic Disturbance Operations (EOP-008/EOP-011)*

The tools and equipment a power company uses to keep the lights on are an integral part of the control center. Power companies must have a plan for continuing operations if their primary control center is unavailable or inoperable.

Geomagnetic disturbances can impact the power system's reliability. During an event, geomagnetically induced currents (GICs) are generated in the earth's surface. They can enter the bulk power system through grounded equipment. GICs can cause problems that lead to a voltage collapse and system blackout.

The Loss of Control Center Functionality/ Geomagnetic Disturbance Operations training course focuses on both challenges. It demonstrates how each entity must have a plan to continue reliable operations if its control center is disabled. It also explains how to mitigate effects of geomagnetic disturbances by implementing operating plans, processes, and procedures. It discusses applicable NERC Reliability Standards. This online course covers:

- Control center contingency plan
- Control center backup functionality
- Geomagnetic disturbances
- Predicting geomagnetic disturbances
- The K-Index
- EOP-008 and EOP-011

Loss of Control Center Functionality/Geomagnetic Disturbance Operations is part of the Emergency Operations Preparedness training series.

378-12 Energy and Weather Event Summary*

Weather has a significant impact on power system operations. Many entities base worst-case scenarios on previous weather events and their demand on generation and load.

The Energy and Weather Event Summary training course reviews the extreme cold weather event in February 2021. This event affected the central U.S. from North Dakota to Texas. The course discusses the impact the weather event had on transmission, generation, and fuel supply in the affected areas. This online course covers:

- Short-term preparations
- Impacts to generation
- Impacts to transmission
- Lessons learned

Energy and Weather Events Summary is part of the Emergency Operations Planning training series.

378-13 Energizing and Restoring the Electric System*

The interconnected electric system is designed and operated to prevent uncontrolled, cascading, or widespread interruptions. However, building and operating an electric system with 100% reliability is impossible. Over the years, several blackouts have impacted the country. General guidelines are to be followed if any part of the interconnected system suffers a partial or complete collapse.

The Identifying and Responding to Blackouts training course demonstrates how quick implementation of organizations' restoration plans is required to ensure the quickest recovery of the electric system. It provides general guidelines for the system operator's responsibilities to restore the system. It also emphasizes the importance of mutual assistance between organizations. This online training focuses on:

- How blackouts occur
- Voltage collapse
- Restoration plan elements
- Blackstart capabilities

Identifying and Responding to Blackouts is part of the Emergency Operations Planning training series.

378-14 Identifying and Responding to Blackouts*

The sequence to restore the electric system includes prioritizing which units to energize first. This prioritization is impacted by the units' size, type, and status just before the blackout. The fossil, hydro, and combustion turbine units online just before the disturbance are the most likely to be restarted if an energizing or cranking path can be re-established within 30 minutes. System operators also must understand the influence of weather and temperature on their generation options.

The Energizing and Restoring the Electric System training course prepares operators and operations staff to perform the steps related to energizing and restoring the system. It reviews the key elements of the Transmission Operator restoration plan. This online training discusses:

- Successful restoration plans
- Blackstart units
- Relay analysis and operation
- Restoration principles and stages
- Blackstart capability plans

Energizing and Restoring the Electric System is part of the Emergency Operations Planning training series.

› 100 Safety, Health, and Plant Science
› 200 Mechanical Maintenance
› 300 Electrical Transmission and Distribution
› 400 Electrical Maintenance
› 500 Power Generating Systems and Operations
› 600 Instrumentation and Control
› 700 Process Systems and Operations
› 800 Industrial Machining and Welding
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378-15 **Performing System Restoration***

Switching operations represent a significant part of the system restoration process. Two strategies may be used to sectionalize the transmission system for restoration, the all open and the controlled operations strategies. For a smooth restoration, operators must manage proper frequency and voltage control. This management helps synchronize areas during restoration

The Performing System Restoration training course covers concepts related to restoration. It prepares operators and operations staff to determine the best switching strategies for restoration. It also outlines components for an efficient restoration process. This online course discusses:

- Switching strategies
- Voltage control and Ferranti rise
- Synchronizing and stability
- Generation

Performing System Restoration is part of the Emergency Operations Planning training series.

378-18 **Blackout Events***

Power blackouts have been making headlines for years. While many people remember the headlines, few are aware that most blackouts also had a powerful effect on the operation of the power grid.

The Blackout Events training course reviews the most historic blackouts in North American history and focuses on each of their individual causes and resolutions. It also discusses the rules and regulations established to prevent similar incidents. This online course discusses:

- The Great Northeast Blackout of 1965
- New York City Blackout of 1977
- The Hydro-Quebec Blackout of 1989
- The Great Northeast Blackout of 2003
- The South Florida Blackout of 2008
- The Southwest Blackout of 2011

Blackout Events is part of the Emergency Operations Planning training series.

378-19 **Geomagnetic Disturbances***

Geomagnetic disturbances (GMD) are caused by activity on the face of the sun. Sunspots or solar flares can produce coronal mass ejections which can induce electric currents within the earth and on high-voltage lines. These currents can flow up from the earth or down into the earth through grounded equipment, usually transformers. System operators should understand GMDs because they can impact the power system's reliable operations. They should also understand how terrain absorbs or conducts them.

The Geomagnetic Disturbances training course provides an overview of solar weather. It defines the causes of a GMD and identifies its effects on the transmission system. It also explains the GMD Operating requirements as outlined by NERC. It demonstrates how to interpret critical space weather information and mitigate space weather impacts in compliance with NERC's EOP standard.

This online course outlines the requirements in a GMD Risk Assessment. NERC allows utilities to adjust GMD operating procedures based on region-specific variables. The course provides an overview of this process and identifies areas at risk.

Geomagnetic Disturbances is part of the Emergency Operations Planning training series.

381 Interconnection Reliability Operations and Coordination

381-05 **Reliability Coordination – Planning and Operations**

Reliable operation of the Bulk Power System (BPS) requires multiple stages of planning and action to ensure customer demand is met as intended. These stages consist of planning, design, construction, operation, maintenance, and restoration. The Reliability Coordination - Planning and Operations training course is designed to focus on planning and operations of individual elements of the Bulk Electric System so each operates in a stable and reliable manner. This online course describes the role each Responsible Entity is expected to fulfill as a participant ensuring Reliability Assurance so the Interconnection is operated in a reliable manner.

381-06 **Coordinating Entities and Duties**

All NERC system operators and their subordinate entities are responsible for specific tasks when coordinating and conducting transactions between power systems. NERC provides guidance detailing the roles and responsibilities of each Functional Entity, and how those entities work together to maintain Bulk Electric System stability. The Coordinating Entities and Duties training course identifies the authority, plans, agreements, and responsibilities of the four NERC system operator classes. Additionally, it defines the roles of Generator Operators (GO), Transmission Service Providers (TSP), Purchasing-Selling Entities (PSE), and other major reliability entities.

- **100** Safety, Health, and Plant Science
- **200** Mechanical Maintenance
- **300** Electrical Transmission and Distribution
- **400** Electrical Maintenance
- **500** Power Generating Systems and Operations
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- **700** Process Systems and Operations
- **800** Industrial Machining and Welding
- **Instructor-led Training**
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381-07 Reliability Coordinator Responsibilities (IRO-001/IRO-008/IRO-009)*

Maintaining reliability in an interconnected power system is a complex task. Events in one part of the system can influence operations in all other parts of the system. Because owning and operating responsibilities are spread among many entities, operating reliably becomes an even greater challenge. It requires cooperation and information exchange. Reliability Coordinators were first established to act in the best interest of reliability for the overall Reliability Coordinator Area and Interconnection before the interests of any other entity.

The Reliability Coordinator Responsibilities training course outlines the responsibility of the Reliability Coordinator to act or direct others to act to ensure reliability. It discusses how to ensure coordinated activity between Interconnections when implementing transmission loading relief procedures to prevent or manage system events. It also describes analyses Reliability Coordinators perform to manage system reliability. This online course focuses on:

- Wide-area view
- Responsibilities and authorities
- Interconnected power system stability
- Operating limits
- Real-time assessments
- IRO-001, IRO-006, IRO-008, and IRO-009

Reliability Coordinator Responsibilities is part of the Interconnection Reliability Operations and Coordination training series.

381-08 Reliability Coordinator Data Needs (IRO-002/IRO-010/IRO-014/IRO-018)*

Bulk Electric System conditions can change instantly. The Reliability Coordinator's job is to continuously check power transmission reliability. It must also make sure emergency actions are coordinated between the entities in its operating area and beyond. Without enough information from these entities, the Reliability Coordinator can't do their job properly. Standards IRO-002, IRO-010, and IRO-018 specify the data needed to monitor and assess the Reliability Coordinator Area.

The Reliability Coordinator Data Needs training course explains what type of data the Reliability Coordinator collects from the different entities in the area. It makes sure the Reliability Coordinator has the right tools and technology to quickly analyze the data and make smart decisions. It also addresses data quality for real-time monitoring and analysis. This online training course includes:

- Data collection
- Analysis tools
- Data specification and examples
- Operating procedures
- Coordination between Reliability Coordinators
- IRO-002, IRO-010, IRO-014, and IRO-018

Reliability Coordinator Data Needs is part of the Interconnection Reliability Operations and Coordination training series.

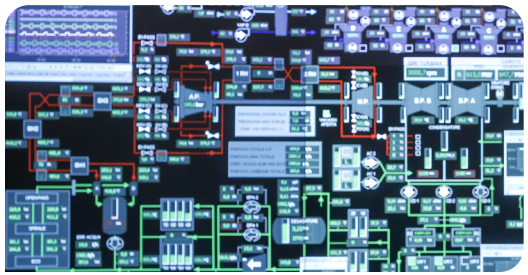
387 System Operations

387-01 Energy Production and Transfers

Energy production and transfer are two basic elements of power system operations. Electrical energy is normally produced at generating plants, then transmitted to support contract customer load or sold to other public utilities to assist them in meeting their customer load requirements. The Energy Production and Transfers training course identifies the elements associated with the production and transfer of energy in power systems.

387-02 Transmission Operations

Transmission systems are the medium by which power is moved various distances from generation to load. Understanding this complex system requires an understanding of basic elements of a power grid, standardized transmission voltages, load characteristics, and reactive power control. The Transmission Operations training course describes the fundamentals and basic control strategies of transmission systems.



387-03 Economic Power System Operations*

Bulk Electric System stability relies on the system operator's ability to maintain a balance of efficient and economic power generation, transmission, and distribution. System operators must:

- Be familiar with types of system costs incurred
- Know how to efficiently load available generation types
- Understand transmission losses
- Know when to exchange power across borders.

The Economic Power System Operations training course identifies system conditions contributing to or negatively impacting stable operations and generation unit loading. This online course explains:

- Fixed versus variable cost
- Efficient generating unit operations
- Non-thermal cost variation
- Transmission line effects on generation cost
- Economic power interchange

Economic Power System Operations is part of the System Operations training series.

› 100 Safety, Health, and Plant Science
› 200 Mechanical Maintenance
› 300 Electrical Transmission and Distribution
› 400 Electrical Maintenance
› 500 Power Generating Systems and Operations
› 600 Instrumentation and Control
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387-04 **Power System Control Elements**

Controlling power systems is a critical task of every system operator requiring an understanding of certain elements. As a collective, system operators must grasp the fundamentals of system control, demonstrate an ability to control Bulk Electric System frequency, and operate the interconnected system while accounting for system error values. The Power System Control Elements training course discusses elements required to control Power Systems within defined parameters.

387-05 **Interconnected Energy Accounting***

Sharing power between two or more systems has become common practice in modern interconnected settings. Because power production and transmission cost money, accounting for factors such as quantity and time is necessary to understand:

- Energy accounting fundamentals
- How meters work
- Categories of interchange
- How to account for transferred energy

The Interconnected Energy Accounting training course identifies the basic concepts associated with accounting for energy transferred between two power systems. This online course discusses:

- Energy accounting fundamentals
- Meter connections and energy measurement
- Interchange negotiations
- Energy accounting between interconnected systems

Interconnected Energy Accounting is part of the System Operations training series.

387-07 **Supervisory Control and Data Acquisition (SCADA) Systems***

The reliable operation of the modern Bulk Electric System depends on the system operator's ability to monitor and control equipment and facilities located great distances from the control center. To do so, companies rely on Supervisory Control and Data Acquisition (SCADA) systems. Successfully operating SCADA systems requires an understanding of all the control and communication functions.

The Supervisory Control and Data Acquisition (SCADA) Systems training course identifies the basic control and communication functions performed by the system's Master Units and Remote Terminal Units. This online course covers:

- SCADA fundamentals
- Control, supervision, and communication
- SCADA operation
- SCADA operations logging and supporting applications

SCADA Systems is part of the System Operations training series.

387-11 **Basics of Power System Operations***

System operators must control current and voltage flow in the power system while maintaining generation-load-balance to ensure reliability. They must understand a power system's components and the interactions of various components in the largest machine ever made, the Bulk Electric System.

The Basics of Power System Operations training course reviews the basic concepts of the power system. This online course focuses on:

- Monitoring and analyzing operating data to maintain a stable and reliable power system
- Identifying potential areas of risk and preparing for credible contingencies
- Understanding how generation, transmission, equipment, and load affect power flow

Basics of Power System Operations is part of the System Operations training series.

387-12 **Human Performance for System Operators***

Human Performance is about outcomes. It is the science of understanding how to measure outcomes, then using the information to improve potential. It consists of two basic measures:

- What a person is trying to do
- How they are trying to do it

More simply put, behavior plus the conditions, equals the outcome.

The Human Performance for System Operators training course identifies the role Human Performance plays in system operations and explores how it can improve training. It discusses how to analyze application of Human Performance measures in training It then shows how to integrate this analysis into training development. This online training course includes:

- Introduction to Human Performance
- Measuring Human Performance
- Understanding Human Performance data
- Responding to Human Performance data
- Improving Human Performance

Human Performance for System Operators is part of the System Operations training series.

› **100** Safety, Health, and Plant Science
› **200** Mechanical Maintenance
› **300** Electrical Transmission and Distribution
› **400** Electrical Maintenance
› **500** Power Generating Systems and Operations
› **600** Instrumentation and Control
› **700** Process Systems and Operations
› **800** Industrial Machining and Welding
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387-13 **Renewable Energy Integration***

The U.S. Department of Energy notes that renewable generation became the second largest generation sector in 2020. It's share of the mix will likely grow with policy changes to reduce reliance on fossil fuels. Changes in renewable technology need to occur more rapidly as the share of this generation increases and lessons are learned. Additionally, changes in customer load technology make it more sensitive to reliability problems. Variable generation, such as wind and solar, requires development of new forecasting techniques with better accuracy and shorter time periods.

The Renewable Energy Integration training course details characteristics and major challenges of integrating renewable resources. It discusses mitigating actions for those challenges and future changes. It also provides NERC and industry resources related to renewable energy challenges. This online course focuses on:

- Forecasting challenges
- Wind generation challenges
- Solar generation operations
- NERC Standard PRC-024 and IEEE Standard 1547-2018

Renewable Energy Integration is part of the System Operations training series.

387-14 **Solar, Hydro, Tidal, Geothermal, and Variable Generation***

Since the beginning of power systems, demand has been variable. Generation operators dispatch generation to meet demand. When generation balances demand, system frequency is stable. The advent of renewable energy and distributed energy resources (DER) introduces variable generation, which interferes with the control of load balance.

The industry change to renewable resources imposes various technical challenges. Most critical challenges relate to the amount of variable generation on the grid. Renewable energy variable generation resources come in two categories: large wind and solar farms connected to the transmission grid and DER resources connected to the power distribution system.

DER represents a shift in new generation from large power plants connected to load centers via high voltage transmission lines to smaller renewable energy resources delivered through the distribution system or close to actual load centers.

The Solar, Hydro, Tidal, Geothermal, and Variable Generation training course discusses these renewable energy resource types, trends, and benefits. It also explores the challenges they place on power grid reliability. This online course focuses primarily on solar resources with secondary renewable resources included for completeness. Wind resources are covered in a separate course.

Solar, Hydro, Tidal, Geothermal, and Variable Generation is part of the System Operations training series.

387-15 **Wind Generation***

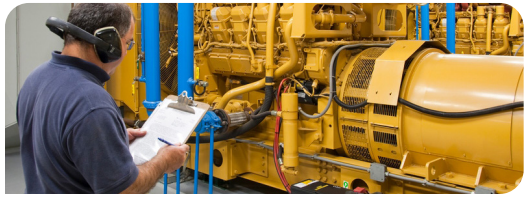
Electric power systems across the world are transitioning to carbon-free renewable energy resources. Although many systems remain fossil fueled, the trend is toward renewable resources. Wind is one of the primary renewable energy resources. While wind is a clean resource, it does have some challenges.

Wind facilities are an intermittent and somewhat unpredictable resource. They cannot provide capacity or voltage support on demand, although they can be curtailed for reliability. During normal operations, wind sites can usually operate to their maximum capabilities for available wind speeds. Wind generation cannot deliver capacity or voltage support on demand. However many wind sites have capacitors and reactors that help control voltage.

The Wind Generation training course describes how local wind characteristics, turbine design, and resulting functionality create a usable renewable energy resource. It explains the major components of wind turbines and farms. It also provides lessons learned from wind system disturbances and explores how to improve system reliability. This online course explains:

- Wind speed
- Altitude and temperature impacts
- Control modes
- Lessons learned

Wind Generation is part of the System Operations training series.



387-16 **Operations Planning, Monitoring Analysis (TOP-002, TOP-003, TOP-010)***

The Operations Planning NERC Reliability Standards ensure the bulk power system is planned to operate reliably. Planning is required for pre- and post-contingency conditions. Pre contingency conditions are normal operations with known or expected conditions, such as outages, load, and in-service elements. Post-contingency is the anticipated failure of an electrical system, also called N-1.

The NERC standards intent is also to ensure Real-time Assessments contain enough details to result in an appropriate level of situational awareness. The assessment data is used to assess conditions, make decisions in real-time, and plan. Other NERC standards require documented specification for the data needed to perform Operational Planning Analysis, Real-time monitoring, and Real-time Assessments. This specification assures real-time data and analysis capabilities are accurate and support reliable system operations.

The Operations Planning and Monitoring Analysis training course ensures Transmission Operators and Balancing Authorities have plans for operating within specific limits. It describes the data needed to fulfill their operational and planning requirements. It also explores the requirements for Real-time monitoring and analysis capabilities to support reliable system operations. This online course discusses:

- Operations planning
- Situational awareness
- Operational reliability data
- Monitoring equipment and system conditions
- NERC Standards TOP-002, TOP-003, and TOP-010

Operations Planning and Monitoring Analysis is part of the System Operations training series.

› **100** Safety, Health, and Plant Science
› **200** Mechanical Maintenance
› **300** Electrical Transmission and Distribution
› **400** Electrical Maintenance
› **500** Power Generating Systems and Operations
› **600** Instrumentation and Control
› **700** Process Systems and Operations
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387-17 **Transmission Operations (TOP-001)***

A transmission system provides paths for energy to travel from generators to customers. It also interconnects power systems. Transmission system equipment is rated by the Transmission Owner. These equipment ratings are the starting point for network models to establish System Operation Limits (SOL).

The transmission system supports power flows from multiple generating systems to millions of loads. These transmission paths are interconnected to form a network across a widespread area on which power flows to meet load demand. Heavy power flows and unscheduled power flows can cause equipment to exceed their System Operating Limits and Interconnection Operating Reliability Limits (IROL). A system operator's job is to maintain equipment within operating limits. They have the authority to take timely and appropriate actions to mitigate SOL or IROL violations.

The Transmission Operations training course explores NERC standard TOP-001 which prevents instability, uncontrolled separations or cascading outages. It explains Operating Instructions and the roles of the related entities. It also discusses why Transmission Operators must keep their systems within operating limits (SOL and IROL). This online training course focuses on:

- Equipment ratings
- SOLs and IROLs
- Violations
- Operating emergencies
- TOP-001

Transmission Operations is part of the System Operations training series.

387-18 **Power System Concepts***

Transmission and distribution systems are critical to meet demand reliably. Generating stations, or power plants, produce electrical energy that is delivered to consumers through transmission lines, substations, and distribution lines. Very high voltage transmission lines transport bulk electrical energy to distribution substations. These substations transform the power received to levels more suitable for distribution to industrial, commercial, and residential consumers. They also provide means for system protection, voltage regulation, and communication to the system control center. System operators must understand this process and how everything works together to manage the power system successfully and reliably.

The Power System Concepts training course introduces power transmission systems. It reviews basic terminology and fundamental concepts. It also explains electrical load characteristics including resistive, inductive, and capacitive electrical load and utilization. This online course provides an overview of bulk power systems featuring:

- Power plants
- Transformers
- Regulators
- Circuit breakers

Power System Concepts is part of the System Operations training series.

387-19 **Transmission and Distribution Operations***

An Energy Management System (EMS) provides advanced software programs that serve as tools for control operators, management, and engineering. The EMS uses SCADA as its critical driver of information and control functionality. The EMS often controls equipment remotely to help ensure reliability.

Motors, load, and power factor are important components for transmission and distribution operations. Commercial and industrial loads often run into low power factor issues. These problems can lead to using too much power from the utility, rising operating expenses, and decreasing service ability. All these challenges can lead to abnormal operations.

Efficiently handling operations during abnormal conditions begins with a deep understanding of key situation indicators such as:

- Critical events
- Workforce arrangements
- Standard procedures
- System tools
- Safety awareness

Emergency situations place everyone in dynamic settings. Areas of intensity and concern are constantly changing. Personnel must deal with several things happening at once.

The Transmission and Distribution Operations training course outlines EMS and SCADA control of substation equipment and field devices. It identifies power needs and how motors meet those needs. It also demonstrates how to calculate power factor and power factor correction. Finally, it describes how to apply a systematic process to addressing abnormal conditions. This online course focuses on:

- Energy management systems
- Equipment
- Power factor
- Abnormal conditions

Transmission and Distribution Operations is part of the System Operations training series.

387-20 **Emergency Response Application with Simulation***

The power system is made up of various components that work together to produce and deliver electrical energy. When any of these components break down, emergency conditions can occur. Different emergency conditions threaten reliability. Real-time operators must be ready to respond to these conditions.

NERC defines emergencies as any abnormal system condition that requires automatic or manual action to prevent or limit generation or transmission failure. A control room losing its ability to perform its intended functions is another type of emergency.

The Emergency Response Application with Simulation training course identifies how to respond to emergencies, including blackstart restoration, load shed, and loss of control center functionality. It explains the purpose and limitations of the transmission system. It also outlines the actions to relieve reliability threats and limit violations. This online course includes:

- Emergency identification
- Emergency response
- System restoration

Emergency Response Application with Simulation is part of the System Operations training series.

› **100** Safety, Health, and Plant Science
› **200** Mechanical Maintenance
› **300** Electrical Transmission and Distribution
› **400** Electrical Maintenance
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387-21 Transmission Stations and Switchyards*

A substation's function and purpose is to contain devices for switching transmission and distribution system equipment, transforming voltages, and providing a source for customer power. Different types of substation equipment help make the connection from generation to customer. A substation's location on the grid determines the type of equipment used to transport electricity.

Control and communication of station equipment is in a substation's control building. Batteries are the primary source of control power for station equipment. SCADA is the communication link between the substation and system operator.

The Transmission Stations and Switchyards training course explains a substation's function. It discusses the differences between generation, transmission, distribution, and customer-owned substations. It also identifies substation controls and communication. This online course covers:

- Substation functions
- General system substations
- Substation control buildings

Transmission Stations and Switchyards is part of the System Operations training series.

387-22 Transformer Principles*

Many types of transformers are used in electric power systems. These types include power transformers, step up transformers, step down transformers, and substation transformers. Transformer functions and operations are related to their location and placement in electric stations. They can act as instrument transformers, regulating transformers, or place shifting transformers.

Two physical laws explain the theory of transformer operations. One law has to do with generating a voltage from a changing magnetic field. The other has to do with a current flowing through a wire creating a magnetic field. Both physical laws are used throughout the entire electric power system from generation through transmission, distribution, and consumption.

The Transformer Principles training course provides an overview of these physical laws. It explains a transformer's basic function and operation. It also identifies transformer relays, detector devices, and alarms. This online training course covers:

- Transformer construction and components
- Transformer cooling ratings
- Protection monitoring and control equipment

Transformer Principles is part of the System Operations training series.

387-23 Circuit Breakers and Disconnects*

A circuit breaker interrupts current flow in a line, transformer, or other equipment. It performs this function either when problems occur or when isolating equipment maintenance or system switching. Circuit breakers are triggered to open or close through the protective relaying equipment operated by control switches and SCADA. Unlike fuses, circuit breakers can open and close repeatedly.

A circuit breaker's opening and closing is based on its design and type. Its type is determined by the insulation medium used to extinguish the arc when contacts are open. The most common types of dielectric medium used to extinguish the arc inside the breaker interrupt are:

- Clean mineral oil
- SF6 or sulfur-hexafluoride gas
- Vacuum
- Air

The Circuit Breakers and Disconnects training course explains basic circuit breaker functions. It identifies different types of circuit breakers and their relaying and protection. This online course includes:

- Overcurrent relays
- Solid state relays
- Current relays
- Switches

Circuit Breakers and Disconnects is part of the System Operations training series.

387-24 Transmission Lines, System Protection, and Monitoring and Control*

Transmission system is a function, not just lines or voltages. The primary function of transmission systems is linking generation and distribution systems by delivering electric power long distances between two points. Transmission lines have been used since the development of AC systems beginning around 1885. In 1895, Westinghouse built a power system at Niagara Falls. The 25-mile power transmission system went from the Niagara power house to Buffalo, NY. Transmission line development has expanded rapidly since then. More than 500,000 miles of transmission lines serve over 90,000 MWh of electricity annually to 145 million customers in the U.S.

Instrument transformers are current and voltage transformers used to scale down actual power system quantities for metering, protective relaying, and/or system monitoring. Application of both current and potential transformers provides scaled down quantities for power and energy information. Instrument transformers include current transformers and potential transformers.

The Transmission Line, System Protection, and Monitoring and Control training course provides an overview of transmission lines. It describes their basic functions and characteristics. It also describes transmission station protection, monitoring, and controlling equipment, including types of instrument transformers. This online training course focuses on:

- Transmission system losses
- Transmission system stability
- System protection equipment
- One-line diagrams
- Load tap changers

Transmission Line, System Protection, and Monitoring and Control is part of the System Operations training series.

› **100** Safety, Health, and Plant Science
› **200** Mechanical Maintenance
› **300** Electrical Transmission and Distribution
› **400** Electrical Maintenance
› **500** Power Generating Systems and Operations
› **600** Instrumentation and Control
› **700** Process Systems and Operations
› **800** Industrial Machining and Welding
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* NERC CEHs are available for qualified operators. Courses taken to fulfill NERC CEH requirements must be indicated at time of purchase.

387-25 **Distribution and Shift Factors***

A system operator must manage the flow of power from generators across the transmission system to the loads. This management includes

- How power flows on the transmission system
- The disturbance results
- What actions are required to manage the instantaneous flow of electricity

The Distribution and Shift Factors training course demonstrates how system operators keep the system within its System Operating Limits by using distribution and shift factors. It explores the tools used to assist a system operator in maintaining a reliable BES. This online training course discusses:

- Power flow management
- Congestion relief
- Power transfer distribution factors
- Outage transfer distribution factors

Distribution and Shift Factors is part of the System Operations training series.

387-27 **Contingency Analysis Application with Simulation***

Contingency analysis is a process which identifies emergency impacts and N-1 Violations. A NERC-certified system operator must know contingency analysis tools and response. They should also recognize limit exceedances.

An Operational Planning Analysis projects what might happen under a set of contingencies. It provides awareness to predict power system operations.

Since events and overloads can occur instantaneously, a system operator probably won't react fast enough. Therefore, system operators need to predict what may happen in Real-time operations.

The Contingency Analysis Application with Simulation training course summarizes and applies contingency analysis to a power system. It explains how to interpret actual and contin-gency reliability analyses to determine what might happen. It also identifies how to operate within System Operating Limits. This online course features:

- Contingency analysis knowledge area
- Operational planning analysis
- Real-time assessment
- Contingency analysis tasks

Contingency Analysis Application with Simulation is part of the System Operations training series.

387-29 **Advanced Human Performance for System Operators***

Many Human Performance tools have been developed since the field gained popularity. While details surrounding the development of any Human Performance tool is often lost to history, they were probably born of necessity. System operators are encouraged, and sometimes mandated, to use Human Performance tools to reduce errors. Many entities implement Human Performance training and embed Human Performance tools and processes into plans and procedures.

The Human Performance for System Operators: Advanced Concepts training course is an extended review of the human condition. It addresses several NERC Lessons Learned examples. These examples are discussed as scenarios to address potential problems, contributing factors, and tools available to help correct issues.

Human Performance for System Operators: Advanced Concepts is part of the System Operations training series.

387-30 **Overview, Interconnected Power System Operations***

Energy causes things to happen around us and exists in many forms. The definition of energy is the ability to do work. As this course explores the power behind the switch, the focus is on the energy we rely on to perform countless day-to-day tasks. This energy is produced, transported, and delivered as electricity across the electric power system.

When a light is switched on, it uses the electric power system. A power plant generates that electricity. Electrical power travels along wires to the house. Turning on the light switch channels that electricity to the light bulb.

The Interconnected Power System Operations Overview training course introduces power system fundamentals. It explains how the power system provides electric power to the people. It shows the breadth of the electrical power system. It also describes the components and basic principles that go into the electricity people enjoy daily. This online training course discusses:

- Power delivery system
- Generating electricity
- Transmitting electricity
- Interconnected power systems
- Balancing load

Interconnected Power System Operations Overview is part of the System Operations training program.

387-31 **Transmission, Substations, and System Protection***

Power is generated, transmitted, and delivered when it is needed. After it is produced at power plants, it must be delivered to the end user. Delivery happens through various methods including high-voltage transmission systems, lower voltage transmission lines, distribution lines, insulated underground cables, and pipeline cables. Our country is crisscrossed with power lines that carry electricity.

The Transmission, Substations, and System Protection training course discusses how electricity moves through transmission lines by looking at their characteristics. It defines normal operating conditions and contingency operations. It also identifies events that affect voltage and system reliability. This online course includes:

- System operating limits
- Surge impendence loading
- Constraints and congestion
- Substation functions and equipment
- Voltage and power control equipment
- Equipment protection

Transmission, Substations, and System Protection is part of the System Operations training program.

› **100** Safety, Health, and Plant Science
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387-32 Control Center Operations and Governance*

An energy management system (EMS) is a system of computer-aided tools electric grid operators use to monitor, control, and optimize performance of the generation and/or transmission system. The system is known as SCADA while the optimization packages are often referred to as advanced applications.

Operators must continuously monitor their system and respond to alarms and possible contingencies. For each problem the operator identifies, they need to have a plan to respond should the given contingency occur. System operators must have a backup approach for planning assessments if any of the EMS tools fail.

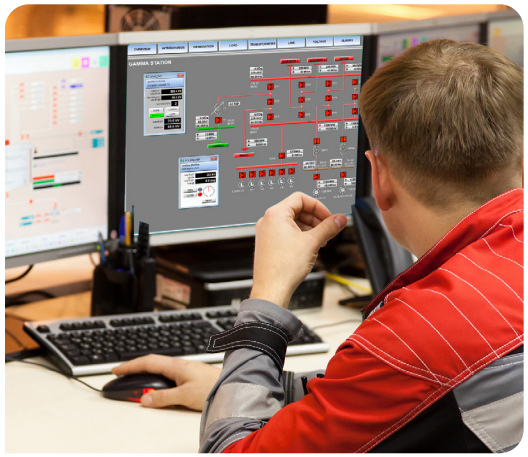
The Control Center Operations and Governance training course explains how power systems are controlled and operated 24 hours a day, 365 days a year. It identifies the tools used for operations. It also outlines the challenges operators face when operating a safe and reliable power system. This online course covers:

- SCADA
- Contingencies
- FERC and NERC
- Reliability Functional Model

Control Center Operations and Governance is part of the System Operations training program.

387-33 Basic Electricity Concepts for System Operators (1 CEH)

NERC System Operators are charged with the safe and reliable operation of the North American bulk power system. This charge requires extensive training in all aspects of electrical power generation, transmission, and distribution. The basic concepts of AC and DC electrical power provide a foundation of knowledge for all current and future system operators. The Basic Electricity Concepts for System Operators training course explains the fundamental concepts of electricity and magnetism as they relate to voltage in the bulk power system. It also describes how capacitance, inductance, and impedance relate to real and reactive power.



387-34 Transmission applications with Simulation*

Transmission lines are electricity's highways. The transmission system connects load to generation. To meet customer demand, the power transportation system must be analyzed using characteristics and path limits.

System operators must be concerned with Real-time loading and potential or contingent loading of power system equipment. Transmission lines, transformers, and other equipment have System Operating Limits. If a system operator experiences an overload or expects to exceed an operating limit, they should have an Operating Plan.

When an undesired power flow occurs, protective relays detect undesired conditions and initiate operations to protect equipment.

The Transmission Application with Simulation training course explains the complex system of energy transmission. It describes how to protect the transmission system by isolating problems to minimize equipment damage. It then applies the concepts to specific situations using simulation. This online course covers:

- Transmission system
- Transmission elements
- Operating limits
- Protection
- Transmission exercises

Transmission Application with Simulation is part of the System Operations training series.

387-35 Math for System Operators*

Mathematics is critical to understanding and operating the power system. Data that represents various electrical properties is used to determine the power system's status. This data is often combined with other data. It is then scaled, adjusted, or otherwise processed using mathematics to provide useful information to the system operator.

The Math for System Operators training course explains principles for power system calculations. This online course discusses:

- Basic math principles
- Calculating Net Interchange and bus sums
- Calculating transformer voltages using ratios
- Using averages to calculate load forecasts and average MVA loading
- Calculating MVA using the power triangle, exponents, and roots

Math for System Operators is part of the System Operations training series.

388 Active and Reactive Power

388-01 Active and Reactive Power Fundamentals

One of the most critical elements of a Bulk Electric System is controlling active and reactive power flow. This control requires understanding fundamental power concepts, the relationship between angles, equations demonstrating flow values and directions, and the factors affecting both active and reactive power flow. With basic concepts explained, one can more readily identify power transfer limits and distribution factors critical to system stability. The Active and Reactive Power Fundamentals training course identifies fundamental concepts of active and reactive power, angle relationships, and the factors affecting power flow values.

