Interactive Plant Operations Training

CD-ROM

Web

AVS

Audio Visual Source

Multimedia

INTERACTIVE
OPERATIONS TRAINING

To make operations-related decisions, an operator must consider three essential factors—safety, efficiency, and productivity. To meet OSHA's Process Safety Management of Highly Hazardous Chemicals Standard (29 CFR 1910.119), companies must certify that operators have the required knowledge, skills, and abilities to safely carry out their duties and responsibilities. This program can help companies better train their operators while meeting regulatory requirements.

INSTRUCTIONAL FEATURES

CD-ROM FORMAT. The interactive CD-ROM format includes up-to-date MPEG full-motion video, audio, three-dimensional graphics, animation, and simulation exercises—all to stimulate and involve the trainee in real-life experiences and operations procedures. This program is a Windows® application with course management network capabilities. Each CD-ROM unit can be customized with site-specific information. Generic pretests and posttests are included, with the added capability of creating custom tests. An online glossary and an online test feature are provided for ease of reference. The automated Course Management System for Windows keeps track of all trainee test scores, log times, and site-information access and provides custom reporting options.

WEB FORMAT. All units administered in the Web format enjoy centralized learning management capabilities and global end-user accessibility. Each unit features an online glossary, embedded learning activities, pre- and post-tests, and a convenient bookmarking function.

OBJECTIVE

This program is designed to enhance operator troubleshooting skills by giving operators an understanding of process plant safety considerations and working conditions, an overview of the processes, a foundation of technical knowledge, and specific training on the complex equipment found in today's plants.

BENEFITS

The benefits of this one-to-one delivery system include: reduction of learning time, consistency of delivery, increase in mastery scores, automated recordkeeping, increased motivation, greater retention, privacy, and remedial or refresher training. Additional benefits include increased trainee interest and flexible scheduling. Also, training units accommodate all learning styles through a variety of media presentation formats.

STRUCTURE

The 119 units of this program are divided into 32 subject areas focusing on basic theory and systems, equipment operation, and systems operation. Each training unit is available in both CD-ROM and Web-based format.

MATERIALS

Each CD-ROM comes with one unit overview and five handbooks. In addition, the course management software and guide are provided for recordkeeping and reporting.

Single user price U.S.$995.00 - each unit

Table of Contents

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Boilers

BASIC PRINCIPLES AND TYPES
(A0BBP)

OVERVIEW

This interactive training unit is designed to introduce trainees to fundamental concepts related to industrial plant boilers. After completing this unit, trainees should be able to describe the basic requirements for steam production and combustion and explain how a boiler produces steam. They should also be able to identify three types of heat transfer and explain how heat transfer occurs in a typical boiler. In addition, trainees should be able to describe how water, combustion gases, and steam flow through fire tube and water tube boilers.

OBJECTIVES

Principles of Operation

State the basic requirements for steam production.
State the basic requirements for combustion.
Explain in general terms how a boiler produces steam.

Heat Transfer

Describe heat transfer.
State three ways in which heat transfer can occur in a typical boiler.
Identify problems that can interfere with proper heat transfer and the effect of each on boiler operation.

Boiler Types

Name two basic types of boilers.
Describe the basic differences between fire tube and water tube boilers.
Describe how water, combustion gases, and steam flow through fire tube and water tube boilers.

SUBJECTS

Principles of Operation

Steam Production and Combustion
Basic Boiler Operating Principles

Heat Transfer

Types of Heat Transfer
Heat Transfer Problems
Heat Transfer in a Boiler

Boiler Types

Fire Tube Boilers
Water Tube Boilers

COMBUSTION, WATER AND STEAM
(A0B0W)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic principles associated with combustion in a boiler and the flow of air and combustion gases during boiler operation. After completing this unit, trainees should be able to identify the elements needed for combustion in a boiler, explain how fuel is delivered to the burners, and describe the parts and operation of various types of burners. They should also be able to describe the air and gas flow path through a boiler and describe methods used to remove particulates and harmful gases from combustion gases. In addition, trainees should be able to explain when and why vents, drains, blowdown valves, and soot blowers are used.

OBJECTIVES

Combustion Equipment

Describe the parts and operation of typical gas burners, oil burners, and stokers.