* NERC CEHs are available for qualified operators. Courses taken to fulfill NERC CEH requirements must be indicated at time of purchase.

388-02 **Active and Reactive Power Limits and Flows**

Reliable power system operations require an understanding of both power flow and power transfer limits. The limits discussed in this course directly impact the flow of active and reactive power from generation, across transmission lines, to a load. To understand flow, system operators must understand and be able to differentiate between voltage, stability, and thermal limits. The Active and Reactive Power Limits and Flow training course identifies both active and reactive power flow values and explains how to differentiate between voltage, stability, and thermal limits.

388-08 **Reactive Power Fundamentals***

Voltages vary throughout an interconnected power system. While frequency is controlled by the amount of generation meeting the demand or load, voltage control is local. Voltage can be critically low in Missouri and extremely high in North Carolina at the same time. The main reason for the variation in system voltage is the availability of reactive power. Either too much capacitive reactive power is making the voltage high or not enough is making the voltage low.

The Reactive Power Fundamentals training course discusses the challenges associated with reactive power and its impact on voltage control. It describes reactive power resources, including what they are and how they are monitored, controlled, and maintained. It also explains the impact of transmission lines and varying generator reactive power output on power system voltage control. This online course focuses on:

- Real and reactive power
- Sine waves
- Phase angle
- Capacitive reactance
- Inductive reactance
- Reactive power losses

Reactive Power Fundamentals is part of the Active and Reactive Power training series.

388-09 **Reactive Power Production Equipment***

Most power generators used in today's power system are turbine generators. They convert mechanical energy to electric energy. Turbine generators used in power systems are synchronous generators. They can product real and reactive power at the same time. These synchronous generators get the excitation for their reactive power from another power source known as an exciter.

The generator produces its own reactive power and, with a voltage regulator, regulates its own voltage. In addition to synchronous generators, the follow equipment produces and controls reactive power in today's power system:

- Power transformers
- Shunt capacitors
- Series capacitors
- Static var compensators
- Shunt reactors
- Series reactors
- Transmission lines

The Reactive Power Production Equipment training course explains reactive power and its role with voltage stability. It describes the equipment used to help maintain transmission system reactive power control and voltage stability. This online training course discusses:

- Synchronous generators
- Power system stabilizers
- VAR-002

Reactive Power Production Equipment is part of the Active and Reactive Power training series.

388-10 **Reactive Power Control Scenarios***

Real and reactive power losses on transmission lines must be included when considering voltage collapse. Power voltage, or P-V curves, and reactive voltage, or Q-V curves, are tools that show the relationship between voltage at the receiving bus and real and reactive power transferred in a radial system. System operators must understand how to use these tools to avoid voltage collapse.

The Reactive Power Control Scenarios training course uses real-life scenarios to provide an understanding of voltage collapse as a result of inadequate reactive power. It explains how to control reactive power and its role in voltage stability. It applies the information from Reactive Power Fundamentals and Reactive Power Production Equipment to different voltage scenarios. This online course includes:

- Radial power system
- P-V and Q-V curves
- Reaction to lower system voltage
- Voltage collapse

Reactive Power Control Scenarios is part of the Active and Reactive Power training series.

388-11 **Electric Power Principles***

Every electrical circuit has certain components and properties in common whether it powers a flashlight or a city. They all have a source of potential energy, a mechanism or a process that separates the normally evenly distributed electrical charges. In a flashlight, the potential energy is chemical action in the battery. In a city, it's the action of magnetic fields in the generators.

Ohm's Law states that voltage equals current times resistance. It tells us that changing a circuit's resistance will have a dramatic effect on current flow. Kirchhoff's Voltage Law says the algebraic sum of all voltages around a closed path is zero. System operators must understand these laws to understand the relationship between voltage, current, and resistance in all circuits.

The Electric Power Principles training course details how system operators work to ensure voltage levels, reactive flows, and reactive resources are monitored, control, and maintained within limits. This activity takes place in Real-time to protect equipment and ensure reliable operation of the Interconnection. It also explains the differences between real, reactive, and apparent power. This online training course focuses on:

- Series and parallel circuits
- Power in AC circuits
- Active and reactive power
- Phase angle and power angle

Electric Power Principles is part of the Active and Reactive Power training series.

› **100** Safety, Health, and Plant Science
› **200** Mechanical Maintenance
› **300** Electrical Transmission and Distribution
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388-12 **Voltage and Reactive Control** *

North American Interconnections operate at 60 cycles per second. The current and voltage cycles are represented using sine waves. The connection between the current and voltage cycles relates to the voltage control on the Interconnection. That connection is the phase angle in a power system, which is the angular separation between the current and voltage cycles. Power systems exhibit three characteristics: resistive, capacitive, and inductive. Understanding these three characteristics is important to understanding power flow and voltage control:

- In a purely resistive system, the current and voltage cycles are in phase
- When the voltage cycles is leading the current cycle, the circuit is more inductive
- When the current cycles is leading the voltage cycle, circuit is more capacitive

The Voltage and Reactive Control training course explains how to monitor, control, and maintain voltage levels, reactive flows and reactive resources to protect equipment and reliably operate the Interconnection. It describes the impact to system voltage when a high voltage transmission line is placed in service or taken out of service. This online course focuses on:

- Voltage control responsibilities
- Zone protection schemes
- Reactive resources
- Transmission system voltage
- Transformer tap changes
- VAR-001

Voltage and Reactive Control is part of the Active and Reactive Power training series.

388-13 Generators and Transmission Lines*

Generators produce most electric power consumed around the world. Driven by multiple power sources, generators produce and maintain the voltage necessary for current to flow in transmission and distribution systems. While supplying the watts demanded by consumer loads, generators are also the major contributors to voltage control in power systems. The strength of their rotating magnetic fields continually adjusts to maintain desired voltage settings.

Transmission lines have characteristics that influence voltage. Like any conductor, they have a certain amount of straight resistance. The flow of current through them causes heating and energy loss. Transmission lines also act as inductors. They demand reactive energy to create the magnetic field around them when they are carrying current.

The Generators and Transmission Lines training course explains the purpose of an Automatic Voltage Regulator in a power system. It also discusses how the MW and MVAR capability of a generator is limited. It identifies many factors that affect the operating characteristics of a transmission line. This online training course includes:

- Generator MVAR output
- Surge impedance loading
- Ferranti Effect
- P-V curve

Generators and Transmission Lines is part of the Active and Reactive Power training series.

388-14 **Generation Operation for Maintaining Network Voltage Schedules***

The electric generator is the primary source of reactive power and a dynamic source of reactive power when its AVR is in service. The AVR is designed to maintain a constant voltage. When in service, it immediately increases or decreases the amount of reactive power on the transmission system in response to changing conditions.

When a generator trips off-line, its cannot supply or absorb MVAR. This event also changes the MW flow on the transmission system, affecting the transmission line load. Transmission Operators must recognize generator voltage regulators that might have to operate on manual or when the generator reactive capabilities are limited.

The Generation Operation for Maintaining Network Voltages training course ensures generators provide reactive support and voltage control within generating facility capabilities to protect reactive equipment and maintain reliable operation of the Interconnection. This online training courses discusses:

- Voltage or reactive power schedules
- Operating and directing resources
- Generator transformers
- Tap setting changes

Generation Operation for Maintaining Network Voltage Schedules is part of the Active and Reactive Power training series.

388-15 **Voltage and Power Control Equipment***

Reactive power management is the key to voltage control. Several different types of equipment are used to maintain power system voltage. All work by either producing or absorbing reactive power, referred to as VAR or MVAR.

System operators control voltage by managing generation supply and reactive power sources while monitoring load and line conditions. Voltage control is the control of reactive power flow. Reactive power is not transmitted long distances because it uses line capacity.

The Voltage and Power Control Equipment training course explains how system operators control voltage through the addition or removal of equipment that produces or absorbs reactive power. It identifies a line trip's effect on the reactive power requirements of the remaining lines on the system. It also describes actions that system operators should consider in controlling system voltages. This online training course covers:

- Shunt capacitors
- Shunt reactors
- Synchronous condensers
- Static VAR compensators
- Load tap changer control
- Phase shifter
- Synchrophasors
- Voltage control

Voltage and Power Control Equipment is part of the Active and Reactive Power training series.

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400

Electrical Maintenance

401 Direct Current (DC)

401-01 Electron Theory

Electricity is the flow of electrons through a conductor. Understanding basic electron theory is essential to understanding how to safely generate electricity and make it do useful work. The Electron Theory training course discusses basic electron theory and explains how interactions between electrons and protons create electrical energy. It also identifies the factors that affect electron movement and how to measure these factors.

This online training course covers electron theory basics and defines current and voltages. It explains voltage production and describes magnetic fields and resistance.

The Electron Theory course is part of the Direct Current (DC) training series.

401-02 Magnetism and Electromagnetism Explained

Many common electrical devices in industrial facilities are designed using magnetic principles. Understanding magnetism and electromagnetism is important to operating these devices, such as AC and DC motors.

The Magnetism and Electromagnetism training course describes the basic principles of magnetism. It describes the relationship between electricity and magnetism and how it's affected by generators and motors. This course also discusses electromagnets.

Magnetism and Electromagnetism explained is part of the Direct Current (DC) training series.

401-03 Ohm's and Kirchhoff's Laws Relating to DC Circuits

Understanding Ohm's Law, the basic formula for determining power in a circuit, and Kirchhoff's Laws is important in knowing how to find unknown values on DC circuits.

The Ohm's and Kirchhoff's Laws Relating to DC Circuits training course introduces these formulas. It also gives examples of how they can be used in practice on DC circuits.

This course is part of the Direct Current (DC) training series.

401-04 Evaluating Series and Parallel DC Circuit Performance

The Evaluating Series and Parallel DC Circuit Performance training course describes how current, voltage, resistance, and power flow through series and parallel DC circuits. It shows how to calculate values of these components. It also explains some techniques for evaluating DC circuit performance.

This online training course explains the concept of solving for power in DC circuits and its relationship to Ohm's Law.

Evaluating Series and Parallel DC Circuit Performance is part of the Direct Current (DC) training series.

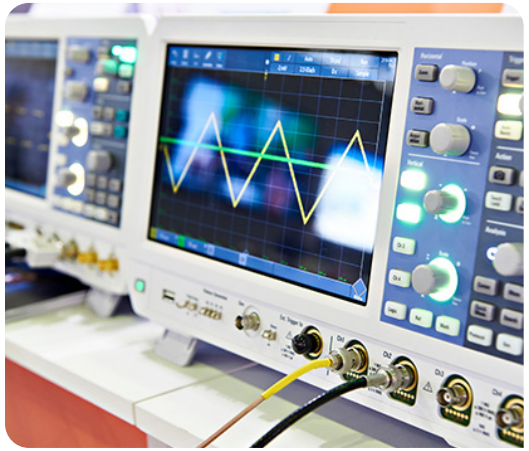
* NERC CEHs are available for qualified operators. Courses taken to fulfill NERC CEH requirements must be indicated at time of purchase.

401-05 **Determine Circuit Outputs from Specified Inputs**

The Determine Circuit Outputs from Specific Inputs training course uses examples to demonstrates the use of Ohm's Law and other formulas to compute DC series and parallel outputs when some inputs into the circuit are known. This online course highlights:

- DC series computations
- Parallel circuit computations

Determine Circuit Outputs from Specific Inputs is part of the Direct Current (DC) training series.



402 Alternating Current (AC)

402-01 **Introduction to Alternating Current (AC)**

Most electrical equipment used in modern industrial facilities operates on alternating current or AC. Introduction to Alternating Current explains significant terminology, concepts, and principles associated with alternating current and its production. This online training course describes the differences between AC and DC power and defines terminology for graphing AC power. It also explains the effective values of AC power.

Introduction to Alternating Current covers AC power waveform characteristics. It discusses how to generate AC power. It also covers inductance and capacitance in AC circuits.

This course is part of the Alternating Current (AC) training series.

402-02 **Ohm's and Kirchhoff's Laws Involving AC Circuits**

Understanding Ohm's law and Kirchhoff's laws is important when determining unknown values in AC electrical circuits. The Ohm's and Kirchhoff's Laws Involving AC Circuits training course introduces these laws and provides examples of their use in determining values in resistive AC circuits.

This online course describes Ohm's law and Kirchhoff's current and voltage laws as they relate to AC circuits. It also demonstrates how to calculate power in a resistive circuit.

This course is part of the Alternating Current (AC) training series.

402-03 **Inductance in AC Circuits**

Inductance is the electrical property that allows electricity to transform into different voltages. It also changes electrical energy to mechanical energy. The Inductance in AC Circuits online training course discusses the importance of inductance in electricity generation and distribution. In addition, this course shows how to calculate inductance values and find a circuit's inductive reactance.

This online training course covers induction, calculating induction, and inductive reactance.

Inductance in AC Circuits is part of the Alternating Current series.

402-04 **Capacitance in AC Circuits**

Every electric circuit, no matter how complex, is made up of three electrical properties: resistance, inductance, and capacitance. Resistance and inductance were discussed in previous courses. The Capacitance in AC Circuits training course delves into the property of electrical capacitance.

This online training course explains how capacitance reacts in an AC circuit. It demonstrates how to calculate total values and describes calculations for capacitive reactance. This course covers:

- Capacitor charging and discharging
- Units of capacitance
- Capacitors in series and parallel
- Capacitive resistance

Capacitance in AC Circuits is part of the Alternating Current series.

402-05 **Impedance in AC Circuits**

When working with AC circuits, using the correct values for calculations is necessary to get the correct answer. AC circuits react differently with inductance and capacitance than DC circuits. Basic Ohm's Law can't be used in AC circuits without understanding how to determine impedance. This understanding is important in installing, troubleshooting, or repairing AC circuits.

The Impendence in AC Circuits training course shows how to determine the total impedance of an AC circuit and apply Ohm's Law to find other unknown values. This online course focuses on:

- Phasor diagrams
- Ohm's Law and alternating current
- AC circuits with inductive reactance and resistance in series
- AC circuits with capacitive reactance and resistance in series
- AC circuits with reactance and resistance in parallel

Impedance in AC Circuits is part of the Alternating Current (AC) training series.

402-06 **AC Power**

The AC Power lesson describes the types of power in resistive, capacitive, and inductive circuits. It explains real power and apparent power. It also discusses power factor and how to calculate its value. This online course includes:

- Right triangle and trigonometric functions
- Power
- Power factor
- Power factor correction
- Power in a resistive circuit
- Power in capacitive and inductive circuits
- Calculating power values

AC Power is part of the Alternating Current (AC) training series.

› 100 Safety, Health, and Plant Science
› 200 Mechanical Maintenance
› 300 Electrical Transmission and Distribution
› 400 Electrical Maintenance
› 500 Power Generating Systems and Operations
› 600 Instrumentation and Control
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402-07 **Fundamentals of Three-Phase AC**

North American power systems are predominantly generated and delivered by Alternating Current (AC) systems. These power systems depend on three-phase AC systems to reliably carry and distribute large quantities of power over great distances. These paths are large AC circuits that rely on the same designs and calculations as small circuits. Three-phase AC operation and maintenance depends on understanding how AC circuits are constructed and calculated for capacity.

The Fundamentals of Three-Phase AC training course:

- Identifies AC circuit construction
- Calculates the circuits' capacity value
- Explains power factor corrections in AC circuits

Fundamentals of Three-Phase AC power is part of the Alternating Current (AC) training series.

405 **Power Quality**

405-01 **Power Quality**

The power supply quality affects the reliable operations of computers, computer-based equipment, and other sensitive electronic equipment. Understanding the requirements for electronic equipment helps provide the power needed to keep it working reliably.

The Power Quality training course discusses the nature of power supplied to electrical equipment and lists circumstances that affect quality. This online training course explains the quality needed for equipment, harmonics, and unbalance. It also covers voltage sags, low voltages, and voltage serves and spikes.

Introduction to Power Quality is part of the Power Quality training series.

405-02 **Harmonics**

With the continued increase in non-linear loads such as battery chargers, converters, and computers, it is important to understand how harmonics relates to this equipment. The Harmonics training course describes problems that may occur in electrical systems due to harmonics. It also highlights the benefits of equipment with minimal harmonic distortion and discusses the wiring methods used to minimize harmonics effects.

This online course explains:

- Harmonics history
- Harmonics wave forms
- Motor reactions
- Transformer reactions
- Power system reactions
- Total harmonic distortion (THD)
- Solutions

Harmonics is part of the Power Quality training series.

405-03 **High Voltage AC**

Many industrial applications require voltage values qualifying as high-voltage applications. The High Voltage AC online training outlines what makes high voltage systems different and how to safely work in them.

This online training course identifies the values of high and ultra-high voltage systems, common system components, and high and ultra-high specific measurement and testing considerations. High Voltage AC discusses the need for high voltage applications, high voltage power system components, and high voltage measurements and testing.

This course is part of the Power Quality series.

409 **Industrial Motors**

409-01 **AC Induction Motors**

AC induction motors have many industrial applications. The AC Induction Motors training course focuses on the types of motors, operating characteristics, and applications in which they may be used. This online course describes the design and function of several types of AC induction motors.

AC Induction Motors covers motor basics. It discusses the types of single-phase AC induction motors and their operation. It also covers the types of three-phase AC induction motors and their operation.

This course is part of the Industrial Motors training series.

409-02 **AC Generators**

AC generators produce the electricity that provides heat, light, conveniences, and the power to do work. AC Generators online training explains how an AC generator produces an AC voltage.

This online training course discusses generator components, electromagnetic induction, three-phase generators, and frequency and voltage control.

This course is part of the Industrial Motors series.

- **100** Safety, Health, and Plant Science
- **200** Mechanical Maintenance
- **300** Electrical Transmission and Distribution
- **400** Electrical Maintenance
- **500** Power Generating Systems and Operations
- **600** Instrumentation and Control
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409-03 **AC Induction Motor Theory**

As discussed in a previous lesson in this series, AC induction motors are commonly found in industrial and power generation applications. The AC Induction Motor Theory training course explains the operating fundamentals and theory of single-phase and three-phase AC induction motors. It introduces the principles of magnetism and magnetic fields and discusses how they are used in AC motor operations.

This online training course describes how an electric AC induction motor uses the principles of magnetism and magnetic fields to convert electrical energy into mechanical energy. The course covers:

- Magnetic fields
- Electromagnetism and electromagnetic force
- Single-phase AC rotating stator field
- Single-phase squirrel cage rotor
- Three-phase motors

AC Motor Induction Theory is part of the Industrial Motors series.

409-04 **Troubleshooting AC Induction Motors**

AC induction motors are found throughout industrial facilities. Installing, maintaining, and repairing this essential equipment is an important task.

The Troubleshooting AC Induction Motors training course enhances motor troubleshooting skills. It also helps maintenance personnel responsible for AC motors understand the problems they could encounter. This course discusses effective troubleshooting procedures for AC and induction motors. it also discusses various problems related to installation, maintenance, and repair. This course focuses on:

- Troubleshooting steps
- Motor nameplate data
- Temperature effects on motor operation
- Common troubleshooting scenarios
- Testing for insulation failure
- Testing motor winding coils

Troubleshooting AC Induction Motors is part of the Industrial Motors series.

409-05 **AC Induction Motor Maintenance**

AC induction motors efficiently convert electrical energy to the mechanical energy used for material transfer, air flow, water flow, and many other essential plant functions. Diligent maintenance is the key to keeping these motors operating efficiently and reliably.

The AC Induction Motor Maintenance training course describes general electric motor maintenance and inspection activities. This course includes:

- Bearings and lubrication
- Vibration
- Voltage irregularities

AC Induction Motor Maintenance is part of the Industrial Motors series.

409-06 **Overhauling Induction Motors**

When a motor's maintenance schedule or mechanical issues dictate an overhaul, standard steps should be taken to ensure it is safe to work on. After verifying safe maintenance conditions, the following tasks include:

- Motor disassembly
- Parts inspection
- Testing
- Reassembly
- Testing the motor

To maximize motor life, each subordinate task is needed and must be understood by technicians to ensure efficient maintenance practices.

The Overhauling Induction Motors training course describes each of the steps necessary for the induction motor overhaul process.

- Preliminary steps
- Disassembly of smaller motors
- Disassembly of large motors
- Rotor stator inspection and repair
- Reassembly
- Test Running

Overhauling Induction Motors is part of the Industrial Motors training series.

409-07 **Generator System Heat Protection**

Significant amounts of heat are created during AC power generation. If the generator becomes overheated, system failure occurs quickly. Hydrogen cooling systems are commonly employed for industrial AC power generators. Operators must understand why hydrogen gas is a preferred cooling method for large generators. They must also understand how the gas flows through the generator to remove heat and other standard operation activities which play a role in the generator cooling process.

The Generator System Heat Protection training course discusses industry standard heat reduction methods for AC industrial power generators, including hydrogen cooling systems and their associated equipment. This online training course covers:

- Hydrogen cooling system
- Moisture and hydrogen purity monitoring
- Seal oil system
- Stator cooling system
- Isolated-phase bus cooling system

Generator System Heat Protection is part of the Industrial Motors training series.

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409-08 **Generator Overhaul**

Generators play a crucial role in the Bulk Electric System. They are the source customers rely on for electrical power to assist in daily life. Ensuring a generator lasts means periodic overhauls in which the generator's internal components are inspected and repaired or replaced as necessary. Technicians must have a general understanding of common issues and fault diagnosis. They must also be able to determine if the generator can continue to operate.

The Generator Overhaul training course discusses the steps taken to shut down the generator and prepare it for maintenance. It also describes considerations when performing the overhaul inspections. This online course focuses on:

- Generator shutdown
- End shields inspection
- Stator inspection
- Hydrogen cooler inspection
- Rotor inspection
- Electrical testing
- Reassembly

The Generator Overhauled course is part of the Industrial Motors training series.

409-09 **DC Motors and Generators**

DC generators are energy converters. They change mechanical energy into the DC electrical energy that provides power to DC motors. DC motors, in turn, are electrical converters, converting that electrical energy to mechanical energy. To perform basic maintenance on these components, technicians must understand DC theory, basic DC generator and motor types, and the connections between them.

The DC Motors and Generators training course explains how they covert energy from one form to another. It also describes basic DC generating and motor winding configurations and how to use each type. This online course includes:

- Generating DC voltage
- DC generator types
- DC motor basics
- DC motor types
- Speed and direction

DC Motors and Generators is part of the Industrial Motors training series.

409-10 **Maintenance of Direct Current Motors and Generators**

As discussed in the previous course, a DC generator requires a magnetic field, a conductor, and motion to convert mechanical energy to electrical energy. Similarly, a DC motor needs those same components to convert electrical energy to useable mechanical energy. If any item fails, there is no voltage output from the generator or mechanical output from the motor. That means it's important to identify and maintain generator and motor components, helping them function according to their design and provide dependable electrical or mechanical output.

The Maintenance of Direct Current Motors and Generators training course describes basic components. It describes how to conduct basic maintenance and inspections. This online course includes:

- Maintenance basics
- Armatures/rotors
- Commutators
- Brushes
- Bearings
- Stator/field
- Maintenance procedures
- Testing

Maintenance of Direct Current Motors and Generators is part of the Industrial Motors training series.

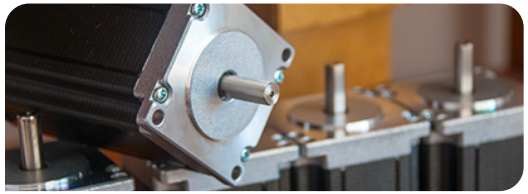
411 **Motor Control and Protection**

411-01 **Introduction to Motor Controls**

To understand AC motor control, troubleshoot motors, and ensure smooth operations, technicians must understand ladder diagrams and the logic that forms the motor control operation framework. The Introduction to Motor Controls training course introduces motor control circuits which carry energy from source to load.

This online training course explains how to draw a simple motor control circuit and describes relative motor logic. It introduces the fundamentals of control, breakers and contractors, and control input and output devices.

This course is part of the Motor Control Centers training series.



411-02 **Motor Protection and Faults**

Electric motors serve as drivers for many industrial applications. Because motors are powered and controlled by attached circuits, they need protection from a variety of faults both in and out of the motor. Understanding diagnosis and relief of these faults is essential in protecting the motor and its connected loads.

The Motor Protection and Faults training lesson describes the difference between internal and external motor faults. It explains how to select the proper overcurrent and short circuit protection devices for motor branch circuits. This online course includes:

- Motor branch circuit basics
- NEMA motor characteristics
- Voltage frequency and deviation effects
- Common faults and diagnosis
- Protective motor care

Motor Protection and Faults is part of the Motor Control and Protection training series.

411-03 **Motor Control Troubleshooting**

Motor control troubleshooting is a developed skill. Many technicians who install control circuits have difficulties when a problem occurs. Critical components to successful motor control troubleshooting include:

- Approaching faults with an analytical perspective
- Understanding control function properties, circuits, and circuit analysis

The Motor Control Troubleshooting training course explains motor control circuit troubleshooting basics. This online training course covers:

- Safety
- General procedures
- Step-by-step troubleshooting

Motor Control Troubleshooting is part of the Motor Control and Protection training series.

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411-04 Motor Control Centers

Commercial and industrial power distribution systems are some of the most complex circuits in existence. Providing power to applications such as HVAC systems, lighting, and motor-driven machines requires control to make the equipment perform specific functions. In particular, motor-driven machines may need to stop, start, or change directions rapidly. Motor control centers are installed to provide specific controls as needed.

The Motor Control Centers training course explains motor control center functions and common components. It explores the differences between common classifications and their associated wiring schemes. This online training course reviews:

- Motor control basics
- Circuit protection purpose and components
- Introduction to motor control centers
- Combination motor control units
- Wiring classes and types

Motor Control Centers is part of the Motor Control and Protection training series.

413 AC Drives

413-01 AC Drives Overview

Electric motors play a vital role within industrial applications. However, they are useless as standalone equipment because electric motors rely on drive devices to control energy flow through the circuits. In AC motors, AC drives allow operators to control direction, speed, and torque by flipping a switch or turning a lever.

The AC Drives Overview training course explains the basic designs, purposes, and applications for AC variable frequency drive (VRD) devices. This online course discusses:

- Driver introduction
- Variable frequency drives
- Drive divisions
- Power converter
- Control
- Switching and stopping
- Cooling and heating prevention

This course is part of the AC Drives training series.

415 Transformers

415-01 Transformer Basics

Transformers use electromagnetism to transform an AC voltage by mutual induction. A basic knowledge of electromagnetic induction is necessary to understand how transformers are used in the transmission and distribution of electricity. The Transformer Basics training course explains magnetism, electromagnetism and the basic principles of electric voltage transformation.

This online training course includes:

- Magnetism
- Electromagnetism
- Magnetic measurements
- Induction
- Self-induction
- Turns ratio
- Transformer losses

Transformer Basics is part of the Transformers training series.

415-02 Transformer Design and Components

A transformer's design determines its efficiency. Transformer cooling determines its load capabilities. Understanding transformer design, cooling, and other components is necessary to understand how transformers are used in the transmission and distribution of electricity.

The Transformer Design and Component training course visually identifies a transformer's core construction. It also describes transformer cooling types and external devices. This online training course explains:

- Core construction
- Winding stress
- Transformer cooling
- Transformer devices
- Tap changers
- Transformer nameplates
- Power ratings
- Sound levels

This course is part of the Transformers training series.

415-03 Transformer Connections

Making proper transformer connections is important for safe and reliable electrical transmission and distribution systems. Transformers step up generation voltage for transmission and step down voltage for distribution. Almost all the electricity used today is transformed through a transformer.

The Transformer Connections training course identifies and explains how to make the most common connections for single-phase and three-phase transformers. It demonstrates how to calculate the value of phase voltage and current and line voltage and current. This online training course includes:

- Single-phase transformer connections
- Three-phase circuits
- Three-phase delta connections
- Three-phase wye connections
- Combination connections

Transformer Connections is part of the Transformers training series.

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415-04 Special Transformers

Special transformers are used in many applications. For example, current transformers and potential transformers are important in metering and measuring electricity for control and billing.

The Special Transformer training course identifies the different special transformer types and describes how they're used. The special transformers discussed in this online course include:

- Reactors
- Isolation transformers
- Auto-transformers
- Buck-boost transformers
- Control transformers
- Potential transformers
- Current transformers
- K-factor transformers

This course is part of the Transformers training series.

416 Batteries, Battery Chargers, and UPS

416-01 Battery Basics

Technicians use batteries every day. They are in the flashlight used to see a motor nameplate better and the computer used to operate systems. The Battery Basics training course explains the overall design and function of today's batteries. It also identifies maintenance practices to keep them ready for service. This online course covers:

- Cell basics
- Primary and secondary cells
- Specific gravity and cell voltage
- Battery capacity rating
- Battery maintenance
- Safety

Battery Basics is part of the Batteries, Battery Chargers, and UPS training series.

416-02 Electrical Backup Systems

Electrical backup systems provide a source of power when the normal source is interrupted. The Electrical Backup Systems training course explores types of electrical backup systems and examines their design and function.

This online training course distinguishes between types of backup systems and provides criteria for identifying which systems fit different applications. The course covers:

- Backup power use
- Backup systems overview
- Backup system components
- Backup system types

Electrical Backup Systems is part of the Batteries, Battery Chargers, and UPS training series.

416-03 Uninterruptible Power Supplies (UPS)

Power system reliability is directly linked to the performance of protective devices interconnected by IT devices. As such, the uninterruptible power supply (UPS) is one of the most critical components. The Uninterruptible Power Supply training course introduces UPS systems and explains how each is supplied.

This online training course includes:

- Types of power problems
- UPS types and characteristics
- UPS battery life considerations
- UPS functionality software
- UPS application

This course is part of the Batteries, Battery Chargers, and UPS training series.

417 Switchgear Maintenance

417-01 Switchgear

Switchgear is an important connection and protection system for a power plant. This Switchgear online training describes the function and operation of switchgear. It also identifies equipment that makes up a switchgear system and explains the purpose of protection relays.

The course features the switchgear line up including breakers and switches, electrical bus, transformers, relays, and indication and communication.

This course is part of the Switchgear Maintenance series.

417-02 Low Voltage Breakers

Breakers are everywhere in a power generating plant. The Low Voltage Breakers training course explains the purpose and use of low voltage circuits breakers in electrical circuits.

This online training course provides a circuit breaker overview and discusses circuit operations. It covers low voltage molded case circuits breakers, large frame circuit breakers, and insulated case circuit breakers.

Low Voltage Breakers is part of the Switchgear Maintenance training series.

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417-03 Medium and High Voltage Switchgear

In addition to low voltage switchgear common to generation and distribution buses, high and medium switchgears are vital at all power system switching points. Medium and high voltage switchgears cover a range of 3.3 kV to 800 kV. This voltage range is used in transmission and distribution systems to transmit and convert system voltage. Understanding design and application of these assets is essential to power system operation.

The Medium and High Voltage Switchgear training course identifies the technical details associated with construction and operation of high and medium voltage switchgears. This course includes:

- Medium and high voltage operating mechanisms
- Switchgear considerations
- MV switchgear applications

This course is part of the Switchgear Maintenance training series.

417-04 General Switchgear Maintenance

Low, medium, and high voltage switchgear is essential to reliably send electrical power from source to load. Because this equipment is vital, not maintaining assets can result in power loss, equipment damage, and other problems. Preventing asset failure relies on standard preventive maintenance tasks and electrical tests common to all switchgear types.

The General Switchgear Maintenance training course identifies and explains the common tests and tasks for modern switchgear including:

- General circuit breaker maintenance
- Basic operating mechanism maintenance
- Basic pneumatic and hydraulic operating mechanism maintenance
- General circuit breaker electrical tests

This course is part of the Switchgear Maintenance training series.

417-05 Breaker Specific Maintenance

While all breakers are subject to general maintenance tasks, each classification also has specific needs to maintain operating conditions. Before performing maintenance, all technicians must be familiar with tasks specific to air, vacuum, oil, or gas breakers because of the different extinguishing mediums in each.

The Breaker Specific Maintenance training course explains how to complete breaker-specific maintenance tasks to maximize breaker life and maintain system stability. This online training course focuses on:

- General air-magnetic and vacuum breaker tasks
- Air-magnetic breaker specific tasks
- Vacuum breaker specific tasks
- Oil breaker specific tasks
- Gas-blast breaker specific tasks
- Air-blast breaker specific tasks

Breaker Specific Maintenance is part of the Switchgear Maintenance training series.

417-06 Circuit Breaker Time-Travel Characteristics and Testing

Bulk Power System stability relies on the effective operation of transmission and distribution substation components, especially circuit breakers. Because substation circuit breakers are critical in making and breaking circuits to supply power and protect systems, they must be tested periodically to determine if operations work as they should. Of all the field tests available, the most used is the time-travel test.

The Circuit Breaker Time-Travel Characteristics and Testing training course identifies the purpose and principles of circuit breaker time-travel testing. It explains the processes associated with conducting the three types of time-travel testing. This online course covers:

- Time travel testing purpose and principles
- Circuit breaker time and travel characteristics
- Circuit breaker time-travel test equipment
- Drop-bar recorder testing
- Light-beam recorder testing
- Digital timer/analyzer testing

Circuit Breaker Time-Travel Characteristics and Testing is part of the Switchgear Maintenance training series.

418 Electrical Protection and Grounding

418-01 Electrical Faults and Current Ratings

Electrical faults can cause serious injuries or death. Understanding the types of faults that can occur in electrical circuits is necessary for safe equipment installation and maintenance. The Electrical Faults and Current Ratings training course explains causes and types of electrical overcurrent and identifies how to protect circuits from overcurrents and faults.

This online training course covers electrical overcurrent and conductors. It discusses overcurrent fault and overload protection.

This course is part of the Electrical Protection and Grounding training series.

418-02 Overcurrent Protection, Fuses, and Breakers

Electrical circuits must have overcurrent protective devices that protect personnel, electrical devices, and conductors. Understanding the basics of fuses and breakers is important to safely and efficiently troubleshoot and repair electrical circuits.

The Overcurrent Protection, Fuses, and Breakers training course identifies fuse and breaker types used in electric distribution systems. It also explains how they work. This online course describes:

- Fuse types
- Fuse selection
- Selective coordination
- Circuit breakers
- Breaker selection
- Breaker coordination

Overcurrent Protection, Fuses, and Breakers is part of the Electrical Protection and Grounding training series.

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418-03 **Protection Relays**

Protection relays shield personnel and equipment from catastrophic damage caused by an uncontrolled short circuit or ground fault. Relays act quickly, disconnecting power from the fault area while leaving the rest of the system unaffected. To ensure safety and reliability, technicians must understand the protection system.

The Protection Relays training course identifies protection relay elements on an electrical drawing according to the ANSI (American National Standards Institute) standard device numbers. It also describes basic relay operations. This online course compares the accuracy and options provided by commonly used relays.

This course focuses on:

- Protection relay basics
- Protection relay functions
- Electromechanical relays
- Electronic relays

Protection Relays is part of the Electrical Protection and Grounding training series.

418-04 **Generator, Transformer, and Motor Protection**

As discussed, electrical protective devices play an important role in the safe and reliable operation of equipment. The Generator, Transformer, and Motor Protection training course continues to build on this concept. This online training course explains the operating principles governing:

- Ground fault protection
- Phase-to-phase short circuit
- Time overcurrent protection
- Motor overload protection

Generator, Transformer, and Motor Protection is part of the Electrical Protection and Grounding training series.

418-05 **Grounding and Bonding**

Grounding is an important part of any electrical system. To install and maintain a safe and dependable electrical system, it's important to understand various types of grounding systems and the concepts that impact their effectiveness.

The Grounding and Bonding training course describes how grounding systems are used to ground electrical systems and equipment. This online course focuses on:

- Purpose of grounding
- Grounding terminology
- Grounding system types
- Grounding methods

Grounding and Bonding is part of the Electrical Protection and Grounding training series.

419 **Motor Operated Valves**

419-01 **MOV (Motor Operated Valve) Application & Construction**

Using motor operated valves (MOVs) aids remote valve operation throughout a plant. Valves in hard-to-access areas can be operated from control rooms or other remote locations. To satisfy a range of torque, thrust, and speed requirements, these MOVs come in a variety of basic designs that use different gear drives/ratios and spring pack assemblies. The MOV (Motor Operated Valve) Application and Construction training course describes MOV components, uses, and operations.

This online course covers basic MOV operation including:

- Actuator motors
- 00/000 declutch mechanism
- 00/000 worm and drive sleeve assembly
- 00/000 handwheel assembly
- 00/000 torque and limit switches
- Nameplates
- 0-3 actuator components
- 03 declutch mechanism operation

The MOV Application and Construction course is part of the Motor Operated Valves training series.

419-02 **MOV Disassembly and Inspection, Part 1**

As discussed in MOV Application and Construction, Limtorque® valve operators come in many designs. Their use facilitates remote operation of valves throughout the plant. Maintaining MOVs (motor operated valves) involves disassembly and inspection of individual components for wear and damage. This inspection contributes to longer run times and fewer forced outages, resulting in increased plant efficiency.

The MOV Disassembly and Inspection, Part 1 training course explains how to disassemble, inspect, and reassemble a Limitorque SMB-00/000 MOV actuator.

This course is part of the Motor Operated Valves training series.

419-03 **MOV Disassembly and Inspection, Part 2**

Limitorque® valve operators come in many designs. Their use helps valves operate remotely in a plant. The previous lessons discussed MOV (motor operated valve) maintenance by disassembling and inspecting components for wear and tear. Diligence in this maintenance contributes to longer run times and fewer forced outages, resulting in increased plant efficiency.

The MOV Disassembly and Inspection, Part 2 training course builds on the previous lesson by focusing on the steps to reassemble MOVs. This online course describes the reassemble techniques applied to the SMB 00/000 Limitorque MOV.

This course is part of the Motor Operated Valves training series.

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419-04 **Limit Switch Adjustment**

As discussed in previous courses, motor operated valves can help remote and automatic operations. They can also start other equipment operation throughout the plant. They provide a fast-acting mechanical advantage.

The Limit Switch Adjustment training course builds on this knowledge by focusing on adjustment of the motor operated valve limit switch, which is associated with valve position control. This online training course explains the process for adjusting a Limitorque(R) actuator limit switch. It includes:

- Limit switch function review
- Limit switch adjustment steps

Limit Switch Adjustment is part of the Motor Operated Valves training series.

421 **Wiring Installation**

421-01 **Wire and Cable Management**

Wire management is considered a technician's ability to install wiring and cables in compliance with the National Electric Code (NEC). Defined as a raceway installed in a neat and workmanlike appearance, wire management is more than just presentation.

Proper wire management is the first line of defense in overheating, which can lead to electrical fire. Avoiding overheating relies on devices that separate and direct wiring safely and efficiently. The Wire and Cable Management training course identifies how to properly use conduit and cable trays to ensure the necessary neat and workmanlike appearance required by the NEC.

This online course explains cable trays and junction boxes. It also covers load centers and control panels and numbering and marking.

This course is part of the Wiring Installation training series.

421-02 **Terminating and Connecting Wires in a Control Panel**

Control panels can control a single motor or a complete process system. Whether designing controls for a machine, a process loop, or a fully integrated plant control system, it's important to select the right components and use good wire management practices.

Wiring even the simplest control panels is an art form. Technicians who carry out this task successfully take pride in their work. The Terminating and Connecting Wire in Control Panels training course teaches the basics of wiring a control panel. This course explains:

- Enclosure types
- Components
- Color coding for content panels

This online course is part of the Wiring Installation training series.

421-03 **Making Connections in a Junction Box**

An electrical junction box is a container that houses electrical junctions. Junction boxes are an important part of an electrical system. They provide a place to splice and terminate wire. Like any other part of the electrical system, junction boxes have to be well managed for best results.

The Making Connections in a Junction Box training course explains how to make connections and terminations using several systems. This online course covers:

- Forming the wire
- Wire nuts
- Crimp-on terminals
- Terminal strips
- Motor connection boxes

Making Connections in a Junction Box is part of the Wiring Installation training series.

421-04 **Installing Conduit and Pulling Wire**

Electrical conduit is pipe that surrounds and protects electrical wires from damage. Properly installed conduit reduces the risks of shorting, fire, and moisture damage. The Installing Conduit and Pulling Wire training course explains the major types of electrical conduit. It reviews how to install conduit and the basics of pulling wire through the installed conduit.

Installing Conduit and Pulling Wire is part of the Wire Installation training series.

423 **Cable Splicing**

423-01 **Introduction to Medium Voltage Cable**

Understanding the difference between medium voltage and low voltage cable is important. Many, if not all large motors in a plant are medium voltage. Technicians need to understand the medium voltage cable system to install, troubleshoot, repair, or replace medium voltage cables and keep the plant operating reliably. The Introduction to Medium Voltage Cable training course describes medium voltage cable components and explains why each is important.

This online course covers:

- Medium voltage cable construction
- Cable conductors
- Strand shielding
- Insulation
- Insulation shielding system
- Outer jacket
- Installation and testing

Introduction to Medium Voltage Cable is part of the Cable Splicing training series.

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423-02 **Medium Voltage Splices and Terminations**

Understanding medium voltage splicing and terminations is helpful to maintain and troubleshoot electrical equipment. It's important to understand the steps needed to prepare a good splice or termination and see any potential trouble when inspecting equipment.

The Medium Voltage Splices and Terminations training course outlines the steps to splice and terminate medium voltage power cable. This online course includes:

- Reasons to splice
- Cable preparation
- Connecting the conductors
- Re-shielding and re-insulating
- Preparing for terminations
- Stress control
- External leakage control
- Preventing environmental contamination

Medium Voltage Splices and Termination is part of the Cable Splicing training series.

425 **Troubleshooting Electrical Circuits**

425-01 **Troubleshooting AC Circuits**

A maintenance technician is often asked to troubleshoot electrical circuit problems. Understanding circuit components helps find the cause of the problem and fix it. The Troubleshooting AC Circuits training course outlines the logical steps used to troubleshoot AC motor control circuits.

This online training course covers basic troubleshooting procedures and determining probable cause. It also describes visual inspections. The course explains testing with power off and power on.

Troubleshooting AC Circuits is part of the Troubleshooting Electrical Circuits training series.

425-02 **Troubleshooting DC Circuits**

As with AC circuits, troubleshooting DC circuits requires a logical, step-by-step approach. It also needs a clear understanding of the circuit and how it works. The Troubleshooting DC Circuits training course outlines the logical steps used to troubleshoot DC circuits. This online course explains:

- Basic troubleshooting procedures
- Testing DC circuits
- Voltage dividers
- DC breaker control

This course is part of the Troubleshooting Electrical Circuits training series.

427 **Freeze Protection**

427-01 **Electrical Freeze Protection Components and Application**

The heat-trace system is one of the overlooked power plant process systems. Neglecting this system can cause extra work for operations and maintenance personnel as a frozen distribution line can lead to lost production time. Understanding freeze protection components and their proper application is critical to plant function.

The Electrical Freeze Protection Components and Application training course describes heat-tracing fundamentals. It also identifies the types of electrical heat-tracing and their internal and external maintenance concerns.

This online training course covers:

- Heat-trace fundamentals
- Overview of heat-tracing methods
- Electrical heat-tracing
- Internal and external electrical heat-tracing maintenance

This course is part of the Freeze Protection training series.

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- 200 Mechanical Maintenance
- 300 Electrical Transmission and Distribution
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500

Power Generating Systems and Operations

501 Power Generation

501-01 Energy Conversions

Power plants use equipment, pumps, and piping systems to convert other types of energy into electrical energy. Understanding energy conversions in a power plant helps understand a plant's operation. The Energy Conversion training course describes how energy from fossil and renewable fuels is captured and converted into electrical energy. It also discusses efficiency and its role in energy conversions.

This online training course explains what energy is. It also outlines energy conversions in a fossil-fuel power plant and energy conversion efficiency.

Energy Conversions is part of the Power Generation training series.

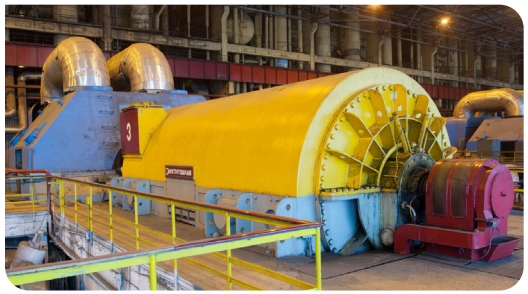
501-02 Steam Turbine Basics

The steam turbine is the workhorse of the power plant. Its ability to drive the large generators found in fired-boiler, combined-cycle, and nuclear power plants makes the steam turbine crucial to electrical power production. Steam from the power plant is provided to the steam turbine at a high temperature and pressure, The steam contains enough energy to rotate the turbine and generator connected to it inside the turbine.

The Steam Turbine Design training course explains the role the steam turbine plays in power plant operations. This online training course discusses:

- Basic steam turbine design
- Steam turbine valves
- Turbine lube oil system

Steam Turbine Design is part of the Power Generation training series.



501-03 Combustion System Component Overview

Power plants convert the chemical energy stored in fuel into thermal energy in the boiler. Understanding the components in the combustion system is necessary to understand how fuel is processed and controlled as it burns in the boiler.

The Combustion System Component Overview training course describes the equipment used to prepare and control natural gas, fuel oil, and coals as it is burned in the boiler. It also identifies advantages and disadvantages of using each fuel type in a power plant. This online course includes:

- Boiler fuels
- Natural gas components
- Fuel oil components
- Coal components

Combustion System Component Overview is part of the Power Generation training series.

* NERC CEHs are available for qualified operators. Courses taken to fulfill NERC CEH requirements must be indicated at time of purchase.

501-04 **Boiler Water and Steam Cycle Overview**

As discussed previously, power plants convert the chemical energy stored in fuel into thermal energy in the boiler. The boiler water and steam stores thermal energy before sending it to the steam turbine. There, it is converted to mechanical energy. Understanding the basic boiler water and steam components is necessary to understand how power plants operate.

The Boiler Water and Steam Cycle Overview training course describes where boiler water comes from and how it enters and flows through a boiler. It explains the basic flow path the steam follows from the boiler to the steam turbine. This online course focuses on:

- Water/steam cycle overview
- Condensate system
- Feedwater system
- Basic steam cycle
- Superheaters

Boiler Water and Steam Cycle Overview is part of the Power Generation training series.

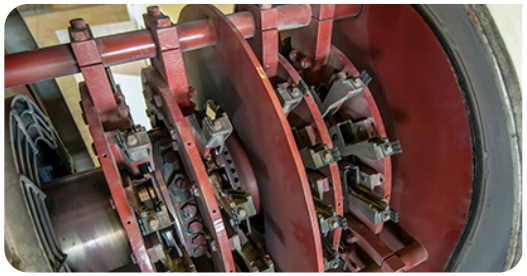
501-05 **Generator Overview**

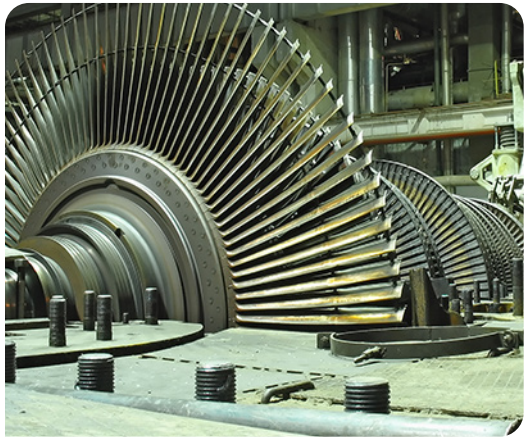
The generator is the heart of the power plant. Understanding its basic operation is critical to understand how electricity is produced. It's also important to know how customer usage affects the generator's operation.

The Generator Overview training course describes the relationship between electrical use and generator output. It also explains the basic principles of producing electricity using an electromagnet. This online course discusses:

- Electrical supply and the customer
- Basic generator components
- Exciters

Generator Overview is part of the Power Generation training series.





505 **Turbine Auxiliaries System and Control**

505-01 **Steam Turbine Design**

The steam turbine is an essential part of all combined-cycle and fired-boiler power plants. Generators rely on the rotating motion to produce electrical power. The Steam Turbine Design training course describes the basic components in a typical steam engine and explains their purpose. It also traces the steam flow path through a typical steam turbine.

This online training course covers energy conversion, basic steam turbine design, and common configurations.

The Steam Turbine Design course is part of the Turbine Auxiliaries System and Control series.

505-02 **Steam Turbine Control and Operations***

The steam turbine is a power plant's workhorse. To function safely and efficiently, the turbine's speed and operation must be precisely controlled. The Steam Turbine Control and Operation training course covers the basic operation of valves to control a steam turbine's speed and operation.

This online course describes controlling speed, turbine valves, mechanical-hydraulic control systems, and turbine operation.

Steam Turbine Control and Operations is part of the Turbine Auxiliaries System and Control series.

505-03 **Steam Turbine Auxiliaries**

As discussed in previous lessons from this series, the steam turbine is the power plant component that converts thermal energy from steam into mechanical energy to power a generator. The steam turbine requires auxiliary equipment to function. Understanding this auxiliary equipment is necessary to operate steam turbines safely and effectively.

The Steam Turbine Auxiliaries training course describes the design and function of two turbine components: the lube oil system and the gland steam seal system. The course also discusses operator roles and responsibilities.

Steam Turbine Auxiliaries is part of the Turbine Auxiliaries System and Control Series.

505-10 **Steam Turbine Governor System**

As discussed in previous courses, the steam turbine is the power plant component which converts thermal energy from steam into mechanical energy to power a generator. The steam turbine requires a governor to operate. Understanding the governor system components and normal and trip operation is necessary to operate steam turbines safely and effectively.

The Steam Turbine Governor System training course identifies the components and function of a typical turbine governor system. This online course explains:

- History
- Components
- Normal operations
- Shutdown operations

Steam Turbine Governor System is part of the Turbine Auxiliaries System and Control Series.

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507 Generator and Auxiliary Systems and Control

507-01 Generator and Auxiliary Systems' Functions*

The generator is a major component of modern generation stations. It converts the energy in fossil fuels to electricity. The Generator and Auxiliary Systems' Functions online training course focuses on the generator and its auxiliary systems' functions. It also explains maintaining a generator for efficient operation.

This course includes generator functions, generator cooling techniques, auxiliary systems, rotor winding assembly, and shaft sealing systems.

This course is part of the Generator and Auxiliary Systems and Control series.

507-02 Generator and Auxiliary Systems' Flow Paths and Major Components

As discussed in the previous lesson, the generator is a major link in the chain or equipment that modern generation stations use to convert the energy in fossil fuels to electricity. The Generator and Auxiliary Systems' Flow Paths and Major Components training course focuses on the generator and its auxiliary systems' flow path. It also examines some of its major components.

This online training course identifies the flow paths associated with the major components that support generator operation. It covers:

- Seal oil system/hydrogen side
- Seal oil return
- Seal oil system/air side
- Hydrogen supply system

This course is part of the Generator and Auxiliary Systems and Control training series.

507-03 Generator Construction and Process Control*

Generator construction in the power industry is based on several standard operational principles. Once in operation, the generator is placed on the electrical grid using process control loops and other methods of control.

The Generator Construction and Process Control training course describes generator construction and explains some of the principles behind generator operation and process control. This online course covers:

- Generator construction
- Operational principles
- Methods of control

This course is part of the Generator and Auxiliary Systems and Control training series.

507-04 Generator and Auxiliary Systems Startup

Successful generator and auxiliary system startup depends on operators following specific procedures and monitoring multiple parameters. The Generator and Auxiliary System Startup training course examines the pre-start checks and start-up procedures for the generator and its auxiliary systems.

This online course describes the steps to start up the generator and establish it on the electrical grid. It covers:

- Starting the seal oil unit
- Purging and gassing the turbine
- Pre-checks for generator startup
- Rolling on the turbine

This course is part of the Generator and Auxiliary Systems and Control training series.

507-05 Generator and Auxiliary Systems Normal Operations

Correct operation of the generator and its auxiliary systems is a must for safe and profitable operations.

The Generator and Auxiliary Systems' Normal Operations training course focuses on the operator's role and tasks performed during normal operations. This online training course includes:

- Normal generator operation
- Hydrogen dryer operation
- Seal oil system operation

This course is part of the Generator and Auxiliary Systems and Control training series.

507-06 Generator and Auxiliary Systems Shutdown

To prevent equipment damage and danger to personnel, it is important to follow appropriate procedures when shutting down the generator and its auxiliary components.

The Generator and Auxiliary Systems Shutdown training course describes the worker's role during shutdown. This online training course covers:

- Generator shutdown
- Seal oil system shutdown
- Stator cooling water system shutdown

This course is part of the Generator and Auxiliary Systems and Control training series.

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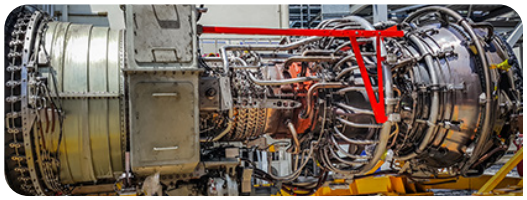
511 Combustion Turbine Fundamentals

511-01 Gas Turbine Fundamentals and Configuration of Generating Facilities

Configuring a power plant layout requires analyzing many variables, including economics, environmental factors, licensing, and others. The Gas Turbine Fundamentals and and Configuration of Generating Facilities training course discusses the basic design of a simple cycle power plant and the function and operation of its fundamental piece of equipment, the combustion turbine.

This online course covers generating facility configuration, basic principles of gas turbines, gas turbine design and components, turbine temperature distribution and monitoring, and engine configurations.

The Gas Turbine Fundamentals course is part of the Combustion Turbine Fundamentals series.

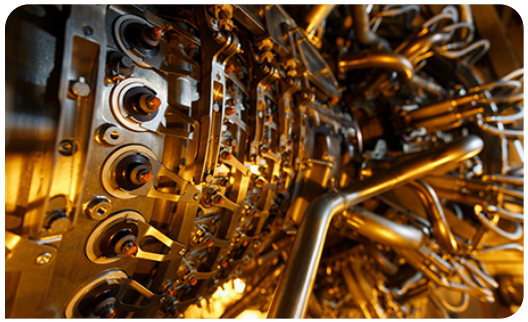


511-02 Introduction to the GE LM Series Gas Turbine

General Electric has developed a vast fleet of gas turbines used extensively around the globe. These turbines serve many different applications. Basic knowledge of the components and design of the LM Series Aero-derivative Gas Turbine is necessary to distinguish it from others in the GE fleet. The Introduction to the GE LM Series Gas Turbine training course describes GE's LS series basic design. It also explains the compressed gas and hot gas flow paths through each type of LM gas turbine.

This online training course covers gas turbine basics, including the LM series gas turbine components and design.

This course is part of the Combustion Turbine Fundamentals training series.



511-03 Introduction to GE Frame Series Gas Turbines

As discussed in the previous course, General Electric Company (GE) has developed a fleet of gas turbines serving many different applications. Understanding the components and design of the F-series gas turbine is necessary to distinguish it from others within GE's fleet.

The Introduction to the GE Frame Series Gas Turbine training course discusses why the F-series gas turbine was developed. This course describes the Frame 7 gas turbine's design, basic components, and general operation.

This course is part of the Combustion Turbine Fundamentals training series.

511-04 Introduction to the Siemens V-series Gas Turbine

Siemens Westinghouse has developed a large fleet of gas turbines used in many different applications across the globe. Understanding the components and design of the Siemens Westinghouse V-series gas turbine is necessary to distinguish it from others within the Siemens fleet.

The Introduction to the Siemens V-series training course describes the basic components of the V-series gas turbine. It also identifies the basic compressed air and hot gas flow paths through the V94 3 gas turbine. This online course includes:

- V-series gas turbine background
- Basic design characteristics
- Advantages of a combined cycle

Introduction to the Siemens V-series is part of the Combustion Turbine Fundamentals training series.

511-05 Heavy Duty Gas Turbines - Major Components and Support Systems

Gas or combustion turbines convert thermal energy to mechanical energy by fuel combustion. It takes in air, compresses it, adds fuel for combustion, then exhausts the gases. Heavy Duty Gas Turbine Major Component and Support Systems online training provides an overview of these turbines. It discusses the motivation behind the heavy gas turbine development and describes its base components and general operation.

Heavy Duty Gas Turbines includes the turbine history, basic heavy duty design, flow path, components, exhaust, and lube oil.

This course is part of the Combustion Turbine Fundamentals series.

511-07 Aero-Derivative Gas Turbines - Major Components and Support Systems

The impact of the gas turbine on the history of power generation cannot be overstated. Since the late 1940s, what started as jet engine technology has transformed the power industry. Gas turbines, also known as combustion turbines, convert thermal energy to mechanical energy through the combustion of fuel. They do so by taking in air, compressing it, then exhausting the gases.

The Aero-Derivative Gas Turbines - Major Components and Support Systems training course is an overview of these gas turbines. They are more efficient than their heavy duty counterparts, but less rugged and cost more per kilowatt.

This online course discusses the motivation behind the auto-derivative gas turbine. It also describes the gas turbine's basic components and support system. This course focuses on:

- Industrial auto-derivative turbine history
- Basic auto-derivative design
- Components
- Exhaust
- Lube oil

Aero-Derivative Gas Turbines - Major Components and Support Systems is part of t he Combustion Turbine Fundamentals series.

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511-10 Fundamentals of Gas Turbine Operation and Routine Maintenance

The gas turbine can be one of the most valued assets of a power plant. However, just like any generation asset, documented operating procedures and routine maintenance requirements must be followed to keep it operating in peak condition.

The Fundamentals of Gas Turbine Operation and Routine Maintenance training course explains several common procedures for operating a combustion turbine. It also identifies conditions that need emergency procedures. This online training course includes:

- Pre-startup maintenance and inspection
- Basic startup procedure
- Fuel swapping
- Water wash
- Windmilling
- Emergency conditions
- Environmental effects

The Fundamentals of Gas Turbine Operation and Routine Maintenance is part of the Combustion Turbine Fundamentals training series.

511-11 Gas Turbine Control Schemes

The gas turbine compressor is one of the most versatile assets in power generation. To keep a unit operating at peak efficiency, operators and technicians must have a good understanding of gas turbine compressor control schemes and operations.

The Gas Turbine Control Schemes training course identifies common control schemes. It also discusses gas turbine compressor startup and shutdown operations. It reviews exhaust control on both simple cycle and combined cycle exhausts. This online training course focuses on:

- Critical operating parameters
- Flameout protection system
- Simple cycle exhaust
- Combined cycle exhaust
- Starting sequence
- Shutdown sequence

Gas Turbine Control Schemes is part of the Combustion Turbine Fundamentals training series.

511-12 Gas Turbine Fuel and Combustion Systems

The gas turbine can be one of the most valued assets in power generation. To keep the unit operating at peak efficiency, operators and technicians must have a good understanding of the fuel and combustion systems.

The Gas Turbine Fuel and Combustion System training course identifies common fuel and combustion components and their functions. This online course includes:

- Fuel types
- Gaseous fuel system components
- Gaseous fuel system operation
- Fuel oil skid components
- Fuel oil skid operation
- Fuel oil forwarding skid
- Combustion section designs

This course is part of the Combustion Turbine Fundamentals training series.

511-13 Gas Turbine Lube Oil and Control Oil Systems

Regardless of industry and no matter how small or large a gas turbine compressor unit is, the lube oil system and control oil system are the most important systems for safe and efficient operations.

The Gas Turbine Lube Oil and Control Oil Systems training course identify common components and operations for both systems. This online training course discusses:

- Lube oil system components
- Lube oil system operation
- Control oil system components
- Control oil system operation

This course is part of the Combustion Turbine Fundamentals training series.

511-14 Gas Turbine Air Systems

If properly maintained, the gas turbine can be a power plant's most valuable asset. However, just like any other generation asset, the technician must be able to identify systems and subsystems to keep it running at peak efficiency.

The Gas Turbine Air System training course focuses on several of an air system's subsystems. This online course covers:

- Air inlet systems
- Cooling air and sealing air
- Exhaust temperature reference
- Simple cycle exhaust
- Combined cycle exhaust

Gas Turbine Air Systems is part of the Combustion Turbine Fundamentals training series.

511-15 Gas Turbine Water Wash and Drain Systems

If properly maintained, the gas turbine can be one of a power plant's most valued assets. Like any other generation asset, it requires a technician to identify systems and subsystems to keep it running at peak efficiency.

The Gas Turbine Water Wash and Drain System training course describes several subsystems of the water and drain system. This online course explains:

- Water wash system
- Steam/water injection
- Water/fuel drains

Gas Turbine Water Wash and Drain System is part of the Combustion Turbine Fundamentals training series.

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521 Combustion Air and Flue Gas Systems

521-01 Introduction to Combustion Air and Flue Gas Systems

Combustion air is used to efficiently burn fuels in boiler applications. When fuel burns, it travels through the flue gas system. The Introduction to Combustion Air and Flue Gas Systems training course introduces these systems and their contribution to efficient electricity generation.

This online course describes how the combustion system works and provides a working knowledge of combustion and flue gas systems. Topics included are combustion air, combustion principles, primary and secondary air characteristics, forced draft and induced draft fans, air preheaters, and dust collection techniques.

This course is part of the Combustion Air and Flue Gas System series.

521-02 Combustion Air and Flue Gas Flow Paths and Components

The previous lesson in this series introduced the design and function of the combustion air and flue gas systems. The Combustion Air and Flue Gas Flow Path and Components training course builds on that knowledge and focuses on the individual flow paths and their elements. It highlights how their efficient operation relates to overall plant performance.

This online training course traces the flow paths of typical power plant combustion air and flue gas systems. It describes how major components within these paths operate. This course covers:

- Forced draft (FD) fans
- Air preheaters
- Wind box/primary and secondary air
- Boiler components
- Dust collection/particulate recovery components
- Scrubber components
- Induced draft (ID) fan
- Flue gas stack

This course is part of the Combustion Air and Flue Gas System training series.

521-03 Control Loops and Methods of Control

Power plant startup, shutdown, and normal operations involve many individual operational events. Each of these events must occur successfully and in the right sequence to ensure the plant's safe operation. The Control Loops and Methods of Control training course introduces control loops and methods of control that safely direct operational events in a power plant.

This online training course covers:

- Control basics
- Integration of interlock logic gates
- PID closed loop control methods

Control Loops and Methods of Control is part of the Combustion Air and Flue Gas System training series.

521-04 Combustion Air and Flue Gas System Startup

The startup process for boiler fan operation systems vary from plant to plant. However, most plant standing operating procedures share a similar set of activities. Pre-start preparation and post-start monitoring of the fan operation system are important pieces of an operator's job.

The Combustion Air and Flue Gas System Startup training course describes the steps performed when putting the boiler fan operation system into service. This online course focuses on:

- ID and FD fan preparation
- Ignitor and boiler preparation
- Starting the FD fans
- Boiler purge
- Air preheaters

This course is part of the Combustion Air and Flue Gas System training series.

521-05 Maintaining Fan Operations in Combustion and Flue Gas Systems

Boiler fan operating procedures vary from plant to plant. The Maintaining Fan Operations in Combustion Air and Flue Gas Systems training course illustrates standard operational procedures for maintaining normal fan operations.

This online training course describes how to perform the checks and monitoring necessary to maintain fan operations. It includes:

- Maintaining normal fan operations
- Maintaining fan oil lube reserves
- Air preheater maintenance
- Miscellaneous maintenance checks
- Abnormal conditions

This course is part of the Combustion Air and Flue Gas System training series.

521-06 Combustion Air and Flue Gas System Shutdown Process

Every boiler or power plant has a specific shutdown process outlined in a standard operating procedure. These shutdown procedures must be followed step-by-step to ensure worker safety and minimize equipment damage.

The Combustion Air and Flue Gas System Shutdown training course provides an understanding of the shutdown process. It highlights general knowledge of an operator's shutdown responsibilities, including:

- Primary air fans
- FD and ID fans
- Air preheaters

This course is part of the Combustion Air and Flue Gas System training series.

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522 Coal Handling System

522-01 Coal Handling System

Coal is an abundant natural resource found all over the world. Power plants handle coal delivery in many different ways, including unit trains, barges, and trucks. The Coal Handling Systems training course identifies common coal handling processes. It also discusses the operation of essential equipment at the plant site.

This online training course covers coal transport, storage and management, and processing.

This course is part of the Coal Handling System training series.

523 Boiler Fuel Systems

523-01 Boiler Fuel System Function

The boiler fuel system supplies heat for the boiler to burn. Once fuel is delivered to the boiler, the energy it contains is harnessed to produce electricity. The boiler fuel system consists of many components that must coordinate their operations to ensure the power generating unit operates safely and effectively.

Each generating unit is slightly different, but the basic components are consistent throughout the industry. The Boiler Fuel System Function training course introduces the fuel system components. it describes the boiler fuel system functions and differences between types of systems.

This course covers:

- Boiler fuel system function
- Coals used in boiler fuel systems
- Conveyor, tripper, and silo components
- Gravimetric feeder components and pulverizer
- Cyclone burner port
- Corner fired boiler systems

Boiler Fuel System Function is part of the Boiler Fuel Systems training series.

523-02 Process and Methods of Control for Boiler Fuel System

The Process and Methods of Control for the Boiler Fuel System training course examines the process control loops and methods of control within the boiler fuel systems. It includes operations of the digital control system, its logical variables, and the interface of subsystems to automate the operations of the boiler fuel supply.

This online course describes the digital control system that regulates and automates the boiler fuel system components to meet specific setpoints and desired production totals.

This course is part of the Boiler Fuel Systems training series.

523-03 Boiler Fuel System Startup

When the boiler fuel system is started, each component must be set for operation. The procedure for starting the boiler fuel system begins with ensuring the seal air, pulverizer and feeder components are operational and set for the desired capacity. The oil and lubrication systems must also be checked for operation before starting the pulverizers and completing the feeder permissives. Coordinating these procedures with operators in the control room ensures a safe and efficient startup of the boiler fuel system.

The Boiler Fuel System Startup training course explains standard procedures for initiating the boiler fuel system components during startup. It focuses on:

- Seal air, pulverizers, and feeders
- Lubrication and bearing oil levels
- Starting the pulverizers
- Feeder start permissives

This online training course is part of the Boiler Fuel Systems training series.

523-04 Normal Operation of the Boiler Fuel Systems

The Normal Operation of the Boiler Fuel Systems training course describes normal operations. It identifies checks operators perform on system components, including pulverizer, silos and feeder components, and system air supplies.

This online course explains:

- Pulverizer operations
- Feeder operations and silos
- Primary and secondary air fans

This course is part of the Boiler Fuel Systems training series.

523-05 Shutdown of the Boiler Fuel System

The Shutdown of the Boiler Fuel System training course focuses on the shutdown procedures. It describes the controlled and emergency shutdown procedures, including:

- Feeders and pulverizer
- Emergency pulverizer and feeder shutdown
- Extinguishing a pulverizer fire

This online course is part of the Boiler Fuel Systems training series.

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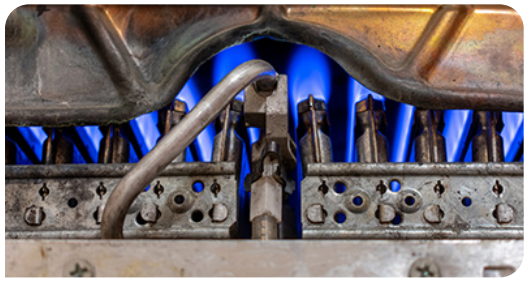

531 Hydrocarbon Fired Boilers

531-01 Combustion Theory

Energy is stored in fuel. That energy is released when the fuel is burned. Knowing basic combustion theory is necessary to understand how fuel is safely and efficiently used to generate electricity.

The Combustion Theory training course explains the different types of fossil fuels used in an industrial setting and describes their characteristics. It also covers the elements and conditions that must be present for fuel combustion to happen.

This course examines:

- Fossil fuels
- Fossil fuel characteristics
- Basic combustion process
- Combustion types
- Three T's of combustion

Combustion Theory is part of the Hydrocarbon Fired Boilers training series.

531-02 Basic Boiler Design

Boilers have many applications, including heating systems, industrial processes, and electricity production. Understanding basic boiler design is necessary to safely operate high and low pressure steam boilers.

The Basic Boiler Design training course explains why different boiler types are used for different processes. It also describes the basic components that make up a firetube and watertube boiler. This online course discusses the circulation paths through each type of boiler.

Basic Boiler Design is part of the Hydrocarbon Fired Boilers training series.