Air Flow

Identify some devices used to improve the efficiency of boiler operations.
Explain how air flow is produced in a typical boiler.
Explain why changes in boiler load require fuel and air adjustments.
State why it is necessary to maintain a proper fuel-to-air ratio in a boiler.
Describe the parts and basic operation of a typical rotary air heater.
Explain how rotary air heaters improve efficiency of boiler operations.

Water and Steam Flow

Explain how natural circulation occurs in a typical water tube boiler.
Explain how controlled circulation occurs in a typical water tube boiler.
Describe an economizer, why it is used, and how it improves efficiency.
Name some devices commonly used to remove moisture from steam and how they operate.

SUBJECTS

Combustion Equipment

Gas Burners
Oil Burners
Stokers

Air Flow

Draft
Fuel-to-Air Ratio
Air Heaters

Water and Steam Flow

Boiler Water Circulation
Economizers
Moisture Separators

Chemistry

BASIC PRINCIPLES I
(A0CB1)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with the composition of matter and the general characteristics of compounds, mixtures, and solutions. After completing this unit, trainees should be able to identify the particles that make up an atom and describe two ways in which atoms form chemical bonds. They should also be able to explain what compounds and mixtures are, and how they differ from one another. In addition, trainees should be able to describe what a solution is, calculate the weights of materials in a percent-by-weight solution, and explain what a pH measurement represents.

OBJECTIVES

Introduction to Chemistry

Define: *material, matter, mass, element, atom, proton, neutron,* and *electron*.
Identify the particles that make up an atom.
Define: *valence electron* and *ion*.
Describe two ways in which atoms form chemical bonds.

Compounds and Mixtures

Define: *compound* and *chemical reaction*.
Define *mixture*.
Explain how compounds and mixtures differ from one another.

Solutions

Define: *solution, solute, solvent, homogeneous,* and *concentration*.
Calculate the weights of the materials in a percent-by-weight solution, given the weight of the solution and the percentage of solute.
Explain what a pH measurement represents.

SUBJECTS

Introduction to Chemistry

Composition of Matter
Valence Electrons and Chemical Bonds

Compounds and Mixtures

Compounds
Mixtures

Solutions

Characteristics
Percent-by-Weight
pH Measurements

BASIC PRINCIPLES 2
(A0CB2)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the principles of chemical reactions, material balancing, and organic chemistry. After completing this unit, trainees should be able to use a chemical equation to explain what occurs during a chemical reaction, and how combustion reactions, replacement reactions, and neutralization occur. Trainees should also be able to define material balancing, and describe the basic steps involved in balancing the materials represented in a simple equation. In addition, trainees should be able to explain what organic chemistry is and how some organic chemicals are named.

OBJECTIVES

Chemical Reactions

Identify three common types of chemical reactions.
Define: *chemical equation* and *chemical reaction*.
Use a chemical equation to explain what occurs during a simple chemical reaction.
Define *endothermic* and *exothermic* in terms of their application to chemical reactions.
Explain how a combustion reaction, replacement reaction, and neutralization reaction occur.
Explain how the acidity or alkalinity of a liquid is measured.

Material Balancing

Explain the meaning of *material balancing*.
Identify the steps involved in balancing the materials represented in a simple equation.
Given the actual weight of one material in a reaction, use the relative weights of the atoms in the reaction to determine the actual weights of the other materials involved.

Organic Chemistry

Define *organic chemistry*.
Explain how some organic chemicals are named.

SUBJECTS

Chemical Reactions

Chemical Equations
Combustion Reactions
Replacement and Neutralization Reactions

Material Balancing

Steps in Material Balancing
Relative and Actual Weights

Organic Chemistry

Basis of Organic Chemistry
Naming Organic Chemicals

MATERIAL BALANCING
(A0CMB)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with using balanced chemical equations to calculate the amounts of reactants and products in process reactions. After completing this unit, trainees should be able to explain what material balancing is, verify that a chemical equation is balanced, and use a balanced equation to calculate the amounts of reactants and products in a reaction when the weight of one reactant is given. They should also be able to identify two basic factors that can limit the production of a process system, perform material balancing for a process system when reactant supply is the limiting factor, and perform material balancing for a system in which a specific amount of product is to be produced.