531-03 Boiler Valves and Steam Fittings

All boilers require steam fittings and auxiliary equipment, such as valves, gauges, and steam traps, to operate. Understanding the design and operation of these components is necessary to operate steam boilers safely and efficiently.

The Boiler Valves and Steam Fittings training course identifies the different types of valves, gauges, and steam traps used to operate a steam boiler. It also explains how these steam fittings are used to safely operate a steam boiler. This online training course focuses on:

- Valve types
- Water columns and gauge glasses
- Safety and relief valves
- Pressure gauges
- Steam traps
- Feedwater regulators

Boiler Valves and Steam Fittings is part of the Hydrocarbon Fired Boilers training series.

531-04 Boiler Fuel and Air Systems

An operating boiler requires a controlled amount of fuel and air to safely and efficiently product steam. Understanding the equipment found in the fuel and air systems and knowing how to properly operate it is necessary to manage a boiler.

The Boiler Fuel and Air Systems training course identifies the basic equipment found in high-pressure gas and fuel oil systems. It describes fuel oil burner design and operation. This online course also discusses boiler draft and outlines the different equipment used to control draft in a boiler. This course covers:

- Boiler firing rate
- High-pressure gas systems
- Fuel oil systems
- Burner design and operation
- Boiler draft

Boiler Fuel and Air Systems is part of the Hydrocarbon Fired Boilers training series.

531-05 Boiler Water and Steam Cycle

Boilers depend on three main systems that make up the water and steam cycle to operate effectively. Understanding the condensate, feedwater, and main steam systems is necessary to operate high and low pressure steam boilers.

The Boiler Water and Steam Cycle training course explains the basic components that make up a condensate and feedwater system. It describes the flow path through those systems. It also discusses the difference between saturated steam and superheated steam. This online course identifies the factors that affect steam quality. It covers:

- Heat transfer
- Heat exchangers
- Condensate systems
- Feedwater systems
- Steam cycle

Boiler Water and Steam Cycle is part of the Hydrocarbon Fired Boilers training series.

531-06 Boiler Heat Recovery System

A boiler's efficiency can be significantly increased by using heat recovery systems. Understanding the design and operation of superheaters, economizers, and air preheaters is necessary to efficiently operate a boiler.

The Boiler Heat Recovery System training course explains the equipment used to recover waste heat in a boiler. It also describes the basic design and operation of this equipment. This online course focuses on:

- Types of heat recovery equipment
- Economizers
- Superheaters
- Air preheaters

Boiler Heat Recovery System is part of the Hydrocarbon Fired Boilers training series.

- 100 Safety, Health, and Plant Science
- 200 Mechanical Maintenance
- 300 Electrical Transmission and Distribution
- 400 Electrical Maintenance
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531-07 Scrubbers and Ash Removal Systems

Burning fossil fuels in boilers creates byproducts harmful to the environment. Knowing the harmful byproducts of combustions, such as fly ash, sulfur dioxide, and nitrogen dioxide, is necessary to understand the importance of pollution control equipment installed on modern boilers.

The Scrubbers and Ash Removal System training course identifies the primary pollutants emitted from fossil-fuel boilers. It explains the basic design and operation of baghouses, electrostatic precipitators, and scrubbers. This online course includes:

- Pollution types
- Bottom ash removal systems
- Fly ash removal systems
- SO2 and NO2 control

Scrubbers and Ash Removal Systems is part of the Hydrocarbon Fired Boilers training series.

531-08 Boiler Operator Roles and Responsibilities

Modern boilers operate with sophisticated computer systems and automated controllers. A boiler operator's primary role is taking the correct action when the automated systems fail. Knowing the operator's roles and responsibilities is necessary for the plant's safety and success.

The Boiler Operator Roles and Responsibilities training course explains the operator's work environment and primary responsibilities. It describes the basic rounds and routine an operator completes during their shift. This online training course covers:

- Work environment
- Operator rounds and routines
- Boiler startup and shutdown

Boiler Operator Roles and Responsibilities is part of the Hydrocarbon Fired Boilers training series.

533 Boiler Firing Controls and Components

533-01 Fuel Combustion and Controls

Complete combustion is important in any furnace to ensure fuel is fully consumed to achieve its peak Btu value. Any unburned fuel is a waste and costs the company efficiency and production. With fuel costs always rising, fuel controls must operate at peak performance.

The Fuel Combustion and Controls training course explains the importance of complete combustion. It also describes the components needed to make complete combustion possible. This course identifies the different fuel controls used on a pulverized unit and cyclone unit.

This online training course discusses:

- Combustion chamber
- Types of fuel burned
- Oil guns
- Pulverized coal firing
- Cyclone furnace
- Fuel oil atomizer

Fuel Combustion and Controls is part of the Boiler Firing Controls and Components training series.

533-02 Boiler Burner Controls and Management

Combustion controls and burner management systems have two functions. First, they maintain constant steam flow or pressure under varying loads by managing the proper input of fuel and air. Second, they maintain safe and efficient operation throughout the boiler's load range. Many systems are available to fit the needs of specific applications. Proper system selection depends on the boiler size and type, the fuel used, and the plant's operating requirements. Using proper burner controls increases the plant's efficiency, response time, and safety.

The Boiler Burner Controls and Management training course describes the control types used, control hardware, and the effects of optimizing combustion. It explains the system requirements for burner management, including flame monitoring techniques and scanning coal flames.

This online course is part of the Boiler Firing Controls and Components training series.

535 Fundamental Aspects of Emission Controls

535-01 Flue Gas Desulfurization System

Pollution introduces contaminants into an environment in predetermined or agreed upon proportions or frame of reference. These contaminants cause instability, disorder, harm, or discomfort to physical systems and/or living organisms. The flue gas produced by power plant boilers contains waste gases and particulates. If flue gas is released without being treated, these waste gases and particulates could pollute the environment.

The Flue Gas Desulfurization System describes the design and function of control systems that remove sulfur oxides and particulates from flue gas. It also outlines recovery systems which concentrate the sulfur oxides present in the flue gas and convert them into usable by-products.

This online training course identifies the wastes contained in flue case. It covers scrubber basics, including components and operation of wet and dry scrubbers.

This course is part of the Fundamental Aspects of Emission Controls training series.

535-02 Flue Gas Desulfurization, Open Spray Design, Part 1

As discussed in the previous course, flue gas produced by power plant boilers contains water gases and particulates that can pollute the environment if released untreated. Using the flue gas desulfurization system (FGDS) open spray design has proven to substantially reduce sulfur dioxide in the flue gases emanating from a coal-fired plant.

The Flue Gas Desulfurization, Open Spray, Part 1 training course explains how open spray FDGS design effectively reduces sulfur dioxide and provides flexibility in meeting its emission requirements. This online training course covers:

- Operating philosophy and purpose
- Flyash and lime modes
- Absorber tower and reaction tank
- Dampers and ductwork

This course is part of the Fundamental Aspects of Emission Controls training series.

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535-03 **Flue Gas Desulfurization, Open Spray Design, Part 2**

Part one discussed how the flue gas travels through the open spray design scrubber. Flue Gas Desulfurization, Open Spray, Part 2 discusses the process surrounding waste slurry, including cleaning and reuse.

This online training course explains the process for cleaning SO2 out of flue gas. It also provides general knowledge of each system used in the process. This course includes:

- Maintaining scrubber slurry
- Blowdown system
- Pond return system
- Lime process
- Flyash process
- Scrubber inverters

This course is part of the Fundamental Aspects of Emission controls training series.

535-04 **Dry Scrubber Operation**

Dry scrubber air pollution control systems vary in complexity. Simple units dump a reagent into the duct in front of a conventional baghouse. Integrated systems use proprietary temperature control, reagent mixture, and specialized baghouse designs. As a result, scrubber operating efficiency varies widely.

The Dry Scrubber Operations training course explores dry scrubber design and function. It compares different installations and describes some subtle design and operation differences that may account for higher pollution removal efficiencies. This online course discusses:

- Dry scrubber basics
- Dry scrubber operation
- Dry scrubber design
- Baghouse design

Dry Scrubber Operation is part of the Fundamental Aspects of Emission Controls training series.

535-05 **Selective Catalytic Reduction (SCR) System**

Selective Catalytic Reduction (SCR) is used throughout the world today to lower greenhouse gases such as nitrous oxides (NOx).

The Selective Catalytic Reduction (SCR) System training course explains what SCR is and its importance. It identifies the SCR system components. This online training course focuses on:

- What SCR is
- SCR chemistry
- SCR components
- SCR operation and safety

Selective Catalytic Reduction System is part of the Fundamental Aspects of Emission Controls training series.

535-09 **Introduction to Continuous Emission Monitoring Systems**

In 1990, Congress passed the Clean Air Act and changed the way industries monitor and account for certain air pollutant emissions. The act requires industries to use Continuous Emission Monitoring (CEM) for these emissions. The pollutants monitored vary depending on the industry and processes taking place. The Environmental Protection Agency (EPA) has identified various industrial facilities affected by CEM requirements. This course focuses on power generation facilities, specifically fossil-fuel burning plants.

The Introduction to Continuous Emission Monitoring Systems training course describes the purpose, function, and major components of CEM systems, including:

- Fundamentals
- Certified loop components
- Additional components
- Fuel gas flow transmitters
- Megawatt transmitters
- Probe and sample system

This course is part of the Fundamental Aspects of Emission controls training series.

535-10 **Fundamentals of Using a CEMS**

In 1990, Congress passed the Clean Air Act and changed the way industries monitor and account for certain air pollutant emissions. The act requires industries to use Continuous Emission Monitoring (CEM) for these emissions. The pollutants monitored vary depending on the industry and processes taking place. The Environmental Protection Agency (EPA) has identified various industrial facilities affected by CEM requirements. This course focuses on power generation facilities, specifically fossil-fuel burning plants.

The Fundamentals of Using a CEMS training course describes:

- Collecting CEMS data readings
- Changing calibration gas bottles
- Entering new data into the engineering workstations
- CEM probe and sample system troubleshooting
- Preventative maintenance procedures

It also explains the processes for performing weekly, monthly, quarterly, semi-annual, and annual preventive maintenance procedures.

This online course is part of the Fundamental Aspects of Emission Controls training series.

535-11 **Calibration of CEMS Components**

The Clean Air Act states acidic deposition (acid rain) is believed to cause long-term and long-range detrimental impacts. The first effects appear on trees and in lakes. The gradual rise in worldwide temperatures, called global warming, is believed to be caused by increasing carbon dioxide emissions from fossil fuel combustion. These reasons require fossil fuel plants to have a certified, operational Continuous Emissions Monitoring System (CEMS) in place.

The Calibration of CEMS Components training course describes how system components are calibrated to maintain accurate emissions records. This online course discusses:

- Stack flowmeter calibration
- Nitrogen oxide, sulfur dioxide, and carbon dioxide analyzer calibration
- Opacity monitor calibration

This course is part of the Fundamental Aspects of Emission Controls training series.

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551 Circulating Water System

551-01 Introduction to Circulating Water Systems

Power generation produces large amounts of heat which must be removed for continued operations. The circulating water system is responsible for cooling even the largest power generation plants. The Introduction to Circulating Water Systems training course introduces the design and operation of a circulating water system.

This online course covers the function of a circulating water system, intake structure and inlet header, condenser, outlet header and discharge structure, and system operation.

This course is part of the Circulating Water System series.

551-02 Function of the Circulating Water System

Thermal power plants need a large amount of cooling water to condense the turbine exhaust steam. The primary function of a circulating water system is to help this process by providing the plant's condensers with a continuous supply of cooling water. The Function of the Circulating Water System training course describes the basic design and operation of a circulating water system.

This online training course covers a circulating water system's general operation. It discusses water versus air cooling media and covers types of circulating water systems.

This course is part of the Circulating Water System training series.

551-03 Circulating Water System Components

As discussed previously, modern electrical generation systems burn fossil fuels to produce heat, which is used to boil water to make steam. The energy in the steam is converted into mechanical energy in the turbine which is then converted to electrical energy in the generator. This process requires thousands of gallons of water per minute passing through the condenser. The primary function of the circulating water system is to provide a continuous supply of cooling water to the power plant condensers.

The Circulating Water System Components training course takes a closer look at some of the components that make up the circulating water system. This course describes the components and explains their functions, including:

- Intake structure components
- Circulating water pumps
- Condensers
- Cooling components

This online course is part of the Circulating Water System training series.

551-04 Circulating Water System Startup

As discussed in previous courses, circulating water pumps are very powerful and can quickly move immense volumes of water. The circulating water system is usually started in conjunction with the unit startup. It is required to support steam system operation and is placed in operation before releasing steam from the steam generators to the condenser. If the circulating water system cools auxiliary water cooling systems or supplies raw water for other purposes, it may be needed earlier in the startup sequence.

Starting the circulating water system is a complex activity that requires planning, preparation, and careful execution to prevent system damage and ensure efficient operation. The Circulating Water System Startup training course explains the steps needed to safely start the circulating water system. These steps include:

- Preparing to start
- Starting the circulating water pump
- Post-start activities

This online course is part of the Circulating Water System training series.

551-05 Circulating Water System Normal Operations

Keeping a power plant running efficiently and safely is important. Doing so depends on the circulating water system delivering a continuous supply of water to the condenser and removing waste heat from the plant. To support normal operations, operators:

- Monitor plant conditions
- Realign the systems for periodic maintenance
- Operate systems to ensure safety and improve efficiency

The Circulating Water System Normal Operations training course describes how to monitor and adjust the system during normal operations. This online course covers:

- Circulating water system parameters
- System maintenance
- Cycle efficiency

This course is part of the Circulating Water System training series.

551-06 Circulating Water System Shutdown

In addition to supplying indispensable condenser cooling water, the circulating water system provides many plants with a source of auxiliary water for cooling and other industrial purposes. Because so many essential functions depend on it, the circulating water system is not normally shut down except for essential cleaning or repairs. If operators are forced to shut the system down, they do it in a safe, controlled manner to minimize damage and get the plant back into operation in an efficient manner.

The Circulating Water System Shutdown training course describes system shutdown procedures, including:

- Shutdown preparations
- Shutting down the circulating water system

This course is part of the Circulating Water System training series.

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› 200 Mechanical Maintenance
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551-07 Circulating Water System Controls

As discussed in previous courses, circulating water systems play a large role in a power plant's efficient operation. Instruments and controls provide operators with a way to monitor, adjust, and manage circulating water systems.

The Circulating Water System Controls training course looks at how instrument output signals can be coupled to controls that allow the system to automatically respond to changing conditions. It describes typical instruments and control systems used within the circulating water system. This online course discusses:

- Basic instruments
- Automatic controls
- Intake structure instruments
- Condenser instruments

This course is part of the Circulating Water Systems training series.

551-08 Cooling Towers: Operating Principles and Designs

Cooling towers are used in large industrial facilities to cool hot circulating water streams. The Cooling Towers: Operating Principles and Designs training course introduces the theory of cooling tower operation. It also describes their classification. It explores the advantages and disadvantages of different tower designs. This online training course focuses on:

- Cooling tower definition
- Natural draft cooling towers
- Mechanical draft cooling towers
- Cooling tower classification by air flow
- Cooling tower classification by shape

This course is part of the Circulating Water Systems training series.

551-09 Cooling Towers: Components

Cooling towers are designed to cool hot circulating water streams. Cooling tower components are crucial to this process.

The Cooling Towers: Components training course describes the major structural, mechanical, and electrical components of most cooling towers.

This online course is part of the Circulating Water systems training series.

551-10 Air Cooled Condensers

Condensers remove spent steam from equipment and transform it into useable water via condensation. Although condensers are used in many industries, an air cooled condenser (ACC) is a commonly employed component at electrical power facilities worldwide. The low pressure turbine sends exhaust steam to the ACC which condenses the steam into water using cool ambient air. The condensed water returns to the boiler for heating so it can be reused to power the turbine.

This process results in a flow of water that continuously changes states from liquid to steam, to liquid, to steam. It offers a convenient method to improve the power plant's efficiency.

The Air Cooled Condensers training course describes their basic design principles, structural components, and operating considerations. It discusses the flow of water for steam condensation in an A-frame ACC. It also explains typical ACC maintenance procedures. This online training course focuses on:

- ACC fundamentals
- ACC principle and design
- Water flow through an ACC
- ACC operations
- ACC maintenance and operational considerations

Air Cooled condensers is part of the Circulating Water systems training series.

553 Condensate and Feedwater Systems

553-01 Introduction to the Condensate System

Industrial boilers need a pure source of water. Two systems supply the water: the condensate system and the feedwater system. The Introduction to the Condensate System training course covers the condensate system. This system provides the initial water supply to an industrial boiler.

This online training explains the purpose and operation of all major components in the condensate system. Topics include understanding the boiler water supply, major condensate system components, and deaerator design. This training also discusses the relationship between the condensate and feedwater systems.

Introduction to Condensate Systems is part of the Condensate and Feedwater Systems series.

553-02 Introduction to the Feedwater System

As discussed in the previous lesson, industrial boilers need a constant supply of water while operating. This water is supplied by both the condensate system and the feedwater system. The feedwater system is essential to all power plants that rely on steam production to generate electricity. This system, along with the condensate system, reuses water for steam production as part of the boiler steam and water cycle.

The Introduction to Feedwater System training course examines the feedwater system, which supplies high pressure water to the steam drum when the boiler is operating. Understanding the components of this system is needed to safely operate power plant boilers.

This online training course explains the feedwater flow path, boiler feed pumps, and feedwater heat exchanges.

This online course is part of the Condensate and Feedwater Systems training series.

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› 200 Mechanical Maintenance
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553-03 Condensate and Feedwater Systems Operation

The condensate and feedwater systems supply the boiler with preheated water. Understanding the basic startup and operation of these systems is required to safely operate power plant boilers.

The Condensate and Feedwater Systems Operation training course describes the basic procedures for startup and operation of the condensate and feedwater system. It explains:

- Filling the condensate system
- Filling the feedwater system
- Normal operating checks

This course is part of the Condensate and Feedwater Systems training series.

553-04 Condensate and Feedwater System Control

Modern power plants use sophisticated automatic control systems to track and control process flows through plant systems. Operators must understand the components and flow paths within the condensate and feedwater systems to ensure they respond correctly when abnormal conditions develop.

The Condensate and Feedwater System Control training course explains steam drum level control methods. It discusses their overall relationship to condensate and feedwater systems. This online training course also describes:

- Single-and three-element control
- Level indication types
- Abnormal operating conditions

This course is part of the Condensate and Feedwater System training series.

555 Boiler Feed Pumps

555-01 Boiler Feed Pump and Associated Auxiliary Equipment

Power plants that generate steam must be able to pump large quantities of water at high pressure. Large boiler feed pumps can pump water at 2500 psi or more into a steam drum while maintaining enough flow to keep the steam generation process working at full capacity.

The Boiler Feed Pump and Associated Auxiliary Equipment training course examines the design and function of a boiler feed pump. It describes the general description and features, including:

- Pump drives
- Pump auxiliaries 1
- Pump auxiliaries 2

This course is part of the Boiler Feed Pumps training course.

555-02 Boiler Feed Pump Flow Path and Major Components

The boiler feed pump is a critical piece of equipment used to maintain water level in a boiler. A large boiler manages this by keeping an operating level in the steam drum.

The Boiler Feed Pump Flow Path and Major Components training course lists the components in the feedwater flow path. It also describes how different components contribute to the feedwater system's operation. This online training courses focuses on:

- Closed loop system
- Suction side path
- Discharge side path
- High pressure feedwater heaters
- Other components

This course is part of the Boiler Feed Pumps training series.

555-03 Boiler Feed Pump Water Supply and Control Systems

The boiler feed pump is in a closed loop system that supplies and maintains water in the steam drum. The process loop ties together a condensate side and a feedwater side to complete the process cycle. Understanding this process, and the control loops that make it possible, is critical to successful power plant operation.

The Boiler Feed Pump Water Supply and Control System training course discusses the value of maintaining proper water levels in the hotwell, deaerator, and steam drum. It also describes how built-in controls help maintain a balanced system. This online training course explains:

- Condensate side controls
- Deaerator controls
- Boiler feed pump controls
- Boiler feedwater controls
- Steam drum gauge glass
- Boiler master control

This course is part of the Boiler Feed Pumps training series.

555-04 Boiler Feed Pump Startup

Specific steps are required to place a boiler feed pump in service. Starting a boiler feed pump without following the step-by-step procedures can cause damage to the pump and the operators.

The Boiler Feed Pump Startup training course explains the proper steps to place a boiler feed pump in training. This online course includes:

- Sign off and permissives
- Normal start up - motor-driven boiler feed pump
- Deaerator and control room checklist
- Normal start up - steam-driven boiler feed pump
- Turbine, pump, and control center checklists

This course is part of the Boiler Feed Pumps training series.

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555-05 Boiler Feed Pump Daily Operations

The boiler feed pump is one piece of equipment that must be dependable for 24-hour-a-day operation. Conducting regular checks and monitoring the pump continuously is important to ensure this reliability. Performing routine inspections may seem like a mundane task at times, but it is during these routine checks that deficiencies are found and many costly repairs prevented.

The Boiler Feed Pump Daily Operations training course describes routine tests associated with the boiler feed pump. It explains the importance of performing these tests regularly. It also describes what steps to take in response to test results. This online course focuses on:

- Routine inspections on a running pump
- Performing tests
- Boiler feed pump trips
- Shutting down a boiler feed pump

This course is part of the Boiler Feed Pumps training series.

557 Boiler Water and Steam Systems

557-01 Function of Boiler Water and Steam Systems

Power plants need a constant supply of water to produce steam in a boiler. Water is heated as it travels through boiler tubes and turns into steam capable of driving a steam generator. The Function of Boiler Water and Steam Systems training course examines the common boiler types and how their boiler water and steam systems are arranged. Understanding these principles is critical to safely operate a power plant boiler.

This course describes:

- Natural-circulation boiler water systems
- Natural-circulation boiler steam systems
- Forced-circulation boilers

This course is part of the Boiler Water and Steam Systems training series.

557-02 Flow Paths & Components of the Boiler Water and Steam Systems

The Flow Paths & Components of the Boiler Water and System Systems training course explains and describes the flow paths and major components in the boiler steam and water systems. It discusses the efficient use of feedwater, boiler flame, the drying and heating of steam, and using flue gases to continually produce and reheat steam to power turbines.

This online training course identifies and explains the major components of boiler water and steam systems including:

- Flow paths and components of boiler water
- Steam cycle and components
- Steam cycle controls

This course is part of the Boiler Water and Steam Systems training series.

557-03 Process Controls for Boiler Water and Steam Systems

The Process Controls for Boiler Water and Steam Systems training course explores the processes for monitoring and controlling the boiler drum water levels. It also reviews the fuel, water, and air supplies that meet the steam system demands. This online training course describes the process and controls of the boiler water and steam systems. It includes:

- Boiler drum levels
- Steam flow controls
- Low water fuel cutoffs

This course is part of the Boiler Water and Steam Systems training series.

557-04 Startup Procedures for Boiler Water and Steam Systems

The Startup Procedures for Boiler Water and Steam Systems training course presents the startup procedures for these systems. Startup begins by assessing the systems' initial conditions and ensuring those conditions meet the design standards identified in the plant's operating manual. The second step is starting the boiler feed pumps and ensuring their proper function. A specific order of operations and many specifications cause the boiler to roll online. A comprehensive walk-down of the boiler's water and steam systems completes the startup.

This online course identifies and explains the general startup procedures for a boiler's steam and water cycle. It covers:

- Initial conditions
- Boiler feed pumps
- Startup procedures

This course is part of the Boiler Water and Steam Systems training series.

557-05 Normal Operation of the Boiler Water and Steam Systems

The Normal Operation of the Boiler Water and Steam Systems training course identifies and describes the:

- Normal operations of the water and steam systems
- Relationships of components and systems affecting the water and steam cycle within the plant
- Adjustments to temperature, pressures, and levels that may impact the efficient operation of the power generation unit

This online course includes:

- Water level maintenance
- Boiler water systems
- Boiler steam system

This course is part of the Boiler Water and Steam Systems training series.

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557-06 **Shutdown of the Boiler Water and Steam Systems**

The Shutdown of the Boiler Water and Steam System training course reviews the system and explains the shutdown process.

This course is part of the Boiler Water and Steam Systems training series.

559 Water Treatment

559-01 **Molecular Chemistry of Water**

Water and its unique characteristics are essential for operating most industrial facilities. Water's molecular chemistry highlights its many uses and handling requirements. The Molecular Chemistry of Water training course discusses which elements combine to form water and why they bond. It also covers water's special characteristics and its basic history.

This online course starts with water's origin, history, and importance. It then covers water's atomic structure, molecules and characteristics.

Molecular Chemistry of Water is part of the Water Treatment training series.

559-02 **Elements and the Periodic Table of Elements**

Industrial facilities use many chemicals to treat the water they use for cooling and other industrial purposes. Some working knowledge of elements and their interactions is important in understanding water chemistry.

The Elements and the Periodic Table of Elements training course presents the periodic table of elements and introduces how electrons control an elements' chemical behavior and actions. This online training course explains how elements are named, grouped, and listed on the periodic table. Topics include:

- History of the periodic table
- Elements and classifications
- Periodic table layout

This course is part of the Water Treatment training series.

559-03 **Chemical Compounds**

Most of the chemicals used in water treatment at industrial plants are simple compounds. Understanding how these compounds are formed and how they chemically react with water and other substances helps determine the proper chemicals needed for various water treatments.

The Chemical Compounds training course identifies individual compounds and describes their creation, reactions, and bonds. It also provides a working knowledge of solutions. This online training course covers:

- Chemical bonding
- Chemical formulas and reactions
- Solutions, solubility, and saturation

Chemical Compounds is part of the Water Treatment training series.

559-04 **Corrosion Causes and Effects**

Corrosion affects many systems throughout an industrial facility. It plays a major role in a facility's efficiency and availability. The water treatment program is the first line of defense in stopping and controlling unwanted corrosion.

The Corrosion Causes and Effects training course identifies those causes and effects found in an industrial facility's water and steam systems. This online course discusses:

- Corrosion basics
- Localized corrosion, macroscopic
- Localized corrosion, microscopic
- Acids, bases, and pH
- Corrosion in steam production

Corrosion Causes and Effects is part of the Water Treatment training series.

559-05 **Corrosion Control in Steam Production**

Corrosion occurs on an ongoing basis throughout a steam production facility. Due to their temperature, pressure, and environmental differences, specific systems in steam production experience different types of corrosion. The main purpose of a water treatment program is to minimize corrosion and add to the long-term availability of the facility.

The Corrosion Control in Steam Production training course describes how corrosion affects various systems within a steam production facility. It explains how to detect common failures caused by excessive corrosion. It also identifies causes and discusses means employed to control corrosion. This online course includes:

- Introduction to chemical treatment programs
- Commonly used treatment programs
- Pre-boiler or feedwater system-specific corrosion
- Boiler system-specific corrosion
- Condensate system-specific corrosion

Corrosion Control in Steam Production is part of the Water Treatment training series.

559-06 **Steam Chemistry Control Guidelines**

Converting treated water into steam is the boiler's primary purpose. Steam purity is achieved only through adherence to strict control guidelines through the entire system. Proper sampling and analysis programs are critical to achieving an efficient and highly accurate water treatment program.

The Steam Chemistry Control Guidelines training course describes the importance of steam purity and chemistry to the steam turbine. It identifies how water and steam chemistry are controlled and monitored. This online training course focuses on:

- Steam purity
- Carryover
- Steam turbine deposition and corrosion
- System sampling and analysis

Steam Chemistry Control Guidelines is part of the Water Treatment training series.

› **100** Safety, Health, and Plant Science
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› **600** Instrumentation and Control
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559-07 Industrial Water Treatment Systems

The proper processing and treatment of raw water to reach high quality boiler feedwater is essential to maintaining boiler efficiency and performance. Water pre-treatment and treatment involves many steps and chemicals. The systems used must handle large volumes of water while removing specific contaminants.

The Industrial Water Treatment Systems training course builds on information provided in previous lessons. It examines the entire water treatment system step-by-step. This online course describes the water pre-treatment and treatment process as it may exist in a typical industrial plant. It also discusses chemical cleaning options for boilers and turbines. This course explores:

- Raw water sources flow
- Clarification
- Filtration
- Ion exchange or demineralization
- Water treatment chemicals
- Chemical cleaning

This course is part of the Water Treatment training series.

559-08 Introduction to Desalination

Freshwater is essential for industrial, agricultural, and domestic purposes. From drinking water to crop irrigation to plant makeup water, an abundance of freshwater remains a critical necessity for society. But as the world's population continues to rise, growing demands on Earth's natural freshwater supplies cannot be sustained.

However, the availability of saline water sources, such as seawater and brackish water, added to the growing number of desalination plants, can be a reliable supplement to, and even substitute for, freshwater resources.

The Introduction to Desalination training course defines desalination and discusses its importance to society. It describes membrane and thermal technologies used for the desalination process. It also explains the purpose of pre- and post-treatment systems. This online course focuses on:

- Introduction to desalination
- Pre-treatment process
- Desalination technologies
- Post-treatment process

Introduction to Desalination is part of the Water Treatment training series.

559-09 Desalination: Pre-and Post-Treatment of Water

A lot of freshwater is needed daily to meet society's domestic, agriculture, and industrial demands. Desalination, creating freshwater from seawater, continues to grow in popularity as a way to supplement the Earth's natural freshwater resources.

However, salty seawater cannot be taken from the sea and sent directly to a desalination system's specialized equipment. It must first undergo pretreatment upstream to prepare it for processing through the specific desalination technology employed at the facility. Similarly, before the produced freshwater can be distributed for use in society, it must undergo post-treatment to prepare it for its intended use.

The Desalination: Pre- and Post-Treatment of Water training course discusses concerns with bringing seawater into a desalination system for processing. It also describes specific pre- and post-treatment applications common to processing water through reverse osmosis and thermal distillation desalination systems.

This online course is part of the Water Treatment training series.

559-10 Reverse Osmosis

Desalination is the process of separating freshwater from the dissolved salts and minerals in a saline water source, such as seaweed or brackish water. Both membrane and desalination technologies exist. Reverse osmosis (RO) is a commonly employed membrane technology used in industrial desalination facilities. The most advanced RO membranes use the following, in a compact and efficient design:

- Thin film composite construction
- Membrane spacers
- Crossflow processing

Other processes and devices, such as pre-treatment, post-treatment, and energy recovery systems, are used with the RO system to complete the separation of freshwater from seawater.

The Reverse Osmosis training course discusses the scientific principles on which RO technology is based. It explains the primary function of an RO desalination system. This online training course identifies the key components of a typical RO system, with an emphasis on membrane technology. It also highlights the importance of permeate recovery percentage. This course covers:

- RO technology fundamentals
- RO membrane technology
- RO membrane basics
- RO systems
- RO operations

Reverse Osmosis is part of the Water Treatment training series.

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559-11 Thermal Desalination Technologies

Desalination separates freshwater from the dissolved salts and minerals in a saline water source, such as seaweed or brackish water. One way to do this is to use a thermal desalination technology.

Thermal desalination technologies rely on the distillation process, the evaporation and condensation of the earth's hydrological cycle. Water must reach boiling point to vaporize so it can be collected as freshwater condensate. For this reason, thermal processes need a substantial amount of energy.

Waste heat and steam from other sources, such as power generation, can greatly reduce the energy used.

The Thermal Desalination Technologies training course discusses the principles on which these technologies are based. It explains the importance waste heat or steam plays in multiple effect distillation (MED) and multi-stage flash (MSF) systems.

This course discusses the key components of MED and MSF systems, including the function of evaporators, condensers, demisters, and brine heaters. It discusses the differences between MED and MSF systems. This online course includes:

- Thermal desalination technology fundamentals
- Thermal desalination processes and systems
- Multiple effect distillation (MED)
- Multi-stage flash (MSF) distillation
- Thermal desalination operations

Thermal Desalination Technologies is part of the Water Treatment training series.

560 Plant Electrical Systems

560-01 Main Transformers

Main station transformers are an integral part of the power transmission system. The Main Transformers training course examines the components, functions, protective systems, and operator inspections involved with a power plant's main station transformer.

This online training course describes a main station transformer's design and function. It discusses systems and inspections related to system protection. This course also explains operator inspections.

Main Transformers is part of the Plant Electrical Systems training series.

560-02 Station Service System

Station service systems, also called plant electrical distribution systems, are used to supply electricity to the equipment and utilities that operate a power plant.

The Station Service System training course discusses the components, operation, and routine inspections associated with a typical power plant's station service system. It describes a system's general design and operation.

This course is part of the Plant Electrical Systems training series.

560-03 Fuses and Circuit Breakers

Circuits in industrial equipment need protection from overcurrents and faults. Though simple in theory, circuit breakers and fuses serve some of the most complex roles in modern electrical systems. Unlike other devices, circuit breakers serve as both operation and protection devices, while fuses are the most reliable method of system protection available.

The Fuses and Circuit Breakers training course explains the design and function of commonly used fuses and circuit breakers. It also discusses how to protect them. This online training course explains fuse and circuit breaker construction, application, testing, and troubleshooting. It includes:

- Fuse uses
- Fuse replacement
- Circuit breaker operation
- Circuit breaker types

Fuses and Circuit Breakers is part of the Plant Electrical Systems training series.

560-04 Protective Relays and Instrument Transformers

Industrial plant equipment requires protection against a variety of electrical faults. The Protecting Relays and Instrument Transformers training course explains the role and use of this equipment. It describes the design and function of different types of protective relays and instrument transformers used to protect electrical circuits and equipment.

This online course is part of the Plant Electrical Systems training series.

560-05 Equipment Disconnects and Grounding

Many devices are used to isolate and shield equipment from damage and protect personnel working on electrical equipment and circuitry.

The Equipment Disconnects and Grounding training course describes the design and function of disconnects used to isolate electric equipment. It also explains some methods of grounding plant equipment.

This online course is part of the Plant Electrical Systems training series.

561 Unit Startup and Shutdown

561-01 Preparing for Power Plant Startups

Power plant startups are complicated tasks that require plant operator planning and preparation. Understanding plant equipment operating procedures is necessary to prepare for a power plant startup. The Preparing for Power Plant Startups training course describes the basic checks that must be performed on plant equipment before a plant startup.

This online training course explains boiler and turbine ramp rates. It also reviews pre-startup checks for boilers, turbines, and generators. Preparing for Power Plant Startups is part of the Unit Startup and Shutdown training series.

This online course is part of the Unit Startup and Shutdown training series.

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561-02 **Power Plant Startup Procedures**

Power plant startups require interaction between plant operators who have a complete understanding of plant systems. Knowing the relationship between plant systems is necessary to perform a power plant startup safely and efficiently.

The Power Plant Startup Procedures training course describes the basic concepts and typical tasks associated with putting a fossil fuel plant online. These include:

- Firing the boiler
- Rolling the turbine
- Synchronizing the generator
- Picking up load

This online course is part of the Unit Startup and Shutdown training series.

561-03 **Preparing for Power Plant Shutdown**

Power plant shutdown, much like startup, is a complicated task that needs planning and preparation from plant operators. The Preparing for Power Plant Shutdown training course focuses on the operating procedures and equipment knowledge needed for a safe and effective shutdown. It describes the basic tasks that must be performed on plant equipment before a shutdown. This course focuses on:

- Defining power plant shutdowns
- Preparing the boiler for shutdown
- Reducing load on the turbine/generator

This online course is part of the Unit Startup and Shutdown training series.

561-04 **Power Plant Shutdown Procedures**

As discussed in the previous course, safe and effective power plant shutdowns require interaction between plant operators who have a complete understanding of plant systems.

The Power Plant Shutdown Procedures training course focuses on the operating procedures and equipment knowledge needed to safely and effectively shut down a power plant. It describes the steps associated with taking a fossil-fired fuel plant off-line. It also explains how operators prepare a plant for an annual outage. This online course covers:

- Shutting down the boiler
- Shutting down the turbine/generator
- Preparing the plant for maintenance

This course is part of the Unit Startup and Shutdown training series.

563 Efficiency, Reliability, and Environmentally Sensitive Operations

563-01 **Basic Power Plant Efficiency**

A power plant burns fuel such as coal, oil, or gas in a boiler to make steam. The steam turns a turbine which is connected to an electric generator. The electrical energy generated is then sold to customers.

A power plant can lose energy in many places during this process. Knowing where the losses will be and how much is acceptable is vital to effective power plant operations.

The Basic Power Plant Efficiency training course explains the relationship between energy, work, and efficiency. It describes how the boiler, turbine cycle, and generator comprise heat rate, which is the term used to express power plant efficiency. It discusses how power plant losses know as controllable losses affect heat rate.

Finally, it covers the roles of operations, maintenance, engineering, and plant management in the plant heat rate program.

This course includes:

- Main plant components
- Power plant efficiency terms
- Performance parameters
- Workgroup responsibilities

Basic Power Plant Efficiency is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-02 **Water and Steam: Terms and Principles**

Water is the working fluid in a typical power plant. Liquid water under high pressure feeds into the boiler where heat is added to turn it to steam. The steam turns the turbine generator to generate electricity. Steam leaves the turbine and goes to the condenser where it turns back to liquid. It is then pumped back into the boiler to start the process again.

During the process, energy is either added or removed from the working fluid. Knowing the terms and principles of the water process is necessary to understand how a power plant's components and systems work.

The Water and Steam Terms and Principles training course explain the relationship between energy, temperature, and the phases of water. It also describes the importance of latent heat, which is associated with water phase changes without a temperature change.

This online training course explains how to calculate quality and moisture content given the weights of steam and water in a vessel. It also explains the relationship of a subcooled liquid, saturated liquid, saturated steam, latent vaporization heat, and superheated steam on a temperature/enthalpy diagram.

This course is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

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563-03 **Heat Transfer Principles**

Efficiency improvement is an ongoing task in power plants. The ability to effectively transfer heat is one of the functions that optimizes efficiency. Almost every component in the plant uses heat transfer as its main or secondary function. Understanding basic heat transfer concepts is necessary to understand how equipment works and how to troubleshoot when things go wrong.

The Heat Transfer Principles training course identifies the primary parameter that causes heat transfer. It explains the three types of heat transfer and their characteristics. It also describes conditions and problems that negatively affect proper heat transfer. This online course explores heat transfer rate given operating parameters in heat transfer equipment. This online training course includes:

- Heat transfer basics
- Heat conservation
- Heat transfer rate
- Heat transfer problem analysis

Heat Transfer Principles is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-04 **Laws and Principles of Thermodynamics**

Heat in motion (thermodynamics) is a common theme to most major power plant components and systems. Understanding the laws, relevant fluid properties, and principles is necessary to operate a power plant safely and efficiently.

The Laws and Principles of Thermodynamics training course explains thermodynamics and defines terms associated with it. it also explains the relationship of thermodynamic principles to plant efficiency. This online training course focuses on:

- Thermodynamics and thermodynamic properties
- Thermodynamic laws
- Using steam tables, charts, and diagrams
- Efficiency of plant processes

Laws and Principles of Thermodynamics is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-05 **Performance Parameters**

The power industry has adopted Heat Rate as the standard method of evaluating power plant unit efficiency. Net unit heat rate (NUHR) is the number of British thermal units (Btu) in fuel required to generate each kilowatt-hour of electrical energy delivered to the grid. Many things affect a power plant unit's NUHR. Among these things are some key controlled and/or monitored operating parameters that affect efficiency. Knowing these parameters, how much they affect unit efficiency, and conditions that can prevent them from being operated at their optimum level is important for maintaining efficient unit operation.

The Performance Parameters training course list several key operating parameters that affect efficiency. It describes problems that can prevent key operating parameters from being operated at optimum level. It also shows how to calculate the approximate extra fuel cost associated with operating a key performance parameter off design value.

Performance Parameters is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-06 **Balancing Efficiency, Availability, Capability, and Flexibility**

Power plants must operate efficiently. But efficiency should not be the only consideration in decisions about unit operation. Power plant units operate as part of a fleet that must be efficient yet flexible, available, and capable. Understanding this balance is important in making proper operations and maintenance decisions for power plant units in a fleet environment.

The Balancing Efficiency, Availability, Capability, and Flexibility training course describes the concept of economic dispatch. It also discusses running and shutdown reserves and why they are important. This online course explains:

- Economic dispatch
- Reserve capacity
- Efficiency
- Availability
- Capability
- Flexibility

This course is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-07 **Instrumentation and Controls**

Instrumentation and controls are some of the most important tools power plant operators use. Several small instrumentation and control systems make up what is known as the distributed control system (DCS). The DCS makes operating a common electrical generation unit much easier. Operators make small adjustments to the system to keep important operating parameters at their designated value.

The Instrumentation and Controls training course explains the operation of a boiler-following instrumentation and control system. It describes the effects when actual parameter values are different than what is indicated. it also discusses common responses to instrumentation and control problems. This online course covers:

- Instrumentation principles
- Control principles
- Principles and purposes of instrumentation and control
- Boiler-following system
- Parameter actual and indicated mismatch
- Responding to IC problems

The Instrumentation and Controls course is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

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563-08 **Boiler Efficiency**

Maintaining boiler efficiency, at a level as close as possible to design, is important for safe and efficient power plant operation. Properly monitoring and controlling parameters that affect boiler efficiency helps maintain a safe working environment while keeping unit operation costs low and efficiency high.

The Boiler Efficiency training course discusses the major factors that can cause an increase or decrease in efficiency. It describes boiler efficiency and explains how to determine it. This online course includes:

- Efficiency components
- Analyzing efficiency
- Air heater efficiency
- Furnace, windbox, burner, and regulator efficiency
- Waterwalls, economizer, superheater, and reheater efficiency

Boiler Efficiency is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-09 **Boiler Reliability**

When operated and maintained properly, boilers can be safe and reliable. However, many things can affect boiler reliability. Knowing and avoiding these things is an important part of ensuring the boiler is a safe and reliable power plant component.

The Boiler Reliability training course explains the importance of maintaining proper boiler parameters. It identifies several things that can decrease a boiler's reliability. This online training course covers:

- Controlling parameters
- Maintaining chemistry
- Common operations
- Emergency operations

Boiler Reliability is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-10 **Turbine Efficiency**

The turbine is one of the most important components in a power plant unit. A reduction in turbine efficiency or integrity can directly affect the unit's production costs, capacity, or safety. Understanding which conditions can increase or decrease turbine efficiency or reliability is vital to keeping the turbine efficient, reliable, and safe.

The Turbine Efficiency training course describes how parameters, components, and problems can affect efficiency. It explains how to calculate turbine efficiency. This online course discusses:

- Turbine efficiency analysis
- Chemical deposits erosion
- Seal leakage
- Steam attributes
- Attemperation
- Steam flow

Turbine Efficiency is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-11 **Condenser Efficiency**

Turbine back pressure is the performance parameter with the largest impact on power plant unit efficiency. The condenser is the component that maintains turbine back pressure at levels that promote high efficiency. Therefore, understanding condenser efficiency and operation is necessary to reach optimum power plant unit efficiency and reliability.

The Condenser Efficiency training course explains how to evaluate and maintain this efficiency. This online course covers:

- Key parameters
- Efficiency calculation
- Heat transfer
- Performance curves

Condenser Efficiency is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-12 **Condenser Operation and Reliability**

Many things can affect a condenser's operational performance. Almost all condenser problems result in an increase in low pressure turbine back pressure. As discussed in the previous course, this parameter has the most impact on power plant efficiency. Understanding how to troubleshoot and correct the operational problems associated with condensers is necessary to maintain safe and reliable operations.

The Condenser Operation and Reliability training course describes ways to troubleshoot condensers. It identifies symptoms of several problems that can negatively affect condenser reliability. It also discusses methods to fix specific condenser problems and optimize operational performance. This online training course focuses on:

- Normal operation
- Problems that reduce effective heat transfer surface area
- Problems that reduce the heat transfer coefficient
- Problems that increase the average circulating water temperature
- Pump selection curves

Condenser Operation and Reliability is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

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563-13 Feedwater Heater Operation and Efficiency

Steam is extracted from the turbine at various points after some of its energy has been used to make electrical energy. This steam is used for various purposes. Feedwater heaters use a large part of extraction steam to heat condensate and feedwater before it returns to the boiler. This practice makes the unit more efficient and reliable.

The Feedwater Heater Operation and Efficiency training course describes operations. It also discusses problems that affect performance. This online training course covers:

- Normal feedwater heater operation
- Methods of evaluating feedwater heater performance
- Common feedwater heater problems
- Effects of poor feedwater heater performance

This course is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-14 Pump Efficiency and Reliability

Pumps are used throughout power plants to move a variety of fluids for various purposes. There are many types and sizes of pumps, each designed to perform specific functions. As with other plant components, it's important to understand pump operation to operate and maintain them and evaluate their efficiency.

The Pump Efficiency and Reliability training course describes commonly used pumps and discusses their maintenance. This online training course explores:

- Pump operation and efficiency basics
- Reliability
- Net positive suction head
- Pump curves
- Pump laws

Pump Efficiency and Reliability is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

563-15 Environmentally Sensitive Operations

Many power plant operations and components can negatively impact the environment. Such releases are usually related to poor operation, equipment malfunction, or plant inefficiencies. These challenges can lead to negative environmental effects, health hazards, and/or government agency imposed penalties. Understanding environmentally sensitive operations is an important part of minimizing negative impacts.

The Environmentally Sensitive Operations training course discusses a power plant's potential environmental impacts. It describes methods to minimize those impacts. This online course covers:

- Relationship between efficiency and environmental impact
- Types of environmental impacts
- Boiler operation emissions
- Reducing boiler flue gas emissions

This course is part of the Efficiency, Reliability, and Environmentally Sensitive Operations training series.

565 Plant Control System

565-01 Distributed Control System Fundamentals

A distributed control system (DCS) is distributed, or spread, among several different unit processes. Knowing this type of control system is necessary to understand how processes, equipment, and parameters are controlled in a typical power plant unit.

The Distributed Control System Fundamentals training course describes the design and function of a DCS. it provides an overview and covers:

- Digital communication units
- Communications links
- Central control rooms
- Control, interface, and database software

The Distributed Control System Fundamentals course is part of the Plant Control System training series.

565-02 Distributed Control System Components

Distributed control systems (DCS) rely on many components to control processes, equipment, and parameters in a power plant. Understanding the use and capabilities of common DCS components is important to properly operate and monitor the power plant unit.

The Distributed Control System Components training course describes the functions of components associated with a common DCS, including:

- Instrumentation
- Transmitters and input/output modules
- Processors, computer buses, and multiplexers
- Human machine interface
- Control devices/actuators

Distributed Control System Components is part of the Plant Control System training course.

565-03 Using Distributed Control System Diagrams

Power plant diagrams and drawings offer a wealth of information. Understanding these drawings and diagrams, including distributed control system (DCS) logical diagrams, is needed to operate and troubleshoot plant equipment, systems, and controls.

The Using Distributed Control System Diagrams training course describes the basic symbols and parts of a logic diagram. It also explains how to use a DCS logic diagram as a troubleshooting tool. This online course covers:

- Drawing elements
- Interlocks and permissives
- Control and trip setpoints
- Trim and bias
- Troubleshooting

This course is part of the Plant Control System training series.

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565-04 **Power Plant Unit Control**

A modern power plant unit uses a distributed control system (DCS) for monitoring and control. Several small instrumentation and control systems make up the DCS. It makes operating a common electrical generation unit much easier. During normal conditions, operators make small adjustments on the systems, components, and parameters to keep them operating at their designed values. Understanding common unit control methods is necessary to operate and troubleshoot a power plant unit.

The Power Plant Unit Control training course describes the basic design and function of a boiler-following instrumentation and control system. This online course includes:

- Changing unit load
- Steam, feedwater, and condensate flow
- Fuel flow
- Furnace draft and air flow
- Auxiliaries
- Operator responsibilities

This course is part of the Plant Control System training series.

567 Heat Rate Optimization

567-01 **Basic Principles of Water and Steam**

Water and steam are used extensively in industrial plants to transfer energy from one substance to another or one location to another. Understanding water and steam properties, terms, and principles is needed to effectively and efficiently operate those industrial plant systems that rely on the energy in water and steam to function correctly.

The Basic Principles of Water and Steam training course describes water's properties in liquid, solid, and gaseous states. It also details how heat and pressure effect changes between these states.

This online course explains how to calculate quality and moisture content given the weights of steam and liquid water. It also outlines the relationship of subcooled liquid, saturated liquid, saturated steam, latent vaporization heat, and superheated steam on a provided temperature/enthalpy diagram.

This course covers:

- Temperature and heat
- Latent heat
- Pressure
- Natural circulation versus pressure

Basic Principles of Water and Steam is part of the Heat Rate Optimization training series.

567-02 **Saturated Steam Tables**

Steam is used in industry to transfer energy from one source to another. Steam tables document the properties of water and steam under various conditions. Understanding these tables helps in operating equipment that uses water and steam as an energy source.

The Saturated Steam Tables training course explains the terms associated with the physical characteristics of water, saturated steam, and superheated steam. It also demonstrates how to interpret the information shown in steam tables. This online training course includes:

- Introduction to steam tables
- Steam table terms
- Saturated steam tables

Saturated Steam Tables is part of the Heat Rate Optimization training series.

567-03 **Superheated Steam Tables**

As discussed in the previous lesson, many industrial plants rely on superheated steam to power large machinery and manufacture various products. Understanding the physical characteristics of superheated steam is necessary to operate industrial systems and equipment efficiently and effectively.

The Superheated Steam Tables training course discusses the physical characteristics of superheated steam under various circumstances. It shows how to interpret information found in superheated steam tables and use it in practical applications. This online course explains:

- Interpreting superheated steam tables
- Steam tables and steam turbine operation
- Critical point of water

Superheated Steam Tables is part of the Heat Rate Optimization training series.

581 Diesel Power Plant Operation

581-01 **Diesel Engines for Power Generation**

Diesel engines are the workhorse of today's industry. Critical infrastructure depends on them to provide uninterrupted, reliable electrical power when joined with an electric generator. Operators and managers need to understand diesel engine construction, function, and application.

The Diesel Engines for Power Generation training course describes a diesel engine's design and operation. It also explains the diesel generator's importance. This online training course covers diesel engine basics, major diesel engine components, diesel engine types, and the role of the diesel generator.

Diesel Engines for Power Generation is part of the Diesel Power Plant Operation training series.

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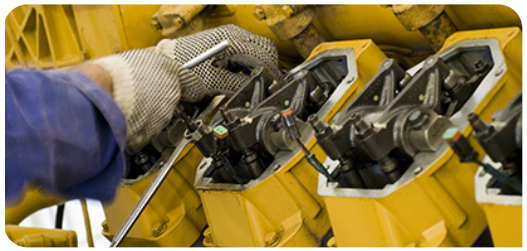
581-02 **Diesel Engine Support Systems**

To operate, a diesel engine needs supporting systems for cooling, lubrication, fuel injection, air intake, and exhaust, Depending on the engine's size, power, and application, these five essential elements vary in size and complexity.

The Diesel Engine Support Systems training course explains the operation and importance of the supporting systems that make the diesel engine run smoothly, including:

- Coolant system
- Lubrication system
- Fuel injection system
- Air intake system
- Exhaust systems

This course is part of the Diesel Power Plant Operation training series.



581-03 **Diesel Powered Generation**

Electric power interruptions, even short ones, create situations that could risk public health and safety. Emergency generation must immediately and reliably delver full strength electrical power when the primary power supply system fails.

The Diesel Powered Generation training course describes applications for diesel power generation. It also explains the effects generators have on society and the environment. This online training course focuses on:

- Prime power generation
- Where diesel powered generation is used
- Diesel power generation features
- DC generator components
- DC generator operating principles

This course is part of the Diesel Power Plant Operation training series.

581-04 **Diesel Power Plant Operations**

Whatever a diesel generator's application, its physical requirements are similar. For a diesel engine to run, it needs fuel and air, lube oil, liquid coolant, and an exhaust system. These requirements must be integrated into operations such as startup and shutdown. They also must be integrated into the plant's monitoring, control, and protective systems.

The Diesel Power Plant Operations training course describes basic diesel power plant operations. This online training course discusses:

- Startup operations
- Shutdown operations
- Monitoring operations

This course is part of the Diesel Power Plant Operations training series.

581-05 **Diesel Plant Control Systems and Protective Devices**

Every diesel generator has a traditional control panel beside the engine. It allows the operator to observe the important operating conditions from this single location. This panel also includes the controls for switching circuit breakers and synchronizing the unit.

The Diesel Plant Control Systems and Protective Devices training course focuses on the panel's functions and the controls it monitors. It describes the design and function of a typical control panel and identifies its primary components. it also explains the importance of the protective devices built into the system. This online course includes:

- Control panel components and generator controls
- SCADA (Supervisory Control and Data Acquisition)
- Protective devices

This course is part of the Diesel Power Plant Operations training series.

581-06 **Diesel Plant Routine Maintenance**

Manufacturers provide specific information for the use and care of their products. Their instructions come from wide experience under varying conditions and should be closely followed. Before performing any other checks, maintenance personnel should always look for signs of physical damage. Routine maintenance instructions include scheduled inspections of prime movers, generators and exciters, and switchgear. When a service or repair is needed, refer to the manufacturer's guidelines for specific information.

The Diesel Plant Routine Maintenance training course describes routine diesel inspections. It also discusses their contribution to safe and efficient operations. This online course focuses on:

- When to perform inspections
- Prime mover maintenance
- Generator and exciter maintenance
- Switchgear maintenance

Diesel Plant Routine Maintenance is part of the Diesel Power Plant Operations training series.

582 **Combined Cycle Power Plant Operations**

582-01 **Combined Cycle Power Plants**

The Combined Cycle Power Plants training course introduces the basics behind operating a combined cycle power plant. This online course describes the thermal cycles of a combined cycle power plant. It also defines common terminology and lists advantages and disadvantages of different plant configurations.

The Combined Cycle Power Plants training covers plant operations, design parameters, and configurations.

This course is part of the Combined Cycle Power Plant Operations series.

- 100 Safety, Health, and Plant Science
- 200 Mechanical Maintenance
- 300 Electrical Transmission and Distribution
- 400 Electrical Maintenance
- 500 Power Generating Systems and Operations
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582-02 Combined Cycle Power Plant Components

The major components of a combined cycle power plant are the combustion turbine, heat recovery steam generator, steam turbine, and electrical generator. The Combined Cycle Power Plant Components training course is based on a heavy duty combustion turbine and explains the basic operation and common designs of the major components.

This online training course covers:

- Combustion turbine
- Heat recovery steam generator
- Steam turbine
- Generator

This course is part of the combined Cycle Power Plant Operations series.

582-03 HRSG - Flow Path and Major Equipment

A heat recovery steam generator's (HRSG) major components are the economizer, evaporator, steam drum, and superheater.

The HRSG - Flow Path and Major Equipment training course discusses these components, plus the combustion gas and water/steam flow paths as they are found in combined cycle plant.

This online training course is part of the combined Cycle Power Plant Operations series.

582-04 HRSG - Auxiliary Equipment and Systems

The main components of a heat recovery steam generator (HRSG) were discussed in the previous lesson. Many other systems also contribute to safe, efficient, and environmentally safe HRSG operation.

The HRSG - Auxiliary Equipment and Systems training course identifies auxiliary system found in an HRSG unit. It also discusses their purpose and how they benefit the unit.

This course is part of the Combined Cycle Power Plant Operations series.

582-05 HRSG - Basic Operating Concerns and Conditions

The successful operation of Heat Recovery Steam Generators (HSRG) depends on operators following specific procedures and monitoring multiple parameters. The HRSG - Basic Operating Concerns and Conditions training course examines the startup and shutdown procedures for HSRG and its auxiliary systems. It also discusses normal operating checks.

This online training course explains the steps for startup. shutdown, and normal operations. It also covers conditions that may cause concern during operations.

HSRG - Basic Operating Concerns and Conditions is part of the Combined Cycle Power Plant Operations series.

582-06 Combined Cycle Steam and Feedwater Operating Principles

Combined cycle power plants need a constant supply of water to produce steam in a heat recovery steam generator, or HRSG. The feedwater pumps supply water to the HSRG where it produces steam sufficient for driving a turbine generator.

A typical HRSG consists of three pressure modules, each of which can produce a different steam pressure. These steam pressures correspond to the low pressure, intermediate pressure, and high pressure stage of the steam turbine.

The Combined Cycle Steam and Feedwater Operating Principles training course describes the feedwater and steam flow paths in a typical combined cycle plant. It also explains the HSRG design principles that govern plant operations. This online training course covers:

- HRSG steam production
- Common HRSG designs
- HRSG feedwater systems

This course is part of the Combined Cycle Power Plant Operations series.

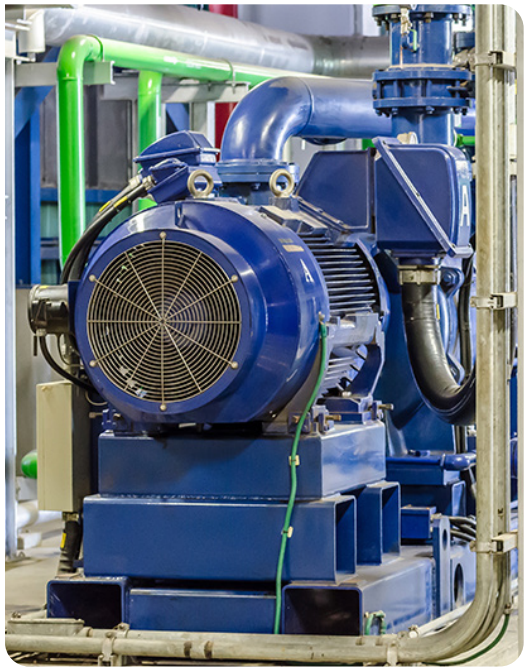
582-07 Combined Cycle Condensate and Circulating Water Systems

Cooling water for the condenser is supplied by the circulating water supply. Large pumps and pipes supply cooling water from a nearby pond or river to the tubes in the condenser. As the turbine exhaust steam passes over the tubes, it transfers heat to the circulating water system, then returns to a cooling tower. In the cooling tower, air cools the heated circulating before returning to its source.

The Combined Cycle Condensate and Circulating Water Systems training course examines the components and major flow paths of the condensate and circulating water systems in a typical triple-pressure combined cycle plant. Understanding these components is necessary for the safe operation of a combined cycle plant. This online course focuses on:

- Condensate system overview
- Condensate system components
- Circulating water system

This course is part of the Combined Cycle Power Plant Operations series.



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582-08 Combined Cycle Auxiliary Systems

The combined cycle power plant uses a gas turbine and generator to produce electrical power. It uses an HRSG to recover heat from the turbine gas exhaust. This heat is used to produce steam which drives a steam turbine and generator, increasing the plant's electrical output. These major components need many auxiliary systems to function. Understanding the auxiliary systems' design and operation is important for safe and efficient power plant operation.

Many components throughout a plant need cooling to function properly. Auxiliary systems provide cooling water to many of the heat loads. They are also responsible for making sure the water used during plant operations is clean and treated to reduce plant component corrosion.

The Combined Cycle Auxiliary Systems training course describes the function and operation of the auxiliary components and systems in a typical combined cycle plant. It covers:

- Closed cooling water system
- Treatment, sampling, and analysis
- Chemical addition methods

This course is part of the Combined Cycle Power Plant Operations training series.

582-10 Steam Turbines in a Combined Cycle Plant

The steam turbine is an essential part of all combined cycle power plants. Generators rely on rotating motion to produce electrical power. The heat recovery steam generator (HRSG) produces high-energy steam, which the steam turbine then converts into rotational energy for driving the generator.

The Steam Turbines in a Combined Cycle Power Plant training course describes the turbine's basic components. It explains their purpose in relation to a combined cycle power plant. It also identifies common turbine auxiliaries and describes basic steam turbine operations. This online course includes:

- Energy conversion in a steam turbine
- Basic steam turbine design
- Turbine valves
- Steam turbine operation

This course is part of the Combined Cycle Power Plant Operations training series.

582-12 Combined Cycle Instrument and Control Air System

Many systems throughout a combined cycle power plant require instrument and control air to function properly. The system used to provide clean, dry air for instrumentation and control functions may be referred to as either Instrument Air or Control Air. In this course, the term Control Air will be used. To ensure the proper operation of controls, instruments, and air-operated valves (AOVs), the control air system relies on various components such as air compressors, receivers, filters, and air dryers to deliver exceptionally pure air.

The Combined Cycle Instrument and Control Air System training course describes the function and operation of the instrument and control air system found in a typical combined cycle power plant. It also discusses the power plant components that use instrument and control air.

582-13 Control Loops in a Combined Cycle Plant

Industrial processes automation involves coordinates equipment, instrumentation, and control techniques to generate a product safely, efficiently, and to specification. Automated control loops, which may be open or closed, use several main elements. In an industrial facility, operators, interact with these control systems to monitor or influence process outcomes.

The Control Loops in a Combined Cycle Plant training course explains the concept of control loops as related to the automated control of power plant processes. It also describes the process control methods used in common power plant systems. This online course includes:

- Automated control introduction
- Closed loop methods of control
- Feedback and feed forward
- Control modes and coincidence logic

This course is part of the Combined Cycle Power Plant Operations series.

583 Hydroelectric Power Plant Operations

583-01 The Hydroelectric Role in the Power System

The Hydroelectric Role in the Power System training course presents the advantages of hydroelectricity and the role it plays in the power system. This course covers the environmental and economic advantages while discussing the hydroelectric generating station's operational efficiency.

This online course introduces hydroelectricity and explains its role in power production and consumption. It describes hydroelectricity's significant contributions to the environment and economy.

583-02 Hydroelectric Power Stations

Hydroelectric power generating stations have a variety of construction designs. The Hydroelectric Power Stations training course identifies a station's major components. It examines hydroelectric power station operations, describes variations, and explains the common components.

This online training course covers:

- Dam designs
- Principles of hydroelectric power generation
- Upstream intake gate design features
- Common hydroelectric generating station components
- Water intake design

This course is part of the Hydroelectric Power Plant Operations training series.

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583-03 **Water Management**

Hydrology is the study of water. It is important to understand the aspects of hydrology that affect hydroelectric operations. Electricity generation is directly related to the water sources available today and in the future.

The Water Management training course discusses the various principles and applications of water management. It identifies the different issues and their impacts on hydroelectric power generation. This online course explains inflow forecasts and environmental considerations.

Water Management is part of the Power Plant Operations training series.

583-04 **Hydroelectric Generators**

The Hydroelectric Generators training course identifies and describes operations of the hydroelectric power generator and the components of the lower unit. This online training course examines:

- Penstock, scroll case, pre-distributor, and suction tube
- Governor
- Wicket gates
- Guide and thrust bearings
- Turning head cover
- Turbines
- Generator and supports
- Generator operations

Hydroelectric Generators is part of the Power Plant Operations training series.

583-05 **Generator Monitoring and Control**

Hydraulic forces monitor and control the speed and frequencies of hydroelectric power generators. Several components also monitor and control the water flow through the wicket gates.

The Generator Monitoring and Control training course describes how generators in hydroelectric generating stations are tracked and managed. It identifies and explains the various controls of the turbine and generator. This online course discusses:

- Turbine generator operating principles
- Hydraulic governor
- Hydraulic governor components

Generator Monitoring and Control is part of the Power Plant Operations training series.

583-06 **Hydroelectric Plant Auxiliaries**

The Hydroelectric Plant Auxiliaries training course focuses on those auxiliary systems operating in a hydroelectric plant. This online course explains:

- Fire protection system
- Packing box
- Cooling water systems
- Cooling water pumps
- Station service air system

This course is part of the Hydroelectric Power Plant Operations training series.

583-07 **Operating Electrical Equipment in a Hydroelectric Plant**

The Operating Electrical Equipment in a Hydroelectric Plant identifies standard operating procedures for the relevant equipment. This online training course discusses:

- Operational pre-check conditions
- Precautions
- System startup and removal from service
- Lockout/tagout procedures

This course is part of the Hydroelectric Power Plant Operations training series.

583-08 **Mechanical Governor**

The governor system of a hydroelectric unit generator is an old but reliable design. It has many different and updated styles, but the operating principle is essentially the same. This discussion covers mechanical type governors. The programmable logical controller is discussed in another course.

The Mechanical Governor training course identifies its components and describes its operation. This online course focuses on:

- Major governor components
- Governor operations

Mechanical Governor is part of the Hydroelectric Power Plant Operations training series.

583-09 **Electric Governor**

The Electric Governor training course identifies the evolution of the electric governor, its components, its functions, and the governor operations.

This online course is part of the Hydroelectric Power Plant Operations training series.

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584 Biomass Energy

584-01 Introduction to Biomass Power Plants

Introduction to Biomass Power Plants discusses using biomass to generate electricity. It reviews the most common biomass fuels and compares the equipment used in biomass facilities. This course describes biomass storage, fuel handling equipment, and various fuel configurations.

This online training course includes:

- Biomass power plant fuels
- Storage and handling equipment
- Boiler furnaces and combustion

Introduction to Biomass Power Plants is part of the Biomass Energy training series.

584-02 Biomass and Waste to Energy Power Plants

The Biomass and Waste to Energy Power Plant course discusses waste to energy power production facilities. It also examines the different fuel types used to fire these facilities. It describes the most common designs and major waste components.

This online training course explains the difference between mass burn and refuse derived fuel waste to energy plants. It characterizes the fuel types and processing that takes place in these facilities. Finally, this course explores the combustion system used in these facilities.

This course covers:

- Municipal solid waste
- Refuse derived fuels
- Handling the raw waste
- Combustion system design

Biomass and Waste to Energy Power Plants is part of the Biomass Energy training series.

585 Wind Energy

585-01 Basic Wind Turbine Design

Wind turbines have become a significant source of the world's electrical energy. Understanding basic wind characteristics and wind turbine design is necessary to operate and maintain wind turbines. The Basic Wind Turbine Design training course explains how a wind turbine harnesses the kinetic energy in wind to convert into useful mechanical energy. This course also identifies the principle components of a modern wind turbine.

This course discusses wind turbine history. It identifies basic wind turbine types and their components.

Basic Wind Turbine Design is part of the Wind Energy training series.

585-02 Wind Farm Development

Developing a modern wind farm is a complex project, requiring multiple studies to determine the project's best size, location, and scale. The Wind Farm Development training course identifies basic considerations to decide a project's scope. It also discusses the factors to consider when identifying a possible wind farm location.

This online training course also explains the importance of an environmental study.

Wind Farm Development is part of the Wind Energy training series.

585-03 Horizontal Wind Turbine Design and Operation

Horizontal wind turbines, used to produce electricity, operate and respond to various wind conditions. Understanding basic wind turbine components and their operation is necessary for successful operation.

The Horizontal Wind Turbine Design and Operation training course explains how wind flowing over the blades causes the turbine rotor to turn. It also describes wind turbine component operation and how wind turbines are controlled. This online training course focuses on:

- Towers and blades
- Transmission and generator
- Wind turbine control

Horizontal Wind Turbine Design and Operation is part of the Wind Energy training series.

585-04 Wind Energy Production

As discussed previously, wind energy is quickly becoming a significant part of the national energy portfolio. Understanding the role wind energy serves in electrical systems helps you understand how it impacts electrical markets.

The Wind Energy Production training course discusses the relationship between the size of a wind farm and its capacity factor. It explains how wind energy impacts traditional energy markets. This online training course includes:

- Understanding wind energy
- Wind energy potential
- Cost of wind energy

This course is part of the Wind Energy training series.

586 Reciprocating Engine Power Plants

586-01 Introduction to Reciprocating Engine Power Plants

Reciprocating power plant engines are gaining in popularity as energy providers look to balance plant cost and efficiency with generation availability. The Introduction to Reciprocating Engine Power Plants training course introduces a reciprocating power plant's basic operations and describes a plant's varying configurations.

This online course discusses the engine's role in power plants and explains the reciprocating power plant layout.

This course is part of the Reciprocating Engine Power Plants series.

586-03 Fundamentals of Reciprocating Engine Design

Reciprocating engines are used at power plants throughout the world to provide flexible and efficient generation. The Fundamentals of Reciprocating Engine Design training course introduces the most common types of reciprocating engines and their major components. It also describes the major component functions as applied to power generation.

This online training course explains the combustion process. It also covers fuel types and additional delivery methods.

This course is part of the Reciprocating Engine Power Plants series.

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586-05 Reciprocating Engine Auxiliary Systems

Large reciprocating engines found in power plants need many auxiliary systems to support their operation. The Reciprocating Engine Auxiliary Systems training course introduces the major auxiliary systems found in a reciprocating engine power plant.

This online training course explains how these major systems operate and describes their components, including:

- Fuel system
- Lube oil system
- Compressed air systems
- Cooling water system
- Charge air and exhaust gas system

This course is part of the Reciprocating Engine Power Plants training series.

586-06 Reciprocating Engine Electrical and Control Systems

Reciprocating engine generating sets used in power production require sophisticated control systems to support their operation. The Reciprocating Engine Electrical and Control Systems training course introduces the common electrical and control systems used.

This online training course explains the electrical control modes used to maintain engine speed. It also discusses the control system used for starting, stopping, and maintaining safe engine operation. It includes:

- Engine control modes
- Engine starting permissives
- Automatic protective functions

This course is part of the Reciprocating Engine Power Plants training series.

586-07 Reciprocating Engine Operations

The successful startup, operation, and shutdown of a reciprocating engine depends on operators following specific procedures and monitoring multiple parameters. The Reciprocating Engine Operations training course examines the startup and shutdown procedures for a typical reciprocating engine generating set. It also discusses the routine checks performed during normal operations. Some special operating conditions are covered.

This course is part of the Reciprocating Engine Power Plants training series.

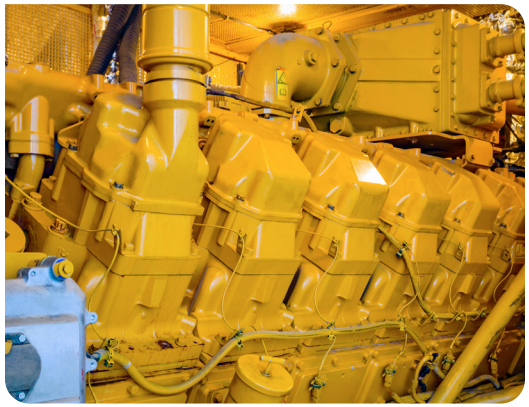
586-09 Generator Control in Reciprocating Engine Power Plants

Reciprocating engine generating sets need electrical control systems for their generators to provide stable power and share loads with other units on the grid. The Generator Control in Reciprocating Engine Power Plants training course introduces the common methods of generator control found in these power plants.

This online course explains generator operation modes and how generator output voltage is controlled. It describes ways the automatic generator control system regulates loading and protects against faults on the generator output. It focuses on:

- Generator control modes
- Synchronizing a generator
- Electrical faults

This course is part of the Reciprocating Engine Power Plants training series.



586-11 Reciprocating Engine General Inspection

Reciprocating engine power plants are a cheap, reliable, and environmentally friendly way to supply electrical power for commercial and home consumption. The Reciprocating Engine General Inspection training course introduces the general inspection concept. It also details some of the maintenance requirements. This online course identifies the components involved in an inspection and how to remove them for further inspection and overhaul.

This course is part of the Reciprocating Engine Power Plants training series.

587 Nuclear Energy

587-01 Nuclear Power Principles and Design

The Nuclear Power Principles and Design training course examines the basic design and operating principles of generating nuclear power to produce electricity. After discussing these concepts, the course examines the fission process. It also explores the most common reactor designs and their major components.

This online training course is part of the Nuclear Energy training series.

587-02 PWR and BWR Operation and Design

The PWR and BWR Operation and Design training course describes the design and operations of the two most common nuclear power plant designs: the pressurized water reactor and the boiling water reactor. This course explains the operating principles for both reactor types.

PWR and BWR Operation and Design are part of the Nuclear Energy training series.

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588 - Battery Energy Storage Systems (BESS)

588-01 Introduction to Battery Energy Storage Systems (BESS)

Battery storage systems are an exciting and evolving sector where innovation is meeting sustainability to revolutionize the way we harness and use electrical energy. Battery storage systems have emerged as key players in the transition toward a cleaner, more resilient energy alternative, offering solutions to challenges such as grid instability, renewable energy intermittency, and peak demand management.

The Introduction to Battery Energy Storage Systems training course explores the working principles of batteries and storage systems, fundamental components and their applications, and the implications of emerging technologies on the electric industry, the environment, and our lives. It explains the fundamental operation of batteries and battery storage systems. It also introduces battery components, applications, emerging trends, and environmental considerations shaping an innovative and exciting field of sustainable, clean energy.

588-02 Battery Energy Storage System Design

Battery energy storage systems, or BESS, are integral components of modern energy infrastructure, enabling efficient management and use of electrical energy across numerous applications. Designing and integrating these systems requires extensive knowledge and planning, considering critical parameters such as capacity, power ratings, efficiency considerations, sizing methodologies, system configurations, and safety protocols. Design of a BESS directly impacts its performance, safety, cost, and ability to support broader energy goals. This course explains and demonstrates key principles of BESS design, including efficiency optimization, scalability, cost-effectiveness, integration with renewable energy sources, and safety protocols. This course is part of the Battery Energy Storage Systems training series.

589 Solar Energy

589-01 Introduction to Solar Energy

The Introduction to Solar Energy training course examines the use of solar energy in electric power generation and explores the most common methods used to produce electricity from the sun. It explains the benefits of solar power generation and how it can complement generation from fossil fuels. It also describes the most common methods used today.

This course introduces solar energy fundamentals. It discusses two methods of generating solar power: photovoltaic systems and thermal systems.

Introduction to Solar Energy is part of the Solar Energy training series.

589-03 Solar Energy – Photovoltaic

The Solar Energy - Photovoltaic training course examines the basic design and operating principles of photovoltaic components used in producing electricity from solar energy. It explains the purpose of photovoltaic cells and describes how they are arranged to form arrays suitable for power generation. It also describes the common components required to support power generation from photovoltaic systems.

This online training course covers:

- Photovoltaic cells
- Cell arrangements
- Related equipment
- Photovoltaic applications

This course is part of the Solar Energy training series.

589-05 Solar Energy - Thermal Application

The Solar Energy - Thermal Application training course examines the basic design and operating principles of components used to produce electricity from solar thermal energy. This online course explains how concentrated solar power are used to generate electricity. This course focuses on:

- Concentrated solar power
- CSP plant components
- Concentrating solar collectors
- Thermal solar power plant design

This course is part of the Solar Energy training series.

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Instrumentation and Control

603 Process Controls Variables

603-01 Instrumentation and Control Review

Instrumentation and control is vital to plant safety and operation. Properly operating instrumentation and automatic control loops does not require a great deal of operator intervention. But, before a process is effectively controlled, it must be measured, or instrumented. The Instrumentation and Control Review training course describes basic operating procedures behind instrumentation and control. It identifies various instrumentation components and discusses how instrumentation systems collect and send information.

This online training course covers:

- Process variables
- Instrument categories/types
- Signals
- Process variable relationships

The Instrumentation and Control Review course is part of the Process Control Variable training series.

603-02 Principles of Temperature

Across most industries, temperature measurement is critical to ensure proper process function and equipment operation. Many processes rely on the transfer of heat energy from one location to another. While direct measurement of heat is difficult, temperature can be used to determine the amount of heat transferred in a system. Temperature can be measured as degrees on a scale or as an absolute value corresponding to the amount of heat energy present in a substance.

The Principles of Temperature training course explains the concepts of temperature and heat transfer, including converting between common temperature scales. This course explains:

- Heat and temperature
- Temperature scales and conversions
- Heat transfer mechanisms

Principles of Temperature is part of the Process Control Variable training series.

603-03 Principles of Pressure

Pressure is the most common process variable. It must be measured and controlled to ensure safe and efficient operations. Pressure is defined as force per unit area. It can be calculated by dividing the force by the area over which it is applied.

Pressure is measured using three common scales: absolute, gauge, and vacuum. The three common pressure units are atmosphere, psi, and inches of water.

The Principles of Pressure training course explains pressure and how it is measured. It explains how to apply conversion formulas to convert readings from one standard pressure scale to another. This online course covers:

- Factors affecting pressure
- Liquid pressure in a tank
- Gas pressure, volume, and temperature
- Pressure scales
- Pressure conversion

Principles of Pressure is part of the Process Control Variable training series.

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603-04 **Principles of Level**

Tank level measurement is crucial in most industrial environments, from power plants to manufacturing facilities to oil refineries. Understanding the different methods of level measurement and the technology used to describe them is needed to effectively work on any process equipment related to level.

The Principles of Level training course explains the concept of level. It describes how it is measured using industry standard terminology. This online course includes:

- Levels and measurement methods
- Additional terminology
- Determining level from pressure

Principles of Level is part of the Process Control Variable training series.

603-05 **Principles of Flow**

Flow, or the movement of fluid through a system, is an important part of process control in most systems. Flow measurement is also one of the most important tasks performed by process instrumentation and control equipment. Flow is normally expressed by the amount of material moved per unit of time, which is more precisely referred to as flow rate.

The Principles of Flow training course describes the principles of fluid flow. It demonstrates how these principles provide multiple means for measuring flow rate in the process industry. This online course covers:

- Measuring flow rate
- Flow measuring devices
- Flow characteristics
- Factors that affect flow measurement

Principles of Flow is part of the Process Control Variable training series.

603-06 **Temperature Instruments**

Temperature measurement is critical to ensure proper process function and equipment operation. The Temperature Instruments training course introduces you to the tools used throughout industry to measure temperature. It identifies various temperature measuring and sensing devices and describes their operation, including:

- Thermal expansion thermometers
- Electrical thermometers
- Infrared radiation thermometers

Temperature Instruments is part of the Process Control Variable training series.

603-07 **Pressure Measuring Devices**

Pressure must be maintained and controlled for many reasons, primarily safety. Pressure is measured using four common scales: absolute, gauge, vacuum, and differential. The Pressure Measuring Devices training course discusses the various measurement scales and the devices used to measure pressure. It also explains how to operate these devices.

Equipment covered includes liquid column manometers and elastic pressure sensors.

This online course is part of the Process Controls Variables series.

603-08 **Level Measuring Devices**

Level is the height of a liquid surface in reference to a starting point or zero. Knowing and maintaining proper levels contributes to safety and environmental compliance. Knowing how much material is located within a vessel is important to make definitive judgements about the process.

The Level Measuring Devices training course looks at instruments used to measure or sense the level of a tank, silo, or other vessel. It identifies various level sensing and measurement devices and describes their operation. This online course focuses on:

- Review of level measuring methods
- Direct measurement instruments
- Indirect measurement instruments

Level Measuring Devices is part of the Process Control Variables training series.

603-09 **Flow Measuring Devices**

Flow rate is defined as the amount of material passing a specific point per unit time. Flow rate measurement is one of the most complicated tasks performed by process instrumentation and control equipment.

The Flow Measuring Device training course identifies and describes the basic operation of various direct and indirect flow measurement devices. This online course covers:

- Mass flowmeters
- Velocity based flowmeters
- Variable area flowmeters
- Pressure based flowmeters

Flow Measuring Devices is part of the Process Control Variables training series.

603-15 **Weight Measuring Devices**

Weight is defined as the force or pull exerted on a an object by the Earth's gravitational field. Many different devices or weighing machines are used in industry to determine the accurate weight of raw materials, products, and equipment.

The Weight Measuring Devices training course examines these common devices. It describes various weight measuring devices and explains their operating principles. This online training course discusses:

- Balance scales
- Spring scales
- Load cells
- Batch scales
- Bell scales

Weight Measuring Devices is part of the Process Control Variables training series.

- 100 Safety, Health, and Plant Science
- 200 Mechanical Maintenance
- 300 Electrical Transmission and Distribution
- 400 Electrical Maintenance
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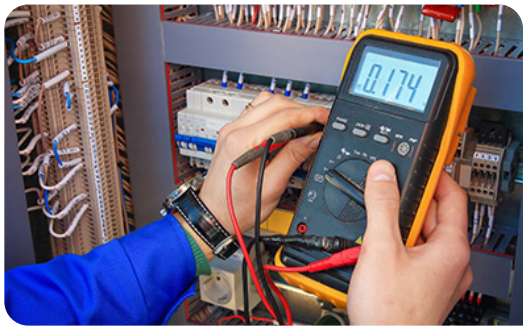

605 Test Equipment

605-01 Multimeter

You take measurements every day when troubleshooting equipment. Accurate measurements require a multimeter. A multimeter is used to diagnose electrical problems by measuring voltage, current, and resistance. The Multimeter training course explains the basics of a digital multimeter and volt-ohm meter and how to use them.

Circuits must be energized to take voltage and current measurements. Only personnel trained to take live measurements should perform current and voltage tests. The Multimeter online training covers functions and symbols, range and resolution, specifications, measurements, and safety.

This course is part of the Test Equipment series.

605-02 Oscilloscopes

Oscilloscopes create a graphic illustration of an electrical signal. The signal is received from electrical, or physical, energy converted to electrical form. By graphing the signal, information can be removed and analyzed. Oscilloscopes are an excellent tool for manufacturing and repairing electrical equipment.

The Oscilloscopes training course explains how to use an oscilloscope's controls to measure electric signals. It also demonstrates how to measure parameters such as voltage, period, amplitude, frequency, and phase shift. This online training course describes an oscilloscope's components and controls. It also covers wave forms and taking measurements.

The Oscilloscopes course is part of the Test Equipment series.

605-03 Power Supplies

A DC power supply has advantages over a battery as a source of DC. A power supply can quickly provide an accurate voltage than can be changed or varied over a wide range. Unlike a battery, a power supply never runs down. Since AC electricity is widely available, most equipment will convert AC to DC within a power supply. This equipment needs a reliable voltage source for accurate testing when troubleshooting.

The Power Supplies training course identifies the main sections of a DC power supply. It describes the types of regulation and regulators. It also examines how a linear regulator works and how to troubleshoot power supply problems. This online course includes:

- DC power supply sections
- Line versus load regulation
- Linear versus switching regulation
- Using a power supply
- Troubleshooting power supplies

Power Supplies is part of the Test Equipment series.

605-04 Signal Generators

A signal generator can produce various voltage patterns at a variety of frequencies and amplitudes. It is used to test circuit response to common input signals. The electrical leads from the device are attached to the ground and the signal input terminals when tested. Technicians and engineers must understand the different signal generator types and capabilities.

The Signal Generators training course explains a signal generator's basic controls and operations. It describes how to use the device to generate basic waveforms for troubleshooting. This online training course covers:

- How signal generators work
- Waveform types
- Waveform parameters
- Using a signal generator

Signal Generators is part of the Test Equipment series.

605-05 Temperature Calibrators

Temperature instrument calibration must verify correct output from the primary element. It also verifies proper operation of the remaining sensor circuitry.

The Temperature Calibrators training course investigates the most common equipment needed to perform temperature instrument calibration. It explains the equipment's basic function and operation.

Temperature Calibrators is part of the Test Equipment training series.

605-06 Manometers

The manometer is the simplest device for measuring pressure. While many types of manometers are available, they are all highly accurate and easy to use. They measure gauge pressure in a system. They also measure differential pressure between two points.

The Manometers training course explains how the most common manometer types are used to measure pressure. This online course includes:

- Manometer description
- Manometer types
- Factors affecting accuracy

Monometers is part of the Test Equipment training series.

605-07 Pressure and Vacuum Calibrators

Industries use vacuum and pressure tools to monitor, regulate, and control processes. Accurately aligning these devices is necessary to maintain a productive and economically sound operation.

The Pressure and Vacuum Calibrators training course discusses different types of pressure and calibration tools, including:

- Pressure and vacuum calibrators
- Deadweight calibrators
- Variators
- Aspirator bulbs
- Hand pumps
- Pneumatic calibrators

Pressure and Vacuum Calibrators is part of the Test Equipment training series.

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605-08 **Megohmmeter**

A megohmmeter applies a high voltage to an insulated conductor to measure resistance. It can help identify degraded insulation and enhance preventative maintenance programs.

The Megohmmeter training course explains how to use the equipment to safely measure wire insulation resistance. This online course focuses on:

- Electrical insulation
- How to take a reading
- High voltage tests
- Spot test examples

Megohmmeter is part of the Test Equipment training series.

607 **Analyzers**

607-01 **Analytical Instruments**

Analytical instruments are designed to monitor a facility's chemical and physical properties. The Analytical Instruments training course identifies various analytical variables and describes the devices most plants use to monitor them.

This online training course identifies analytical variables and explains how to measure them. It defines analysis and describes the basic operation of direct and indirect analysis measurement devices.

This course is part of the Analyzers training series.

607-02 **Introduction to Analytical Testing**

In most plants, analytical tests are run continuously to ensure product quality and equipment safety. Analyzers contain instruments capable of measuring various properties of many sample types. Some properties are automatically analyzed while others need manual sampling and analysis.

The Introduction to Analytical Testing training course identifies and describes the function of several key analyzers found in industrial facilities. This online training course covers:

- Solid moisture analyzers
- Liquid analyzers
- Composition analyzers

Introduction to Analytical Testing is part of the Analyzers series.

609 **Calibrating and Troubleshooting**

609-01 **Calibration Overview, Part 1**

Instrument calibration is a vital task to ensure process control loops within a facility function properly, contributing to a plant's safety and success. For accurate results, trained individuals should perform sensor and instrument calibration on a regular basis. The Calibration Overview, Part 1 training course introduces you to common calibration instruments and methods.

This online training course explains basic calibration methods and equipment. It discusses instrument failures and reviews calibrating control instruments.

This course is part of the Calibrating and Troubleshooting training course.

609-02 **Calibration Overview, Part 2**

As discussed in Part 1, accurately measuring process variables, such as temperature, pressure level, and flow, is essential to a plant's safety, efficiency, and success. The ability to calibrate various control loop components as part of routine maintenance contributes to the accuracy of these measurements.

The Calibration Overview, Part 2 training course explains methods used to calibrate different instruments, including:

- Temperature
- Level and flow
- Valve positioners
- Transducers and transmitters
- Controllers and smart instruments

This online course is part of the Calibrating and Troubleshooting training series.

609-03 **Introduction to Troubleshooting**

Troubleshooting is a group of procedures employing systematic testing to identify and fix a problem. The Introduction to Troubleshooting training course introduces the basics of how to troubleshoot problems related to common temperature, pressure, level, and flow instrumentation in the field. Understanding how each of these instruments work is an important part of producing an accurate diagnosis and successful solution.

This online course discusses:

- Troubleshooting resources
- Troubleshooting common instrumentation
- Troubleshooting a control loop

This course is part of the Calibrating and Troubleshooting training series.

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609-04 **Instrument Troubleshooting**

The Instrument Troubleshooting training course identifies common malfunctions in basic equipment and explores why they happen. It provides a framework for troubleshooting those malfunctions. This online training course explains the basic steps used in instrument troubleshooting. It covers:

- Troubleshooting basics
- Common device malfunctions
- Instrument loop troubleshooting
- Communication and safety

This course is part of the Calibrating and Troubleshooting training.

611 **Prints and Drawings**

611-01 **P&ID Basics**

All plants have a collection of piping and instrumentation drawings or P&IDs. These drawings show how components connect and how the process flows through the system. P&IDs also show the locations of instrument and control equipment relative to components in the process control path.

The P&ID Basics training course provides the skills necessary to read a P&ID. It identifies symbols and function labels and describes how components are related. Reading a P&ID is part of the Prints and Drawings training series.

611-02 **Reading a P&ID**

Being able to read a P&ID is an important part of understanding where equipment is and how it fits into the system process. The Reading a P&ID training course focuses on the key elements of the main diagram, the way it identifies the instrumentation and equipment, and the relationship between components.

This online course discusses the P&ID elements, common equipment symbols, instruments and instrument control loops, and line designations.

Reading a P&ID is part of the Prints and Drawings Series.

611-03 **Electrical Drawings**

Electrical drawings are used to communicate information about components and their relationship in an electrical system. Understanding and following electrical drawings is critical to install, modify, and maintain electrical components and systems.

The Electrical Drawings training course identifies the types of electrical drawings and describes how each is used. It also explains the common elements and symbols that make up electrical drawings. This online course covers:

- Print reading basics
- Symbol and device identification
- Block diagrams
- Line drawings
- Connection diagrams
- Raceway drawings
- Cable schedules
- Logic diagrams

Electrical Drawings is part of the Prints and Drawings training series.

611-04 **Logic Diagrams**

Logic diagrams are important tools for operating and maintaining digital computers and other electronic equipment and circuits. These diagrams are identifiable by their unique symbols called logic gates, which represent logic functions. Logic diagrams use logic gates to provide a complete representation of a circuit.

The Logic Diagrams training course outlines the important features of a logic diagram. It discusses the most common logic type gates and how each is used. This online course identifies the common symbols and components on a logic diagram and explains their relationship to each other. This course focuses on:

- Print reading basics
- Common symbols
- Logic gate principles
- Common logic gates

Logic Diagrams is part of the Prints and Drawings training series.

611-05 **Industrial Print Reading Overview**

Industrial sites are vast facilities made up of hundreds of pieces of equipment, miles of pipe and electrical wire, and thousands of pieces of sophisticated equipment. Facility operators, technicians, mechanics, and engineers rely on a variety of drawings to:

- Help in constructing new facilities and systems
- Repair equipment
- Isolate and troubleshoot system problems

Understanding the basic drawing types used in industrial facilities is necessary to work in this environment.

The Industrial Print Reading Overview training course describes the different drawing types used by site employees to design, repair, and maintain equipment in the facility. It explains how to determine which type should be used to acquire the specific information needed for a specific project.

Industrial Print Reading Overview is part of the Prints and Drawings training series.

613 **Automated Control**

613-01 **Introduction to Automated Control**

Automating industrial processes involves coordinated actions of equipment, instrumentation and control techniques to ensure a product is produced safely, efficiently, and to specification. Automated control loops, which may be open or closed, use several main elements. In an industrial facility, operators can interact with these control systems in a variety of ways to monitor and/or influence process outcomes.

The Introduction to Automated Controls training course discusses the basic design and function of automated control loops. This course covers:

- Automated control
- Open and closed loops
- Operator interaction with the control system

This course is part of the Automated Control training series.

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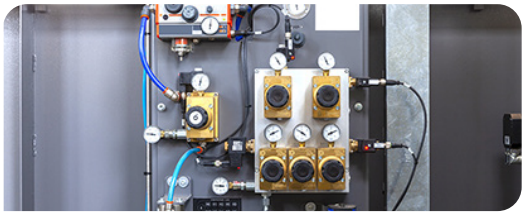
613-02 Pneumatic Control Systems

The two control systems used in industrial facilities are pneumatic and electronic. While new facilities have moved almost entirely toward electronic systems, many pneumatic control systems are still installed.

The Pneumatic Control Systems training course describes the design and function of typical pneumatic control systems used in industrial facilities. It explains topics such as:

- Pneumatic devices
- Signal transmission
- Control room layout
- Advantages and disadvantages

Pneumatic Control Systems is part of the Automated Control training series.



613-03 Introduction to Switches

Switches are electrical components used to control electricity flow. The Introduction to Switches training course examines the most common switches used in industrial applications and describes their operating principles. This online training course examines:

- Switches
- Throw and pole switches
- Mercury switches and relay switches
- Float switches
- Pressure switches
- Limit switches
- Flow switches
- Pushbutton switches
- Selector switches
- Joysticks
- Drum switches
- Interlock switches and safety switches

Introduction to Switches is part of the Automated Control training series.

613-04 Electronic Control Systems

The two control systems used in industrial facilities are pneumatic and electronic. New facilities have moved almost entirely to electronic systems.

The Electronic Control Systems training course discusses the function and operation of electronic control systems. This online course includes:

- Electronic instrument systems
- Electronic field instrumentation
- Electronic control room layout
- Safety in wiring electronic control systems
- Advantages and disadvantages of electronic control systems

Electronic Control Systems is part of the Automated Control training series.

615 Signal Transmission and Conversion

615-01 Signal Transmission

Signal transmission conveys process information from one instrument to another when controlling industrial processes. As process industries have evolved, a variety of transmission signals have been used in many different applications. The Signal Transmission training course introduces various means of transmitting signals and describes the basic operation of each. It also explains how to convert measured values into corresponding transmission values, and transmitted values back into measured values.

This course covers:

- Mechanical signal transmission
- Analog and digital signal transmission
- Pneumatic transmission systems
- Electric transmission systems
- Optical transmission systems
- Wireless transmission systems

The course also discusses converting between transmission and measurement signals.

Signal Transmission is part of the Signal Transmission and Conversion training series.

615-02 Basic Principles of Industrial Transmitters

Operators in industrial facilities need to understand how transmitters send signals from the field to the control room. The Basic Principles of Industrial Transmitters training course describes the basic function and operation of pneumatic and electrical transmitters. It also explains the formula-relating transmitter outputs to inputs.

This online training course discusses:

- Signal transmission
- Principles of pneumatic transmitters
- Principles of electrical transmitters
- Variable inductance transmitters
- Transmitter output calculations

Basic Principles of Industrial Transmitters is part of the Signal Transmission and Conversion training series.

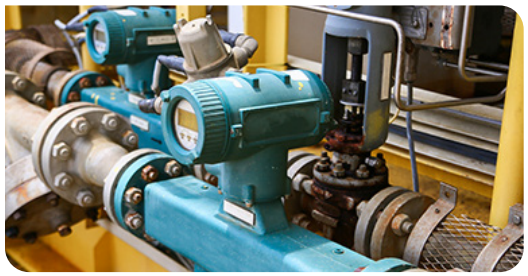
615-03 Smart Transmitters

A new generation of transmitters with improved accuracy is available. These transmitters can be remotely calibrated and store configuration information. The most advanced transmitters offer controller potential and an independent communication port.

The Smart Transmitters training course discusses the capabilities of smart and intelligent transmitters and examines their uses. It describes their basic design, features, and operation. This online training course includes:

- Smart electronic transmitters
- Smart transmitter advantages
- Smart transmitter disadvantages
- Intelligent transmitters

Smart Transmitters is part of the Signal Transmission and Conversion training series.



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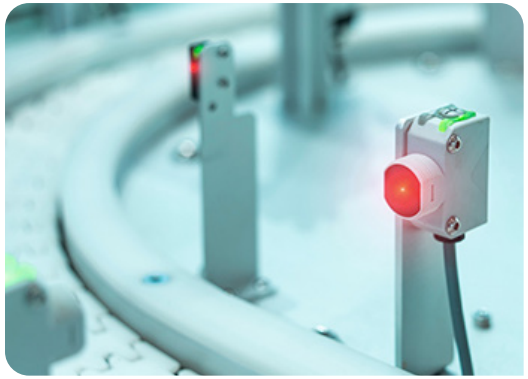
615-04 **Transducers**

Industrial facilities use transducers to convert one type of transmitted signal into another. The Transducers training course examines various industrial transducer types. It discusses their function and describes types of conversions they perform. This online course examines the operating principles behind the most common transducer types. It focuses on:

- Transducer and converter functions
- Variable capacitance transducer
- Variable resistance transducer
- Secondary transducer

Transducers is part of the Signal Transmission and Conversion training series.



617 Controllers and Final Control

617-01 **Controller Control Modes**

The Controller Control Modes training course examines the four main types, or modes, of control action found on instrumentation in industrial facilities. The course explains each mode and illustrates it with examples of control loops.

This course describes the design and function of the four main control modes used by industrial controllers, including:

- On-off control
- Proportional control
- Integral (reset) control
- Derivative (rate) control

Controller Control Modes is part of the Controllers and Final Control training series.

617-02 **Operation of Automatic-Manual Transfer Stations**

To keep industrial process activities running efficiently and on specification, large fluctuations in system processes should be avoided. There also must be a method to perform maintenance on control loop instruments without shutting them down.

An automatic-manual hand station can make this maintenance easier by allowing seamless transfer of control from manual to automatic and from automatic back to manual. The Operation of Automatic-Manual Transfer Stations training course describes the basic design, function, and use of these stations.

This online training course explains station features and transfer balancing.

This course is part of the Controllers and Final Control training series.

617-03 **Final Control Elements**

Final control elements directly change or control the manipulated variable in a control loop. Understanding different final control elements used in industrial facilities helps operate or maintain a plant.

The Final Control Elements training course describes the basic design and function of different final control elements used in control loops. This online course covers:

- Final control basics
- Control valves and actuators
- Dampers (louvres)
- Variable speed drives
- Modulating power controllers

This course is part of the Controllers and Final Control training series.

619 Electronics Fundamentals

619-01 **Introduction to Industrial Electronics**

Modern industrial control systems contain multiple electronic circuits that allow them to monitor and control a variety of systems. Electronic circuits share some similarities with other electrical devices, but the specific components in them operate under different principles and sometimes require different techniques to troubleshoot and repair. The Introduction to Industrial Electronics training course describes the construction and operation of basic electronic components. It also explains common troubleshooting techniques used.

This online course focuses on semiconductor materials, bias voltage, electronic components, and electronics troubleshooting.

Introduction to Industrial Electronics is part of the Electronics Fundamentals series.

619-07 **Digital Electronics and Microprocessors**

Instrumentation and control systems increasing rely on digital circuits and microprocessors to transmit, analyze, and interpret measurements from sensors throughout a facility. Troubleshooting and repairing these systems requires specific knowledge of digital logic and an understanding of digital circuit operation, including microprocessors. The Digital Electronics and Microprocessors training course explains how digital signals differ from analog signals. It describes the operation of many common digital components and circuits.

This online training course covers:

- Digital signals
- Logic gates
- Basic digital circuits
- Microprocessor systems

Digital Electronics and Microprocessors is part of the electronics Fundamentals training series.

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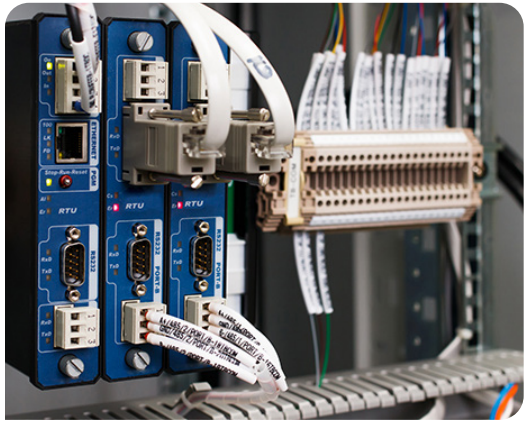

621 Programmable Logic Controllers

621-01 Introduction to Programmable Logic Controllers (PLC)

Programmable logic controllers (PLC) are a specialized computer used in commercial and industrial control applications. A PLC is a solid-state, microprocessor-based programmable controller. While the specific applications vary widely, all PLCs monitor inputs and other variable values, make decisions based on a stored program, and control outputs to automate a process or machines.

The Introduction to Programmable Logic Controllers (PLC) training course examines the theory and structure behind PLC and the basic programming logic and number systems involved. This course describes PLC major components' design and function. It also converts numbers from decimal to binary, binary coded decimal, and hexadecimal.

This online training course covers:

- Operation principles
- Hardware
- Internal architecture
- Input devices
- Output devices
- Number systems

Introduction to Programmable Logic Controllers is part of the Programmable Logic Controllers training series.

621-02 Input/Output (I/O) Processing

The previous lesson discussed how a programmable logic controller (PLC) is a specialized type of computer. A PLC monitors inputs and other variable values, makes decisions based on a stored program, and controls ouputs to automate a process or machine. Understanding a PLC's memory and error detection processes helps understand PLC program operation.

The Input/Output (I/O) Processing training course discusses I/O error checking and its impact on communication and function. It also identifies the types and structure of PLC memory and describes how memory interacts with the peripheral I/O.

This online training course focuses on:

- Error checking
- Memory types
- Memory organization and I/O interaction
- Configuring PLC memory - I/O addressing

Input/Output (I/O) Processing is part of the Programmable Logic Controllers training series.

621-03 Inputs and Outputs

As discussed in the previous course, discrete I/O (input/output) interfaces are the physical connection between the CPU and the physical field equipment. Analog modules translate continuous analog signals into discrete values. The rack enclosures contain the PLC (programmable logic controller) I/O modules. Each modules is identified by a unique address specifying its rack location.

The Inputs and Outputs training course builds on the understanding of I/O operations equipment and PLC program operation from the previous course. It describes the design and function of I/O interfaces. It also discusses the equipment used to produce and communicate I/O data. This online course includes:

- Discrete I/O
- Analog I/O
- Special I/O and serial communication interfaces
- Signal conditioning

Inputs and Outputs is part of the Programmable Logic Controllers training series.

621-04 PLC (Programmable Logic Controllers) Programming Instructions, Part 1

As discussed, programming instruction sets are means of providing programmable logic controllers (PLC) with instructions for implementing control programs.

The PLC Programming Instructions, Part 1 training course focuses on the ladder logic and Boolean language structures that make up most of PLC programming. It describes the functions of the programming instructions commonly used in PLC programming. This online course explains:

- PLC language basics
- Ladder relay instructions programming
- Timers and counters
- Program/flow control
- Arithmetic instructions

PLC Programming Instructions, Part 1 is part of the Programmable Logic Controllers training series.

621-05 PLC (Programmable Logic Controllers) Programming Instructions, Part 2

PLC (Programmable Logic Controllers) Programming Instructions, Part 2 continues the discussion on programming instruction sets from part 1. These sets provide PLCs with instructions for implementing control programs. It describes the functions of programming instructions most commonly used in PLC programming. This online course explores:

- Data manipulation instructions
- Data transfer instructions
- Special function instructions
- Network communication instructions

PLC Programming Instructions, Part 2 is part of the Programmable Logic Controllers training series.

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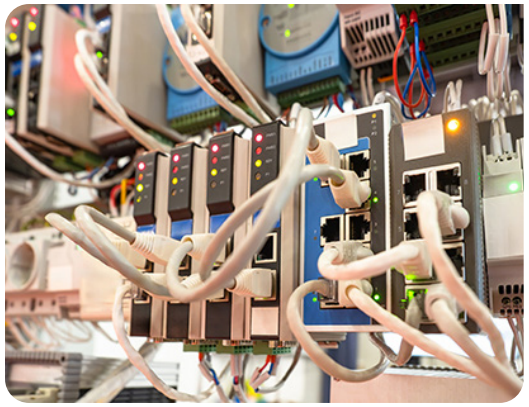
621-06 PLC (Programmable Logic Controllers) Networks

Local area networks (LAN) are the high-speed, medium-distance communication highways that connect PLC systems throughout a plant and its enterprise network. They also connect to host computers and distributed control systems (DCS).

The PLC (Programmable Logic Controller) Networks course introduces PLC network architecture and topology. This online course focuses on:

- Digital communication networks
- Network architecture
- Network access
- Network communication media

PLC Networks is part of the Programmable Logic Controllers training series.

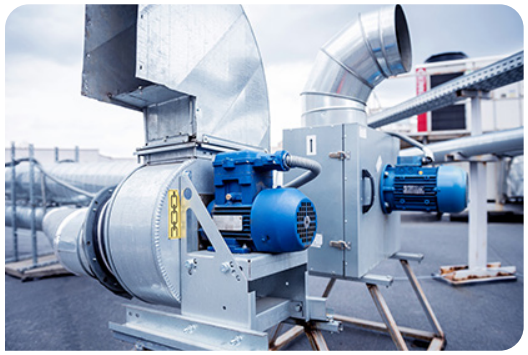


621-07 PLC Network Protocols

Programmable logic controllers (PLC) have certain protocols they must follow to communicate with the network. The PLC Network Protocols training course examines common protocols used in industrial computer networking. It provides a basic understanding of these protocols. This online course discusses:

- Network protocol overview
- FOUNDATION Fieldbus networks
- PROFIBUS networks
- DeviceNet

PLC Network Protocols is part of the Programmable Logic Controllers training series.



670 Heating & Cooling Fundamentals

670-01 Air Conditioning Fundamentals

Air conditioning reduces indoor temperature and/or humidity for personal comfort and safety. It also protects sensitive equipment from damage. To do so, an air conditioner transfers heat from one location to another through the refrigeration cycle process. The Air Conditioning Fundamentals training course explains the basic refrigeration cycle and how it applies to air conditioning.

This online training course covers heat transfer, air conditioning components, and the basic refrigeration cycle.

Air Conditioning Fundamentals is part of the Heating & Cooling Fundamentals training series.

70-02 Ductless Air Conditioning

Ductless air conditioners are small units designed to provide indoor cooling without costly duct work. They are well-suited for use in single rooms or small buildings where duct installation is not practical. Ductless systems may be self-contained or have separate condenser and evaporator units. In either case, the evaporator is located in the room being cooled. Its fan circulates the air directly without ventilation ducts.

The Ductless Air Conditioner training course explains the various types of ductless air conditioners. It discusses how the components function, including basic maintenance.

This online course is part of the Heating & Cooling Fundamentals training series.

670-03 Introduction to Industrial and Commercial Refrigeration

The refrigeration cycle has been critical in developing coolant systems and freezer/refrigeration units over the last 100 years. Industrial and commercial refrigeration rely on this cycle to prolong the life of food products, safely store chemicals and pharmaceuticals, and aid in distributing temperature-sensitive items.

The Introduction to Industrial and Commercial Refrigeration training course explains the purpose and function of industrial and commercial refrigeration. It also discusses how heat transfer and the refrigeration cycle drive the process. It describes the components and refrigerants that may be used in these units. This online training course includes:

- Refrigeration purpose
- Functions and industries
- Heat transfer
- The basic refrigeration cycle
- Industrial/commercial refrigeration components
- Refrigerants

Introduction to Industrial and Commercial Refrigeration is part of the Heating & Cooling Fundamentals training series.

670-05 Refrigerant System Troubleshooting

Today's refrigerant system service technicians must comprehend basic refrigeration principles. They should also understand the skills and tools troubleshoot issues for all refrigeration systems. The most effective technicians apply a systematic troubleshooting approach to diagnose issues correctly.

The Refrigerant System Troubleshooting training course explains how to systematically troubleshoot and diagnose refrigerant systems based on the universal application of the refrigeration cycle. It also discusses industry standard diagnostic and testing tools.

This online training focuses on troubleshooting basics, trade tools and safety precautions, systematic troubleshooting, and airflow issues. It covers refrigerant flow issues, handling, and management.

Refrigerant System Troubleshooting is part of the Heating & Cooling Fundamentals series.

- 100 Safety, Health, and Plant Science
- 200 Mechanical Maintenance
- 300 Electrical Transmission and Distribution
- 400 Electrical Maintenance
- 500 Power Generating Systems and Operations
- 600 Instrumentation and Control
- 700 Process Systems and Operations
- 800 Industrial Machining and Welding
- Instructor-led Training
- NERC Certification
  - Exam Preparation
  - CEH Online Courses

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670-06 **Chiller Design and Maintenance**

Industrial chillers are refrigeration equipment used with commercial HVAC circuits. Chillers continually remove heat from the system's refrigerant so cool air can be circulated throughout the facility. HVAC chillers are a substantial capital investment. For many facilities, they consume the most onsite energy. Capturing and reusing heat from the chiller, combined with routine maintenance, is key to maintaining target operating costs and performance levels.

The Chiller Design and Maintenance training course describes an industrial chiller's purpose. It explains how its main components work together to remove heat from the system's refrigerant, allowing the HVAC to provide cool air to the facility. It also discusses how heat exhausted from the chiller can be reused as energy elsewhere in the facility. This online course identifies general maintenance recommendations which help keep the chiller operating at peak performance. It covers:

- Chiller fundamentals and design
- Chiller components
- General chiller maintenance

Chiller Design and Maintenance is part of the Heating & Cooling Fundamentals training series.

670-09 **Ducting and Air Movement for HVAC Systems**

HVAC units are designed to move a specific volume of air at the correct speed based on the unit's capacity. However, it is important to understand the relationship between the equipment's related capacity to generate air flow and the actual ability of air to flow through the system. When an HVAC system's ducting is not installed properly or is blocked or damaged, energy consumption increases while performance decreases. Poorly designed and implemented ducting causes the HVAC system to work harder while providing less airflow.

The Ducting and Air Movement for HVAC Systems training course explains the important role ducting plays in the HVAC system's ability to provide maximum airflow. It identifies common HVAC airflow issues related to poorly implemented ducting. This online course focuses on:

- HVAC fundamentals
- Airflow through the HVAC system
- Ducting and airflow basics
- Standard ducting components
- Common ducting airflow issues

Ducting and Air Movement for HVAC Systems is part of the Heating & Cooling Fundamentals training series.

670-15 **District Energy Basics**

District energy is growing in the U.S. However, its potential seems to have been even more fully realized in Europe and the Middle East. Being familiar with the theory and concept behind district energy allows a better understanding of its advantages and disadvantages and its adaption in certain parts of the world over others.

The District Energy Basics training course defines district energy. It provides examples of the situations where district energy could be a solution. It also identifies some advantages and disadvantages of the technology.

District Energy Basics is part of the Heath & Cooling Fundamentals training series.

670-17 **Package Boiler Fundamentals**

District energy could not be possible without the compact and economic nature of the package boiler. Becoming familiar with the package boiler, its functionality, components, and uses, creates a better understanding of how district energy works. It also highlights the advantages and disadvantage of using a package boiler.

The Package Boiler Fundamentals training course describes the purpose of the package boiler and the type and relationship of components within the system. It discusses the various situations in which a package boiler may be used. It also outlines its advantages and disadvantages.

This online course is part of the Heating & Cooling Fundamentals training series.

670-19 **Package Boiler Design**

With a basic understanding of package boiler application, a more comprehensive look can be taken at the boiler types and design.

The Package Boiler Design training course discusses package boiler and their layout. It also describe the location and functionality of the major components. This online course explores:

- Package boiler types
- Boiler layout and flow path
- Components

Package Boiler Design is part of the Heating & Cooling Fundamentals training series.

- **100** Safety, Health, and Plant Science
- **200** Mechanical Maintenance
- **300** Electrical Transmission and Distribution
- **400** Electrical Maintenance
- **500** Power Generating Systems and Operations
- **600** Instrumentation and Control
- **700** Process Systems and Operations
- **800** Industrial Machining and Welding
- **Instructor-led Training**
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670-21 Package Boiler Startup, Operation, Shutdown, and Maintenance

In addition to plant specific manuals, package boiler manufacturers provide training and procedural manuals for starting, stopping, operating, and maintaining equipment. However, since not all package boilers are the same, it is important to understand the common methods for performing these functions.

The Package Boiler Startup, Operation, Shutdown, and Maintenance training course describes the common procedures for starting, stopping, and operating a package boiler. It discusses the typical routine maintenance required for the boiler to function properly.

Package Boiler Startup, Operation, Shutdown, and Maintenance is part of the Heating & Cooling Fundamentals training series.

670-23 Package Chiller Fundamentals

District cooling plants use many different components to provide chilled water and refrigeration to their districts. However, a district cooling system's major component is the package chiller, typically an electrically powered centrifugal chiller. This component allows a single- or multi-unit plant to serve an entire district, replacing less efficient multiple chillers that previously serviced one building.

The Package Chiller Fundamentals training course describes the purpose of district cooling and the package chiller. It briefly outlines the major components within this system. This online course discusses the various situation in which a package chiller may be used, including its advantages and disadvantages. This course includes:

- District cooling basics
- Major components
- Applications

Package Chiller Fundamentals is part of the Heating & Cooling Fundamentals training series.

670-25 Package Chiller Design

Package chillers are used in every district cooling application. Their design, location, and functionality play a large role in the overall efficiency of the district cooling plant. It is important for personnel dealing with district cooling to understand how chillers are designed and function within the larger district cooling system.

The Package Chiller Design training course describes the types of package chillers and the type and relationship of components within the system. It discusses the various designs offered for most district cooling package chillers.

This online course is part of the Heating & Cooling Fundamentals training series.

670-27 Package Chiller Startup, Operation, Shutdown, and Maintenance

Package chiller manufacturers typically provide training and procedural manuals for the equipment. However, not all package chillers are the same. Procedures differ from one chiller to another. Therefore, it is important to understand the common methods of starting, stopping, operating, and maintaining package chillers.

The Package Chiller Startup, Operation, Shutdown, and Maintenance training course describes the common procedures for starting, stopping, and operating a package chiller. It also discusses the typical routine maintenance needed for proper chiller functionality.

This online training course is part of the Heating & Cooling Fundamentals training series.

- 100 Safety, Health, and Plant Science
- 200 Mechanical Maintenance
- 300 Electrical Transmission and Distribution
- 400 Electrical Maintenance
- 500 Power Generating Systems and Operations
- 600 Instrumentation and Control
- 700 Process Systems and Operations
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700

Process Systems and Operations

701 Petroleum Refining

701-01 Introduction to Petroleum Refining

Crude oil is of little use in its raw state. A petroleum refinery employs a series of processing steps to refine it into a variety of useful products. The refinery separates and converts the raw materials in crude oil into products such as natural gas, propane, gasoline, diesel fuel, fuel oils, lubricating oils, and asphalt.

The Introduction to Petroleum Refining training course identifies and briefly describes various refining processes that take place in a typical petroleum refinery. This online training course covers:

- Crude oil basics
- Desalting, distilling, and reforming
- Cracking processes
- Alkylation, isomerization, and polymerization
- Treating, purifying, blending, and storing

Introduction to Petroleum Refining is part of the Petroleum Refining training series.

701-02 Basic Petroleum Chemistry

The Basic Petroleum Chemistry training course focuses on the chemical composition of petroleum. It examines properties associated with various hydrocarbon molecules found during crude oil refining. This online training course discusses the molecular structure, physical properties, naming conventions, and commercial uses of several common hydrocarbons.

This course explores:

- Crude oil
- Hydrocarbon covalent bonding
- Hydrocarbon naming conventions
- Hydrocarbon families - paraffins, napthenes, and aromatics
- Hydrocarbon families - olefins and alkynes
- Physical properties and molecular structure
- Crude oil containments

Basic Petroleum Chemistry is part of the Petroleum Refining training series.

701-03 OSHA's Process Safety Management Standard

In 1992, OSHA issued its Process Safety Management (PSM) standard. The standard affects industries, such as refineries, that work with hazardous chemicals. The OSHA's Process Safety Management Standard training course identifies the standard's main components. It also explains its objectives. This online training course covers:

- The PSM standard
- Process safety information
- Process hazard analysis and employee participation
- Operating procedures and training
- Contractors
- Pre-startup safety review and hot work
- Mechanical integrity
- Changes, incidents, and emergencies
- Compliance audits and trade secrets

OSHA's Process Safety Management Standard is part of the Petroleum Refining training series.

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701-04 History of Refining

How did modern oil refineries evolve into what they are today? The History of Refining training course gives a brief history of oil refining. It explores the development and evolution of some of the various refining processes still in use. This online training course provides a general overview of the crude oil processing evolution from 1846 to present day. It includes:

- Whale oil to kerosene
- Gasoline becomes king
- Clean Air Act amendments of 1970
- Regulations in the 1980s
- Clean Air Act amendments of 1990
- Refining today

History of Refining is part of the Petroleum Refining training series.

701-05 Introduction to Crude Oil

Crude oil, also called petroleum or oil, is a naturally occurring liquid made up of hydrocarbons found in various geological formations around the Earth. It exists in a variety of states. Oil businesses spend trillions of dollars in its extraction, refinement, and trade every year. Petroleum can be used to make many petroleum products. It has been used in some form or another since ancient Mesopotamia. Although advancements have been made toward replacing petroleum with more renewable resources, it remains one of the most widely used forms of energy in the world.

The Introduction to Crude Oil training course defies what crude oil is. It describes the different types and characteristics of crude oil and how it is extracted. It also discusses the various uses for crude oil and crude oil products.

Introduction to Crude Oil is part of the Petroleum Refining training series.

701-06 Operator Qualifications in Refining

A refinery is an industrial processing plant used to convert crude oil into useful petroleum products. In such complex environments, skilled and educated personnel are needed to ensure these processes run smoothly, efficiently, and safely. After undergoing a rigorous qualification process, refinery operators must display competency to keep the refinery operating a peak performance.

The Operator Qualifications in Refining training course identifies and discusses the role of a refinery operator. It outlines their many responsibilities and the qualifications necessary to become an operator. This online course covers:

- Refinery operator responsibilities
- Refinery operator education requirements

Operator Qualifications in Refining is part of the Petroleum Refining training series.

701-07 Maintenance Requirements in Petroleum Refining

Petroleum refineries are costly and complex facilities comprised of different systems, equipment, vessels, and machinery. These systems and components are each made up of many valves, instruments, filters, bolts, screws, fittings, and other parts. To ensure a refinery's continued and efficient operation and to reduce costly and time-consuming malfunctions, much of a refinery's operating budget is dedicated to maintaining and repairing systems and equipment. Personnel who understand the types and importance of maintenance and repairs are crucial to a refinery's operations.

The Maintenance Requirements in Petroleum Refining training course identifies and discusses the role of refinery maintenance. It outlines the different types of refinery maintenance. It also discusses the purpose of a refinery turnaround. This online course focuses on:

- Refinery maintenance overview
- Refinery maintenance classification
- Refinery turnarounds

Maintenance Requirements in Petroleum Refining is part of the Petroleum Refining training series.

701-08 Predictive and Reactive Maintenance

Predictive and reactive maintenance are important in minimizing costly downtimes or production losses. Many modern refineries have moved to incorporate predictive maintenance capabilities. Understanding the role reactive maintenance plays remains relevant due to the unpredictability of some systems and components in harsh environments.

The Predictive and Reactive Maintenance training course explains the two types of maintenance in detail. It identifies the differences between them. It also explores the purpose and relevance of predictive maintenance elements and technologies in modern and future refinery settings. This online course discusses:

- Predictive vs. reactive maintenance
- Predictive maintenance elements
- How predictive maintenance works

705 Refining Operations

705-01 Refinery Overview and Configuration

A refinery is an industrial processing plant used for converting crude oil into useful petroleum products. Refinery configurations depend on many factors, including operating costs, location, demand volatility, and construction capital. Some refineries operate on a small scale to produce fractions of crude oil to be further processed in other facilities. Others are large-scale industrial operations using different highly technical processes to maximize product versatility and profitability.

The Refinery Overview and Configuration training course identifies and discusses basic refinery purposes and operations. It describes the different configurations in modern refining. This online training course provides a comprehensive refining overview.

Refinery Overview and Configuration is part of the Refinery Operations training series.

› 100 Safety, Health, and Plant Science
› 200 Mechanical Maintenance
› 300 Electrical Transmission and Distribution
› 400 Electrical Maintenance
› 500 Power Generating Systems and Operations
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705-03 **Crude Unit**

Because crude oil is of little use or value in its natural state, it must be separated out into other products. The first unit used to separate crude oil is the crude unit. This unit can separate crude oil into heavy or light fractions that can either be sent to other processing facilities or directly to end users. It can also be further refined into lighter, more valuable petroleum products such as gasoline, diesel, and jet fuel.

The Crude Unit training course describes the unit and its main components. It also identifies and discusses the process of crude oil distillation.

This course is part of the Refinery Operations training series.

705-05 **Catalytic Reformer**

One of the fractions produced in the crude distillation unit is naptha, also called straight-run naptha. This naptha, particularly heavy straight-run naptha, has a high naphthene content, high paraffin amounts, and low octane. This naptha is not desirable as a feed- or blendstock. It must be sent to a catalytic reformer to boost the octane rating by reforming its natural linear hydrocarbons into aromatic hydrocarbons. The result is called reformate, which is used as a blendstock in producing gasoline.

The Catalytic Reformer training course defines catalytic reforming. It discusses the basic chemistry involved in reforming. It also identifies and describes the catalytic reforming process and components. This online training course includes:

- Naptha chemistry
- Catalytic reformers
- Inputs and outputs

Catalytic Reformer is part of the Refinery Operations training series.

705-07 **Fluid Catalytic Cracker**

Like the catalytic reformer, the fluid catalytic cracker, or FCC unit, is a conversion unit. It is capable of transforming less desirable, heavy distillation fractions into lighter products such as FCC gasoline. The FCC is an important unit for generating products to use in alkylation units and in blending residual fuel oil and diesel.

The Fluid Catalytic Cracker training course defines what a fluid cracker is. It discusses the principles of cracking and describes the catalytic cracking process and components. This online training course focuses on:

- Cracking and catalyst bursts
- Fluid catalytic cracking unit
- Inputs and outputs

Fluid Catalytic Cracker is part of the Refinery Operations training series.

705-09 **Coker Operations**

Large-scale refineries often have coker units, the most extreme unit for upgrading resid and slurry. By operating a coker, refineries can process cheaper heavy crudes, which are high in bottoms or resids. They convert them into higher yields of more usable and valuable light products or petroleum coke. Refineries with coker units can process a large majority of crude oil fractions with little to no product waste.

The Coker Operations training course defines a coker unit and describes its inputs and outputs. This online course also identifies coker unit processes and components.

Coker Operations is part of the Refinery Operations training series.

705-11 **Gasoline Blending**

Gasoline blending is one of the most important and economic drivers of refinery operations. Most gasoline that comes from crude oil refining is unfinished. It must undergo a series of further refining and blending before it is ready for use in automobiles and other combustion engines.

The Gasoline Blending training course describes the various processes behind gasoline blending and why it plays such a vital role in petroleum refining. This online course discusses the process to blend gasoline. It explains the significance of octane and gasoline additives in the gasoline blending process. This course covers:

- Gasoline blending basics
- Gasoline blendstock sources
- Gasoline blending and quality process

Gasoline Blending is part of the Refinery Operations training series.

705-12 **Diesel and Other Fuels**

Like gasoline and other petroleum products, diesel, jet fuels, and heating oils are common products made in refineries around the world. Diesel is an important fuel used worldwide in a variety of applications such as trains, trucks, agricultural equipment, and military vehicles. While the processes used to make diesel, jet fuel, and heating oil are like those for gasoline, the chemical makeup and refinement processes have distinct differences.

The Diesel and Other Fuels training course discusses the process for refining these products. It defines what diesel, jet fuel, and heating oils are and identifies the applications for each of these fuels.

Diesel and Other Fuels is part of the Refinery Operations training series.

› **100** Safety, Health, and Plant Science
› **200** Mechanical Maintenance
› **300** Electrical Transmission and Distribution
› **400** Electrical Maintenance
› **500** Power Generating Systems and Operations
› **600** Instrumentation and Control
› **700** Process Systems and Operations
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705-13 **Sweetening**

Gasoline in the refining process often contains contaminants which must be removed to meet market specifications, comply with emissions and regulatory standards, and control corrosion. Gas sweetening is the process of removing contaminants, mainly the acid gases hydrogen sulfide and carbon dioxide, which turns acid gases into sweet gases.

The Sweetening training course identifies and discusses gas sweetening. It explains the role amines and solvent have in the process. This online course also describes the process and equipment associated with a sweetening plant. It includes:

- Purpose of gas sweetening
- Major system components
- Amines and solvents

Sweetening is part of the Refinery Operations training series.

705-15 **Sulfuric Acid Plant**

Hydrogen sulfide gas is found in crude oil supplies worldwide. Because this compound is harmful to the refinery's equipment, the environment, and the consumer, it is removed in several refinery processes, particularly hydrodesulfurization and sweetening. Sulfur plants remove the hydrogen sulfide byproducts from these processes and turn it into useful elemental sulfur.

About 80 million tons of sulfur are produced annually. The majority is from refinery sulfur recovery units. Many everyday applications use this sulfur including medicine, cosmetics, fertilizers, rubber products, and pesticides.

The Sulfur Acid Plant training course:

- Discusses the process most commonly used for sulfur recovery
- Explains the system components used in the process
- Discusses the uses of elemental sulfur
- Explores the regulatory issues surrounding sulfur production

Sulfuric Acid Plant is part of the Refinery Operations training series.

705-17 **Finishing Processes and Hydrotreating**

Before the different hydrocarbon streams from the various refinery units can be distributed as final commercial products, they must undergo treatment. Treatment, or the finishing process, is the third and final step of petroleum refining after separation and conversion. The finishing process may be comprised of several different steps to:

- Stabilize the product
- Remove harmful chemicals such as sulfur and nitrogen
- Remove heavy metals
- Ensure the products meet the numerous government and consumer specifications

Once the finishing process is complete, the refinery products we depend on for daily use are ready for distribution and consumption.

The Finishing Processes and Hydrotreating training course:

- Defines the purpose of the finishing processes
- Discusses each finishing process
- Identifies the petroleum products related to each finishing process

This online course is part of the Refinery Operations training series.

705-19 **Support Plants and Regulations**

Refineries consist of process systems that produce usable, finished petroleum products. These systems are often considered the refinery's most important features. However, refineries are also supported by any number of additional facilities and plants, called off-sites. These off-sites are equally critical in the production and distribution of finished products as the on-site process systems. A refinery's design, location, and corresponding environmental and product regulations determine the off-site facilities needed to ensure seamless and compliant operation.

The Support Plants and Regulations training course explains the purpose of off-sites. It discusses each off-site facility or process and identifies the regulations related to off-site processes. This online course explores:

- Off-site facility basics
- Tankage
- Flare systems
- Utilities and environmental treatment

Support Plants and Regulations is part of the Refinery Operations training series.

705-21 **Natural Gas Refining**

Like crude oil, natural gas is a limited fossil fuel that must be treated and refined before it can be used. Refineries have many ways to remove impurities, contaminants, and heavier hydrocarbons to turn raw natural gas into pipeline quality natural gas and deliver it to the end user. Natural gas is a relatively clean fuel with many uses for heating, electrical generation, and cooking. It is also a medium for producing plastics and other commercial organic materials.

The Natural Gas Refining training course defines the purpose of natural gas refining. It discusses different contaminants found in natural gas. It also explains the process for natural gas refinement. This online training course focuses on:

- Natural gas origins
- Natural gas sources and characteristics
- Natural gas refining process

Natural Gas Refining is part of the Refinery Operations training series.

› **100** Safety, Health, and Plant Science
› **200** Mechanical Maintenance
› **300** Electrical Transmission and Distribution
› **400** Electrical Maintenance
› **500** Power Generating Systems and Operations
› **600** Instrumentation and Control
› **700** Process Systems and Operations
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705-23 **Lubricants**

Lubricants, also called lubricating oil or lube, are finished petroleum products from the refining process. Lubrication is used in machinery to help reduce friction, heat, and wear and tear of various mechanical components that come into contact with each other, particularly in automobiles and other vehicles. Some types of lubricants can also be used to protect and seal mechanical components.

The Lubricants training course discusses their composition and the processes required to make quality lubricating oil. It also identifies their purpose and types. This online course includes:

- Lubricating oil basics
- Extraction process
- Conversion process

Lubricants is part of the Refinery Operations training series.

705-25 **Asphalt**

Asphalt, sometimes referred to as bitumen, is a viscous chain of hydrocarbons occurring naturally or as a byproduct of crude oil distillation. This sticky, semi-solid substance can be made up of many different compounds including metals, sulfur, nitrogen, and oxygen. It is used for paving, roofing, paint, water proofing, and other applications. Because only 10-15% of crude oils can be used to produce asphalt, refineries must consider several factors when refining asphalt such as:

- The blend of crude oil used
- The refining method
- Which additives should be used

The asphalt training course defines what asphalt is. It discusses the refining process and identifies the applications for different grade of asphalt. This online training course covers:

- Asphalt characteristics
- Asphalt refining process

Asphalt is part of the Refinery Operations training series.

707 **Process Heaters**

707-01 **Features and Operation of Process Heaters**

A process heater is one of the most expensive pieces of equipment to operate. A process heater consumes the most fuel of all facility equipment. It is also a source of air pollution. A process heater must operate as economically and cleanly as possible. A smooth operating process heater is a major factor in reliable facility operations.

The Features and Operations of a Process heater training course describes a process heater's features and operations.

This online course is part of the Process Heaters training series.

709 **Process Tanks**

709-01 **Features and Uses of Process Tanks**

Process tanks have many uses. Therefore, size, volume, position, and construction are different for all tanks. Accessories (instruments and fittings) also change, depending on the tank's purpose. The process conditions in which the tank is used must also be considered. The number of gallons a tank will hold is the primary design consideration. Flow rates and time are checked to get the proper tank volume.

The Features and Uses of Process Tanks training course describes the main features and uses of process tanks.

This online course is part of the Process Tanks training series.

711 **Distillation**

711-01 **Introduction to Distillation**

Distillation is the first step in refining crude oil into finished products. Distillation separates components of a liquid measure by taking advantage of its physical properties.

The Introduction to Distillation training course describes distillation theory and principles. It also explains the configuration of a distillation column and its components.

This online course is part of the Distillation training series.

711-02 **Operation of a Distillation Column**

Distillation columns have varying procedures for their startup, normal operation, and shutdown. The type of distillation the column performs determines the procedures. Operators can run the distillation column safely and efficiently when they know the procedures.

The Operation of a Distillation Column training course describes the startup, normal operation, and shutdown of a typical distillation column. This online course also explains the pre-startup safety review and an emergency column shutdown.

Operation of a Distillation Column is part of the Distillation series.

- **100** Safety, Health, and Plant Science
- **200** Mechanical Maintenance
- **300** Electrical Transmission and Distribution
- **400** Electrical Maintenance
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713 Process Separators

713-01 Introduction to Process Separators

Effective liquid-gas separation is a fundamental step in hydrocarbon production. Operators must produce crude oil free from gas, water, and solid debris to maximize production and prevent problems in downstream process equipment. The Introduction to Process Separators training course describes the types of processes operators and their components. It also explains the principles of operation.

This online course covers two-phase and three-phase separators. It focuses on their operating performance and highlights multi-stage separation.

This course is part of the Processes Separators series.

715 Process Reactors

715-01 Introduction to Process Reactors

A reactor is a vessel where chemical reactions create more valuable products. These products are different from the raw materials fed into the process. They fall under the provisions of safety and control. The Introduction to Process Reactors training course introduces the common processes for using reactors in the refining industry. It describes chemical reactions, features and operations of different reactors and explains their application in the refining industry.

Introduction to Process Reactors covers operating conditions, reactor types, and reactor components.

This online course is part of the Process Reactors series.

717 Reforming and Synthesis

717-01 Introduction to Naptha Reforming

Reforming converts low-octane premium naptha into high-octane gasoline called reformate. This process also creates hydrogen and aromatic compounds used in refineries and the petrochemical industry.

The Introduction to Naptha Reforming training course explains how reforming relates to a refinery's operation. It also identifies reforming techniques, catalytic reformer types, and how variables affect the process. This online training course covers:

- Naptha reforming
- Catalytic reforming
- Process classification

Introduction to Naptha Reforming is part of the Reforming and Synthesis training series.

719 Process Safety Systems

719-01 Safety Alarm Systems and Instrumentation

Production platforms and processing plants use instrumentation for safety systems. Alarm systems alert operators to abnormal process conditions. Shutdown systems stop equipment automatically if process conditions become unsafe. Alarm systems are designed to interact with shutdown systems. Various devices are used to protect equipment from damage due to power failures, extreme process conditions, or fire.

The Safety Alarm Systems and Instrumentation training course describes the design, operation, and use of safety alarm systems and instrumentation. This online course explains:

- Alarm systems
- Shutdown systems
- Equipment protection devices

Safety Alarm Systems and Instrumentation is part of the Process Safety Systems training series.

719-02 Overpressure Safety Systems

Facility equipment needs protection against failure from overpressure. Safety systems consisting of pressure relief devices, flare systems, and drains help prevent overpressure.

The Overpressure Safety Systems training course describes the design, operation, and use of overpressure safety systems. It discusses pressure relief devices, including flares. It also explains the causes of overpressure.

This online course is part of the Process Safety Systems training series.

721 Process Utilities Systems

721-01 Process Utilities Systems Part 1

Utilities systems supply the water, air, and energy required by a plant's process units, maintenance and shop equipment, and other facilities. Although not as complex as processing units, utilities systems can be large and expensive. A plant cannot operate safely and efficiently without the following utilities systems:

- Water supply
- Air supply
- Heat and fuel supply
- Refrigeration system
- Power supply

The Process Utilities Systems Part 1 training course concentrates on the water and air supply systems. It explains the design and function of plant water and air utility systems.

This online course is part of the Process Utilities Systems training series.

- 100 Safety, Health, and Plant Science
- 200 Mechanical Maintenance
- 300 Electrical Transmission and Distribution
- 400 Electrical Maintenance
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721-02 Process Utilities Systems Part 2

Utilities systems supply the water, air, and energy required by a plant's process units, maintenance and shop equipment, and other facilities. Although not as complex as processing units, utilities systems can be large and expensive. A plant cannot operate safely without these systems.

The Process Utilities Systems Part 2 training course builds on the water and air supply system from Part 1 by focusing on the function and design of the heat and fuel, refrigeration, and power supply systems. It also explains how they connect to meet energy demands from industrial processes.

This online course is part of the Process Utilities Systems training series.

723 Process Product Movement and Storage

723-01 Process Product Movement and Shipment

Initial plant facility design and construction must consider product movement and storage dynamics. The system must be kept moving and balanced, accounting for maximum product loading, unloading, and storage needs. Whenever a piece of equipment or unit in the system stops, the process is interrupted, and overall operating efficiency drops. So, starting and stopping equipment occurs only when necessary for maintenance and repair.

The Process Product Movement and Shipment training course describes efficiency considerations in facility design and product storage and transportation types. It also explains precautions taken when handling product.

This online training course is part of the Process Product Movement and Storage training series.

723-02 Tanks and Vessels Used for Storage

All products, whether gaseous, liquid, or liquified gas, are stored in tanks. These products may be a finished product stored for a brief time before shipping or an unfinished product waiting for further processing. A tank's contents represent a large concentration of value. The protection and safe operation of tanks can reduce accidents, personnel danger, product loss, and equipment damage.

The Tanks and Vessels Used for Storage training course describes various types of storage tanks and vessels including:

- Non-pressurized storage
- Pressurized storage
- Refrigerated storage

This online course also explains safety equipment for these tanks and vessels.

This course is part of the Process Product Movement and Storage training series.

725 Process Sampling and Testing

725-01 Sampling Principles and Methods

Sampling is the practice of taking a small quantity of product for testing. The sample must be taken so its representative of the remaining material. The Sampling Principles and Methods training course describes the importance of accurate sampling. It explains several sampling types and systems. It also discusses correct sampling procedures.

This online training course includes:

- Sampling principles and specifications
- Sample types
- Sampling systems and practices

This course is part of the Process Sampling and Testing training series.

725-02 Testing Principles and Procedures

Plants use tests and analyses to determine the quality and performance characteristics of oil, gas, and various other products. Plant operating manuals typically have detailed descriptions of local test procedures. Several hundred chemical, physical, and performance tests have been adopted as industry standards for product specifications. This course covers some of the more common ones.

The Testing Principles and Procedures training course describes how tests are used to ensure on-specification quality products. It explains common chemical and physical tests performed on products to ensure this quality.

This online course is part of the Sampling and Testing training series.

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Industrial Machining and Welding

801 Precision Measurement

801-01 Introduction to Measuring and Care of Measuring Tools

With the intricate designs and close running tolerances of modern machinery, precision measurements are critical to proper equipment maintenance and repair. The ability to accurately measure parts is a necessity in modern industrial plants. The Introduction to Measuring and Care of Measurement Tools training course covers the use and care of measurement instruments in machining and industrial maintenance.

This online introductory course explains the need for measurement tools and describes precautions in properly caring for the tools. It also includes care of coarse and precision measurement tools.

Introduction to Measuring and Care of Measurement Tools is part of the Precision Measurement training series.

801-02 Measuring Rules and Tapes

Rigid rules, folding rules, depth rules, and tape measures are used to take accurate measurements on many machined and mechanical parts. These tools can measure various shapes and sizes of equipment. The ability to identify the proper measuring tool for an identified task is a skill itself. The correct use of the selected tool will provide a high degree of accuracy which is critical in maintenance and machining activities.

The Measuring Rules and Tapes online training course identifies measurement tool types. It also explains the correct procedures for taking accurate measurements with them. This course covers:

- Rigid rules
- Folding rules
- Depth rules
- Tape measures

Measuring Rules and Tapes is part of the Layout and Bench Work training series.

801-03 Micrometers

A micrometer is widely used in machining and maintenance operations. It precisely measures block thickness, the outer and inner dimensions of shafts, and slot depth. Learning to take accurate readings with a micrometer is critical in precision machining and maintenance work.

The Micrometers online training course introduces common micrometer types, their components, and how to correctly take measurements. It covers outside, inside, and depth micrometers. It also explains reading English scale, metric scale, and vernier micrometers.

This course is part of the Precision Measurement series.

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801-04 **Fixed Gauges**

Fixed gauges are precision measuring tools with no moving parts. Maintenance and machining technicians use them to measure or compare machinery part sizes and check tolerances. Fixed gauges come in many styles and are used for a variety of applications.

The Fixed Gauges training course describes the types and purpose of fixed gauges used by maintenance and machining technicians, including:

- Go/no-go gauges
- Plug gauges
- Thickness gauges
- Thread pitch gauges
- Radius gauges
- Small hold gauges
- Wire and sheet metal gauges

Fixed Gauges is part of the Precision Measurement series.

801-05 **Measuring with Calipers**

Calipers are precision measuring tools used to measure thickness and distance between two points. Most calipers have two adjustable jaws or legs and are used to measure small increments of distance. Most measurements taken with calipers are less than one foot.

The Measuring with Calipers training course describes common types of calipers used in machining and maintenance work. It also explains how to properly use them to take accurate readings. This online course discusses:

- Inside calipers
- Outside calipers
- Hermaphrodite calipers
- Transfer calipers
- Side calipers
- Vernier calipers
- Dial calipers
- Digital calipers

Measuring with Calipers is part of the Precision Measurement series.

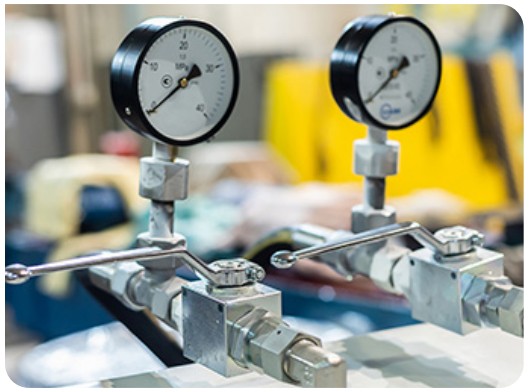
801-06 **Dial Indicators**

Dial indicators are instruments used to accurately measure a small distance. A dial indicator is also known as a dial gauge, dial test indicator (DTI), or a "clock." They are so named because their measurement results are displayed by a dial.

The Dial Indicators training course lists their major components. It demonstrates how to take an accurate reading with dial indicators. This online course describes how to use a dial indicator to measure the run out of a rotating part. It also shows how to align two shafts using a dial indicator. This course includes:

- Dial indicator components
- Reading a dial indicator
- Measuring run out
- Digital indicators
- Digital test indicators

Digital Indicators is part of the Precision Measurement series.



801-07 **Telescoping Gauges**

A telescoping gauge is a precision measuring instrument with an end that can be positioned inside a hole or opening, then expanded to touch the walls. The interior dimension is obtained by measuring the gauge results with a micrometer.

The Telescoping Gauges training course describes the functions and proper use of a telescoping gauge.

This course is also explains its care. Telescoping Gauges is part of the Precision Measurement series.

803 **Layout and Bench Work Series**

803-01 **Layout and Bench Work**

Layout and bench work are key skills to master for design manufacturing and maintenance repair. Hand work requires years of experience and can be a technician's most challenging skill. The Layout and Bench Work training course identifies the basic hand tools and hand work methods required to manufacture replacement or repair parts.

This online course covers the following:

- Hand hacksaw
- Files
- Reamers
- Deburring tools
- Taps and dies
- Broaches

The Layout and Bench Work course is part of the Layout and Bench Work series.

803-02 **Threading and Tapping**

Taps, dies, and die nuts are cutting and threading tools used to cut new threads or repair damaged threads in a workplace. They can be operated by hand or mounted on a machine.

The Threading and Tapping training course focuses on taps and dies used in an industrial facility. It describes taps, dies, and die nuts and explains how they are used in threading operations. This online training course reviews:

- Hand tapping procedures
- Using hand dies
- Machine threading

Threading and Tapping is part of the Layout and Bench Work training series.

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805 Vertical Milling Machine

805-01 Vertical Milling Machine

In the machine shop, the vertical milling machine is a key maintenance and repair tool for manufacturing repair parts. The Vertical Milling Machines training course identifies the basic control systems and machining methods used on the vertical milling machine. It also explains the operations necessary to manufacture replacement or repair parts used in different equipment types.

This online training course includes:

- Operational controls
- Aligning and holding work
- Cutting tool material and type
- Milling methods

This course is part of the Vertical Milling Machines training series.

807 Engine Lathe

807-01 Engine Lathe

The engine lathe is one of the key maintenance and repair tools for manufacturing repair parts. The Engine Lathe training course identifies control systems and machine methods. It explains the basic methods to manufacture replacement or repair parts for different equipment.

This online training course covers basic parts and operational control including:

- Lathe chucks
- 4-jaw chuck operation and use
- Tailstock parts and operation
- Cutting tools
- Basic machining operations
- Specialized operations

This course is part of the Engine Lathe training series.

809 Surface Grinder

809-01 Surface Grinder

The surface grinder is a key tool in the machine shop for maintenance, repair, and manufacture of repair parts. The Surface Grinder training course describes surface grinder controls systems. It also explains basic machining methods to manufacture replacement parts used to repair different equipment types.

This online training course discusses:

- Surface grinder components
- Workpiece clamping
- Grinding wheels
- Grinding techniques

This course is part of the Surface Grinder training series.

811 Pedestal Grinder

811-01 Pedestal Grinder

A pedestal tool is used in industrial machine shops to sharpen other tools such as drill bits and chisels. It is also used for smoothing and forming machined workpieces. Understanding pedestal grinder proper operation and maintenance ensures personnel safety and extends the life of the grinder.

The Pedestal Grinder training course describes a pedestal grinder's design, function, and safe use. This online training course explains:

- Pedestal grinder safety
- Pedestal grinder components
- Grinding wheel replacement
- Dressing the wheel

This course is part of the Pedestal Grinder training series.

813 Band Saw

813-01 Band Saw

Many industrial machine shops use a band saw, or band mill. This machine cuts a variety of shaped contours. Appropriate procedures for set up and operation ensure safe and efficient use of a band saw.

The Band Saw training course describes a band saw's design and operation. It also explains how to use a band saw to produce various cuts. This online training course reviews band saw:

- Components
- Blades
- Operation
- Safety precautions

This course is part of the Band Saw training series.

815 Drill Press

815-01 Drill Press

Drill presses are among the most frequently used tools in an industrial machine shop. They are often used with a drill bit to cut holes in work pieces. Drill presses may also be used with a variety of other cutting attachments for machining operations such as tapping, countersinking, reaming, boring, and counterboring.

The Drill Pass training course explores different types of drill presses and their common components. It also discusses drill press safety and operations. This online course describes the design, use, and operation of a drill press and its major functions and attachments. Topics covered in this course include:

- Safety in drill press operations
- Drill press components
- Holding attachments
- Drill press types
- Drill press operations
- Cutting speeds and feed rates

This course is part of the Drill Press training series.

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820 Rigging, Lifted, and Elevated Work Surfaces

820-01 Scaffold Erection and Components

Scaffold refers to a specific type of assembly structure, usually temporary in nature. It supports workers and materials while they build or repair a structure. Scaffolding involves sturdy connections of frames and planks by bolts and couplets. These pieces come in many forms depending on the size and shape of the desired framework.

The Scaffold Erection and Components training course describes the proper scaffold erecting sequence. It identifies components used to build a scaffold and the different scaffolding types used in many construction projects. This online training course covers:

- Erecting sequence
- Scaffold putlogs
- Rolling tower design
- Erecting scaffold stair towers
- Tube and clamp scaffold

Scaffold Erection and Components is part of the Rigging, Lifting, and Elevated Work Surfaces training series.

820-02 Rigging, Part 1

The Rigging, Part 1 course concentrates on the design and characteristics of wire rope. It covers wire rope construction and the different types of rope lay used. This course identifies the classification of wire ropes. It explains how to install wire ropes correctly and reviews the importance of inspection and lubrication.

Rigging, Part 1 is an introduction which covers:

- Design characteristics
- Fatigue and abrasion resistance
- Non-rotating ropes
- Installation
- Inspection
- Lubrication

This course is part of the Rigging, Lifted, and Elevated Work Surfaces series.

820-03 Rigging, Part 2

Fiber ropes are made from natural or synthetic fibers. The natural fibers come from plants like manila, sisal, and hemp. Synthetic fibers include nylon, polypropylene, and polyester. The strength of these ropes depends on their size, the fiber used, and the stranding type. Proper rope selection, care, and inspection help ensure safe and effective rope use in rigging.

The Rigging, Part 2 training course identifies types of rope and the applications in which they are best used. It also describes the techniques for rope care and use. This online course focuses on:

- Natural fiber ropes
- Synthetic ropes
- Rope inspections
- Rope splicing
- Knots, bend, and hitches

Rigging, Part 2 is part of the Rigging, Lifted, and Elevated Work Surfaces series.

820-04 Rigging, Part 3

Hoisting is not a simple action of typing a rope to an object and lifting it. What is being lifted and what equipment is appropriate for that action must be considered. The hardware used in and with rigging installations and applications is as important as the ropes and chains used with them. Not only must workers know what hardware to use and how to use it, but they must also know how safe working loads compare with the rope or chain.

The Rigging, Part 3 training course describes the design and importance of several types of rigging hardware. It also discusses appropriate applications for their use. This online course covers:

- Chains
- Drums
- Sheaves
- Hooks
- Blocks and reeving
- Slings

Rigging, Part 3 is part of the Rigging, Lifted, and Elevated Work Surfaces training series.

820-05 Ladders

A ladder is defined as a vertical or inclined set of rungs or steps. Ladders are found throughout industry in many shapes, sizes, and materials. Each ladder's design and construction affects how it is used and maintained. Proper use, maintenance, and operator awareness are necessary to ensure a ladder is safe and useful.

The Ladder training course identifies the design and function of several types of commonly used ladders. It also describes proper case and safe use of ladders. This online training course includes:

- Ladder types
- Ladder materials
- Factors that affect the service life of fiberglass ladders
- Ladder care
- Safe ladder use

Ladders is part of the Rigging, Lifted, and Elevated Work Surfaces training series.

820-06 Overhead Cranes

Overhead cranes are used all over the world for lifting and lowering materials. As with other industrial equipment, safety is the first concern. All personnel associated with operation must recognize and fulfill many responsibilities.

The Overhead Cranes training course describes the design and function of various overhead crane types. It explains the importance of responsibilities related to their operation, inspection, and maintenance. This online course discusses:

- Overhead crane types
- Overhead crane mechanics
- Personnel responsibilities
- Crane components
- Overhead crane inspection and maintenance

Overhead Cranes is part of the Rigging, Lifted, and Elevated Work Surfaces training series.

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820-07 **Aerial Lift Devices**

Aerial lifts come in several varieties, but they all share the same purpose of lifting employees and their equipment for above ground work. Lifts are used in warehouses, manufacturing plants, retail stores, construction, utility work, and any application where the work is in a hard-to-reach location.

The Aerial Life Devices training course describes the three main lift designs and their components. It explains how to decide which design best suits the work you're doing. This online course focuses on:

- Aerial lift designs
- Using the proper aerial lift
- Aerial lift features
- Aerial lift safety

Aerial Lift Devices is part of the Rigging, Lifted, and Elevated Work Surface training series.

841 Welding and Cutting for Maintenance

841-01 **Safe Welding and Cutting Practices**

Welding, cutting, and other related processes are associated with several hazards, including electric shock, hot metal, slag, sparks, welding fumes, and exposure to infrared and ultraviolet rays. Anyone who welds must recognize the hazards and understand how to protect the welder and the workplace.

The Safe Welding and Cutting Practices training course identifies common welding hazards and describes how to use personal protective equipment, ventilation, and safety procedures to mitigate these hazards. This course covers:

- Jobsite safety
- Personal protective equipment
- Authorization permits
- Cutting safety
- Oxyacetylene welding safety
- Arc welding safety

Safe Welding and Cutting Practices is part of the Welding and Cutting for Maintenance training series.

841-02 **Weldability of Metals**

Weldability refers to how easy it is to properly weld a metal. Understanding various metal characteristics and the different classifications of metal ensures proper selection of welding procedures to achieve solid welds on different metals.

The Weldability of Metals training course identifies various metal classifications and explains factors influencing their weldability. This online course covers:

- Principles of weldability
- Steel weldability
- Hardening and tempering steel
- Stainless steel weldability
- Cast iron weldability
- Aluminum weldability

This course is part of the Welding and Cutting for Maintenance training series.

841-03 **Shielded Metal Arc Welding (SMAW)**

Shielded metal arc welding (SMAW) is one of the most commonly used welding methods in the world. It is used in the fabrication and repair of many products including pressure vessels, automobiles, appliances, farm equipment, and storage tanks.

Shielded Metal Arc Welding (SMAW) identifies equipment procedures used in successful operations. This online training course focuses on:

- SMAW basics
- SMAW equipment
- Welding arcs
- Weld passes
- Selecting electrodes
- SMAW positions

This course is part of the Welding and Cutting for Maintenance training series.

841-04 **Gas Metal Arc Welding (GMAW)**

Gas metal arc welding (GMAW) is the most common industrial welding process used today. It is sometimes referred to by its subcategories of metal inert gas (MIG) or metal active gas (MAG) welding.

The Gas Metal Arc Welding training course introduces the equipment and techniques used when performing GMAW. It discusses the design and function of components used in GMAW. This course covers:

- Gas metal arc welding principles
- Wire feeders
- GMAW electrode wire
- GMAW guns
- Shielding gases
- Starting a GMAW arc
- Metal transfer modes

Gas Metal Arc Welding is part of the Welding and Cutting for Maintenance training series.

841-05 **Tungsten Inert Gas (TIG) Welding**

Tungsten inert gas (TIG welding, also known as gas tungsten inert welding (GTAW), is used to weld thin section of stainless steel and metals such as magnesium, aluminum, and copper alloys. The TIG welding process gives the welder greater control over methods like shielded metal arc welding and gas metal arc welding.

The Tungsten Inert Gas (TIG) Welding training course introduces the procedures and equipment used in this welding. It also discusses the design and function of components used in the processes. This online course includes:

- Principles of TIG welding
- TIG welding equipment
- TIG welding procedures

Tungsten Inert Gas Welding is part of the Welding and Cutting for Maintenance training series.

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841-06 **Oxyacetylene Welding**

Oxyacetylene welding (OAW) and cutting is versatile. It requires no electricity and works by fusing a metal base and welding rod with the intense heat created by burning acetylene gas in the presence of oxygen. OAW equipment is used to weld, cut, bend, or straighten steel.

The Oxyacetylene Welding (OAW) training course describes OAW techniques. It discusses the design and function of components and apparatus used in the OAW process. This online course focuses on:

- Oxyacetylene welding principles
- Oxyacetylene equipment
- Lighting and adjusting the welding frame
- Flame characteristics and control
- Shutting off the welding torch
- Oxyacetylene welding techniques

Oxyacetylene Welding is part of the Welding and Cutting for Maintenance training series.

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Instructor Led-Training

HSI instructor-led training is taught by our expert instructors with a wide background in instruction, presentation, and industry subjects including system operations. Our instructor-led training enables students to:

- Apply instruction to real-world experiences through exercise and simulation
- Learn in a small group setting which allows customized training for each individual
- Complement online training with more in-depth classroom experience
- Actively participate in training through an interactive high energy format

Advanced Distribution Concepts

This class gives students an in-depth look into the relevant ancillary aspects of distribution planning, design, and operations. Students discuss methods to improve circuit reliability performance, techniques to enhance voltage flicker/transients, and techniques used to trouble-shoot stray voltages and currents. This class also covers modern digital electronic devices and other smart means to improve distribution automation.

Adequate Level of Reliability *(CEH class)*

In this class, students learn how to define reliability, adequacy, and predictability. The information covers how to identify contingencies and apply situational awareness to analyze potential contingencies. During simulation, students learn to locate adjust, and/or direct system components to mitigate the effects of contingencies.

Analyzing and Mitigating Contingencies: Operational Situational Awareness *(CEH class)*

This class develops and tests system operator knowledge in identifying, analyzing, and mitigating contingencies on the BES. During the class, students define and apply situational awareness to improve operating sensibility while analyzing and periodizing system contingencies. Using simulation, students locate, adjust, and/or direct system components to mitigate the adverse effects of contingencies.

Distribution Systems

This class gives students a technical and engineering concepts background and working knowledge of modern distribution facilities equipment, construction practices, and design applications. It starts with an overview of the electric power system as it applies to distribution, customer services, and consumption, then discusses overhead and underground equipment and configurations, service reliability, and power quality. It also includes an in-depth examination of electrical safety in high voltage environments.

Balancing, Voltage Control, and Congestion Management *(CEH class)*

This class delves into balancing concepts in the power system, the intricacies of interconnected networks, and the crucial role of synchronous generators in supporting system frequency. Our expert instructors guide you through the fundamentals of generator characteristics and their impact on interconnection frequency. Students gain a comprehensive understanding of generator operating ranges, automatic protection schemes, and the purpose of under-frequency load shed.

Using simulation, students explore how power flows from generator to load highlighting the potential for congestion and exceeding System Operator Limits. Through engaging discussions and practical examples, students learn strategies for manipulating power flow and effectively managing congestion to ensure reliable system operations.

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Communication, Relay Protection, and Emergency Operations *(CEH class)*

This essential class focuses on recognizing emergencies within the power system and identifying critical situations such as frequency and voltage emergencies. It also covers restoration strategies, addressing various conditions and issues that may arise during emergency scenarios. The student will understand the crucial role of human performance and situational awareness through discussions and simulations that underscore the importance of maintaining effectiveness during emergency operations.

Effective On-the-Job Training

Structured OJT is one of the best training methods available because it is planned, organized, and conducted at the employee's worksite. However, a successful OJT program requires more effort than placing a new employee with an experienced operator to learn the ropes.

This class shows trainers how to avoid unstructured training pitfalls by reviewing how OJT should work and step-by-step practices to build a successful program.

Emergency Operations and Communication *(CEH class)*

This intensive class dives into the Emergency Operating Procedures (EOP) standards and scenarios within the BES. Through a combination of instructor-led presentations and simulation, students gain a comprehensive understanding of the parameters and limits crucial for maintaining electric power system reliability. The class explains the various emergencies impacting voltage and frequency within the Interconnection, while highlighting the pivotal role of operators in recognizing and responding to those situations.

This class reviews each NERC reliability standard pertinent to emergency preparedness and operations, including EOP-004, EOP-005, EOP-006, EOP-010, and EOP-011. Students explore the requirements of each standard and its practical application to system operator duties.

Emergency Operations Overview *(CEH class)*

This class helps students use the NERC EOPS Standards to identify emergency conditions and events that constitute an emergency. Students use the simulator to assess and solve power system disturbances and emergencies.

Frequency Response and Balancing *(CEH class)*

Students analyze the effects of frequency deviations on load, generation, and power flow. They identify Interconnection balancing concepts and requirements and understand system operator responsibilities for supporting interconnection frequency. Through simulation, students reproduce impacts to power system frequency due to generator trip and frequency control during restoration.

Human Performance for System Operators *(CEH class)*

Understanding the psychology and physiology of human performance can help improve awareness and critical thinking skills essential to improving reliability of the bulk power system. Learning to identify the correct tools for system operators can reduce unwanted variable in human behavior. This class is designed to make operators more aware of what goes into their situational decision-making through practical and simulated exercises.

Integrating Renewable Energy Resources *(CEH class)*

This class explores the challenges associated with DERs, including interconnection reliability criteria and industry best practices. Through a combination of lecture, discussion, and simulation exercises, students gain a comprehensive overview of integrating large-scale DERs into the grid.

Key topics include compensating for changes in daytime load characteristics, managing ramp rate requirements, and balancing variable generation and load dynamics. This course also examines real-world examples of power faults affecting DERs and the associated challenges with power, voltage, and frequency profiles. Students explore industry advancements in inverter technology and changes to reliability and interconnection standards aimed at accommodating DER integration. Through hands-on exercises using the HSI transmission simulator, students observe first-hand how DERs impact the reliable operation of the BES.

Managing Power System Reliability *(CEH class)*

This comprehensive class covers a range of topics including frequency deviation impacts, system inertia, governor response, transmission characteristics, voltage control equipment, real-time assessments, and system restoration. Using simulation, students are tasked with various scenarios, including responding to generator droop, ACE and load response during frequency deviations. They also navigate challenges such as single generation outages, voltage decay due to transmission line losses, and real-time contingency analysis. Students also practice mitigating potential System Operating Limit exceedances and system restoration activities.

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NERC Certification: Exam Preparation Instructor-Led

This class is part of a curriculum for new personnel to obtain their NERC System Operator Certification. In conjunction with the other program components, this instructor-led training course provides effective instruction in the basic principles of the BES and the NERC Reliability Standards applicable to system operators. Students leave the course with test-taking tips, study hints, and a variety of resources giving them an added edge in taking the NERC exam. This course is designed to supplement the online portion of the program. We do not recommend taking this class on its own.

Power System Frequency Impacts and Control *(CEH class)*

This class teaches students the fundamentals of frequency control in the power system. The course focuses on generation, balancing, and loads which can all impact frequency. Students use the simulator to observe how power system frequency responds to various Real-time scenarios, including the effect of a generator trip, load, relay operations, and system restoration.

Presentation Skills

This class is designed to improve instructor delivery methods and teach the techniques and tricks that expert instructors use to turn a typical presentation into an effective and captivating one. It is designed to provide participants with advanced training skills necessary to capture audience attention and present material to increase retention and transfer training to job. This class includes role-play exercises and a final presentation to the instructors and fellow students.

Principles for System Reliability *(CEH class)*

Students learn the basic principles of electric generation and transmission, review selected NERC operating standards that govern generator and transmission operations, and study the capabilities of generation and transmission facilities and their effects on emergency conditions. Students use the simulator to visualize, monitor, and control a complex power system. During simulation, specific operating principles, communications, and decision-making processes are reviewed, discussed, and practiced again to reinforce each student's understanding.

Procedure Writing

Procedures are necessary to document operational processes and ensure consistency. Well-written procedures are a strong foundation for training programs. This class walks you through the steps for writing effective procedures, including formatting, understanding your audience, and using a clear writing style.

SAT Fundamentals

This class provides participants with an overview of a systematic approach to training, using the ADDIE process, as it applies to the electric utility industry. The course is built around the five ADDIE stages and includes combinations of presentations, working sessions, breakout groups, and other activities. This class is fast moving and illustrates choices of presentation activities and styles.

System Restoration *(CEH class)*

Students identify possible causes of a system blackout and learn system restoration methodologies. They learn the four issues likely to occur during system restoration and discuss human performance concerns and how to address them. Using simulation, students demonstrate how to restore a power system from start to finish and correctly manage voltage and MVAR when restoring a power system. Students also learn the mechanisms for frequency control during restoration.

Voltage Control 1 *(CEH class)*

This class covers the fundamentals of voltage control in the power system, focusing on different types of equipment which affect or control reactive power. It also takes a more advanced look at these principles, then discusses voltage stability, instability, and collapse. Using simulation, students experience different voltage control scenarios, including voltage stability and instability, preventing voltage collapse, and system emergencies.

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Voltage Control 2 *(CEH class)*

This class provides a deep dive into the fundamentals of voltage control, with a particular focus on the various types of equipment that influence or regulate reactive power. The class starts by exploring the basics of electric power principles, followed by an in-depth examination of generators, transmission lines, and voltage and power control equipment. Building on this foundation, the course delves into more advanced topics such as voltage stability, instability, and collapse. Using simulation exercises, students can immerse themselves in different voltage control scenarios. These simulations cover a range of scenarios, including voltage stability and instability, strategies for preventing voltage collapse, and system emergency response.

Voltage Control and Relay Protection *(CEH class)*

This class dives into the intricacies of voltage control, exploring the fundamental principles and equipment resources involved in managing reactive power. The first part of the class covers various power system conditions that influence voltage requirements, including the impact of transmission line tripping. It also discusses the instantaneous characteristics of the power system and the importance of protection mechanisms to safeguard against fault conditions. The second part of class focuses on relay protection, examining its purpose, functions, and limitations. Students gain valuable insights into relay protection's role in maintaining system reliability and mitigating risks associated with power system faults.

Voltage Control Overview *(CEH class)*

The Voltage Control Overview class deepens students' understanding of AC power fundamentals and voltage control strategies in the power system. It begins with a comprehensive review of essential elements and principles of AC power, including inductance, capacitance, impedance, phase angle, power triangle, and power factor. Building on this foundation, the class delves into SIL curves and P-V curves and explores the range of equipment available for effectively managing reactive power and voltage levels. The class segues to simulation where students can put their knowledge into practice and reinforce the concepts covered. Standards VAR-001 and VAR-002 are emphasized throughout the class.

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NERC Certification Exam Preparation

Our NERC Certification: Exam Preparation Program guides you through a program design to get you certified as a system operator. The combination of online and instructor-led training not only prepares you for the exam, but helps maintain the reliability and safety of the grid.

Our program follows these steps:

- **NERC Pre-Assessment Evaluation** – this evaluation determines if any introductory training is necessary prior to starting the NERC prep program
- **NERC Certification: Exam Preparation Online** – an online training program following the NERC content outline consisting of eight courses with more than 35 lessons
- **End-of-program Exam (OHM Exam)** – three practice exam options for each version of the NERC exam, containing unique questions covering relevant content areas
- **NERC Certification Exam Preparation Instructor-Led** – a 3.5 day fast-paced comprehensive final review preparing students with test-taking tips, study hints, and a variety of resources giving an additional edge in taking the NERC exam

* NERC Instructor coaching is available for one-on-one guidance as needed. Students can take advantage of regularly scheduled office hours to ask questions and clarify topics.

Learn more about NERC Coaching: **CLICK HERE**

Our NERC certification preparation training is designed as a program, with all elements working together to prepare you for the exam. Students who only use one element are less likely to succeed.

After students attain their certification, their credentials are maintained through our University and our continuing education program.

If your student is new to the industry, our Initial Operator Training program includes six additional courses to acclimate them to the Bulk Electric System (BES). This content-rich training introduces the new operator to the power grid and its components and operations.

Initial Operator Training
includes these courses:

- Power System Fundamentals
- Math for System Operators
- Area Control Error Equation
- Basic Electricity
- Transmission Fundamentals
- Voltage Control

PRICING

Initial Operator Training
$3,400/student

- Six introductory courses
- NERC Certification: Exam Preparation Online
- OHM Exam
- Unlimited mentoring including Friday afternoon office hours

NERC Certification: Exam Preparation Online
$2,200/student

- Eight courses with more than 35 lessons
- OHM Exam
- Unlimited mentoring including Friday afternoon office hours

NERC Certification: Exam Preparation Instructor-Led
$1,750/student (3.5 days)

After certification, students can convert NERC training to maintain credentials for the balance of a one-year access. The training offers 20 CEHs.

** Prices subject to change.*

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NERC **Online Courses**

		CEH	STD	SIM	EO
301-02	Electrical Distribution System Fundamentals	2.0	–	1.0	–
301-06	Load Characteristics and Management	1.5	1.0	–	–
301-08	Single and Poly-Phase Metering	1.5	–	–	–
312-01	Basic Electricity	1.0	–	–	–
312-02	Laws of Electricity	1.0	–	–	–
312-03	AC, DC, and Circuit Interactions	1.0	–	–	–
312-04	Three-Phase AC Connections and Effects	1.5	–	–	–
312-05	Electric Devices	1.0	–	–	–
312-06	Ohm's Law, Energy Formulas, Basic Concepts, Circuits	1.0	1.0	–	–
312-07	Formulas for Voltage and Current Division	1.0	1.0	–	–
312-08	Inductance, Capacitance, and Phase and Power Angles	1.0	1.0	–	–
312-09	Phasors, Capacitance, Inductance, and Symmetrical Components	1.0	1.0	–	–
312-10	Electromagnetism, Induction, Transformers, and Conductors	1.0	1.0	–	–
312-11	Generators, Torque Angle, and Synchronizing	1.0	1.0	–	–
320-01	Market Concepts	1.0	–	–	–
320-02	Regulators, RTOs, ISOs, Long Term Power Supply	1.5	–	–	–
320-03	Near Term, Day Ahead, Hour Ahead, Real Time Power Supply	1.0	–	–	–
320-04	Ancillary Services	1.0	–	–	–
320-05	Risk Protection	1.0	–	–	–
345-10	FERC Standards of Conduct (SOC)	1.0	–	–	–
350-01	Elements of System Protection	2.5	1.0	–	–
350-02	Types of Protective Relays	2.5	0.5	–	–
350-03	Monitoring System Conditions	2.5	0.5	–	–
350-04	Disturbance Monitoring Equipment	2.0	1.0	–	–
350-05	Line Protection	1.0	0.5	–	–
350-06	Transformer Protection	1.0	–	–	–
350-07	Pilot Protection	1.0	–	–	–
350-09	Bus Protection	1.5	–	–	–
350-10	Generator Protection	2.5	2.0	–	–
350-11	Protection System Misoperation	1.5	1.0	–	–
350-12	Protection Systems Maintenance Programs	2.0	1.0	–	–
350-14	General Relay Operations and Categories and Input	1.5	–	–	–
350-15	Auxiliary Relays	1.0	1.0	–	–
350-16	Fault Analysis, Relay Coordination, and Back-up Protection	1.5	–	–	–
350-17	Breaker Operations	1.5	–	–	–
350-18	Protection and Control	2.0	2.0	–	–
350-19	Protection and Switching	2.0	–	–	–
350-20	Remedial Action Schemes	1.0	–	–	–
375-12	Real Power Balancing Control Performance (BAL-001)	1.0	1.0	–	–
375-13	Disturbance Control Performance (BAL-002)	1.0	1.0	–	–
375-14	Inadvertent Interchange	1.5	1.0	–	–
375-15	Area Control Error (ACE) Equation	1.5	–	–	–
375-16	Evaluation and Implementation of Interchange Transaction (INT-006)	1.0	1.0	–	✓
375-17	Generation	1.0	–	–	–
376-04	Communications (COM-001, COM-002)	1.5	1.5	–	✓
376-05	Principles of Synchrophasors	1.0	–	–	✓
376-06	Application of Synchrophasors	1.5	–	–	✓
376-07	Overview	1.0	1.0	–	–
376-08	Effective Verbal Communication	1.0	1.0	–	–
376-09	Effective Written Communication	1.0	1.0	–	–
376-10	Effective Communication Strategies and Best Practices	1.5	1.0	–	–
377-06	Critical Infrastructure Protection Overview	1.0	1.0	–	–
377-07	CIP Physical and Electronic Access	1.5	1.5	–	–
377-08	CIP Incident Response and Recovery and Supply Chain Risk Management	1.0	1.0	–	–
378-09	Event Reporting and Emergency Operations (EOP-004, EOP-011)	1.0	1.0	–	✓

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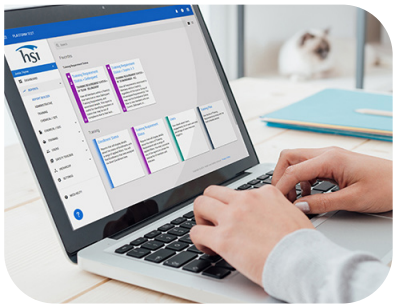
NERC **Online Courses** – *Continued*

		CEH	STD	SIM	EO
378-10	System Restart from Blackstart and System Restoration Coordination (EOP-005, EOP-006)	1.0	1.0	–	✓
378-11	Loss of Control Center and Geomagnetic Disturbance Operation (EOP-008, EOP-010)	1.5	1.0	–	✓
378-12	Energy and Weather Events	1.5	1.5	–	✓
378-13	Energizing and Restoring the Electric System	1.0	1.0	–	✓
378-14	Identifying and Responding to Blackouts	1.0	1.0	–	✓
378-15	Performing System Restoration	1.0	1.0	–	✓
378-18	Blackout Events	1.0	–	–	–
378-19	Geomagnetic Disturbances	2.5	2.5	–	–
381-07	Reliability Coordinator Responsibilities (IRO-001, IRO-008, IRO-009)	2.0	1.5	–	✓
381-08	Reliability Coordinator Data Needs (IRO-002, IRO-010, IRO-014, IRO-018)	1.5	1.5	–	✓
387-03	Economic Power System Operations	2.0	–	–	✓
387-05	Interconnected Energy Accounting	2.0	–	–	✓
387-07	Supervisory Control and Data Acquisition Systems (SCADA)	2.0	–	–	–
387-11	Basics of Power System Operations	1.0	–	–	–
387-12	Human Performance for System Operators	1.5	–	–	–
387-13	Renewable Energy Integration	1.0	1.0	–	✓
387-14	Solar, Hydro, Tidal, Geothermal, and Variable Generation	1.5	–	–	–
387-15	Wind Generation	1.0	–	–	–
387-16	Operations Planning, Monitoring, Analysis (TOP-002, TOP-003, TOP-010)	1.0	1.0	–	–
387-17	Transmission Operations (TOP-001)	1.0	1.0	–	–
387-18	Power System Concepts	1.5	–	–	–
387-19	Transmission and Distribution Operations	2.0	–	–	–
387-20	Emergency Response Application with Simulation	1.0	–	0.5	–
387-21	Transmission Stations and Switchyards	1.0	–	–	–
387-22	Transformer Principles	1.0	–	–	–
387-23	Circuit Breakers and Disconnects	1.0	–	–	–
387-24	Transmission Lines, Station Protection, and Monitoring and Control	1.5	–	–	–
387-25	Distribution and Shift Factors	1.0	–	–	–
387-27	Contingency Analysis Application with Simulation	1.0	–	0.5	–
387-29	Advanced Human Performance for System Operators	1.0	1.0	–	–
387-30	Overview, Interconnected Power System Operations	1.5	–	–	–
387-31	Transmission, Substations, and System Protection	1.5	–	–	–
387-32	Control Center Operations and Governance	1.0	–	–	–
387-34	Transmission Application with Simulation	1.5	–	0.5	–
387-35	Math for System Operators	1.0	–	–	–
387-37	Human Performance for System Operators - Error Prevention	2.0	0.5	–	–
388-08	Reactive Power Fundamentals	1.0	1.0	–	✓
388-09	Reactive Power Production Equipment	1.0	1.0	–	✓
388-10	Power Control Scenarios	1.0	1.0	–	✓
388-11	Electric Power Principles	1.0	–	–	–
388-12	Voltage and Reactive Control	1.5	1.0	–	–
388-13	Generators and Transmission Lines	1.0	–	–	–
388-14	Generation Operations for Maintaining Network Voltage Schedules	1.0	1.0	–	–
388-15	Voltage and Power Control Equipment	1.5	1.0	–	✓
505-02	Steam Turbine Control and Operation	1.5	–	–	✓
507-01	Generator and Auxiliary Systems' Functions	1.0	1.0	–	✓
507-03	Generator Construction and Process Control	1.0	1.0	–	–

✓ For PER compliance, EO training must be applicable to each individual organization. Please check with your compliance group for eligibility.

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

HSI and HSI_SOS_001 are recognized by the North American Electric Reliability Corporation as a continuing education provider who adheres to NERC Continuing Education Program Criteria.



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