OBJECTIVES

Chemical Equations

Explain the meaning of *material balancing*.
Verify that a chemical equation is balanced.
Define *molecular weight* and explain how to calculate the weight of a molecule.
Calculate the amounts of reactants and products in a reaction when given the weight of one reactant.

Limiting Factors

Identify two basic factors that can limit the production of a process system.
Convert reactant supplies expressed as total amounts into supply rates.
Determine the limiting factor of a process system that is being operated to produce as much product as possible.
Perform material balancing for a process system when reactant supply is the limiting factor.
Perform material balancing for a system in which a specific amount of product is to be produced.

SUBJECTS

Chemical Equations

Equations
Molecular Weights
Actual Weights

Limiting Factors

Determining the Limiting Factor
Determining Reactant Amounts

REACTION RATES
(AOCRR)

OVERVIEW

This interactive unit is designed to familiarize trainees with basic concepts associated with the rates at which chemical reactions occur. After completing this unit, trainees should be able to describe two factors that determine the rates of reactions, and the effects of temperature, pressure, concentration, and surface area on reaction rates. They should also be able to describe how catalysts affect reaction rates and how temperature and pressure affect equilibrium reactions.

OBJECTIVES

Reaction Rate Factors
- Define *reaction rate*.
- Explain how chemical reactions occur and describe two factors that determine the rates of reactions.
- Describe the effects of temperature, pressure, concentration, and surface area on reaction rates.

Catalysts
- Define *catalyst*.
- Describe how adsorption catalysts work.
- Explain how some catalysts can become poisoned.
- Describe how catalysts work by forming an intermediate product during a reaction.

Equilibrium Reactions
- Define *equilibrium* and *equilibrium point*.
- Describe the effects of temperature and pressure on an equilibrium reaction.
- Describe one way that products can be stabilized.

SUBJECTS

Reaction Rate Factors
- Chemical Reactions
- Effects of Variables

Catalysts
- Adsorption-Type Catalysts
- Intermediate-Type Catalysts

Equilibrium Reactions
- Equilibrium
- Temperature and Pressure
- Stabilizing Products

DISTRIBUTED CONTROL SYSTEMS
(AOCCD)

OVERVIEW

This interactive program covers normal and abnormal DCS components, functions and monitoring. Learn how to effectively examine a DCS and use it to keep operations running smoothly.

OBJECTIVES

System Components
- Describe the basic purpose of a distributed control system (DCS).
- Describe the function of each component of a DCS.
- Describe the function of the network in the operation of a DCS.

Monitoring Normal Operation
- Describe how a DCS can be used to monitor plant systems during operation.
- Describe how a DCS can be used to monitor and change discrete device states and analog device setpoints.
- Describe how a DCS can be used to build a trend screen on a human machine interface (HMI) to monitor system variables.

Troubleshooting Abnormalities
- Describe how a DCS can be used to examine an input device.
- Describe how a DCS can be used to exercise (stroke) a typical valve.
- Describe how a DCS can be used to display loop and ladder diagrams to troubleshoot abnormalities in a combined cycle power plant.

SUBJECTS

System Components
- DCS Overview
- DCS Components
- DCS Network

Monitoring Normal Operation
- Examining the State of the System
- Changing Outputs and Setpoints
- Setting Up Trends

Troubleshooting Abnormalities
- Examining Input Devices
- Exercising Output Devices
- Displaying Loops and Ladders

HEAT RECOVERY STEAM GENERATORS
(AOCCH)

OVERVIEW

Learn to describe the components and operations of HRSGs, including low pressure, intermediate pressure and high pressure steam systems.

OBJECTIVES

HRSG Fundamentals

Describe the basic purpose of a heat recovery steam generator (HRSG).
Identify and describe common types of HRSGs.
Identify the major sections of a horizontal flow, triple-pressure reheat HRSG.
Define some common terms used to describe HRSG components.
Describe basic operating principles of a HRSG.

HRSG Sections

Describe the basic purpose of the low pressure (LP) steam system in a triple-pressure reheat HRSG.
Identify and describe components of the LP steam system, and describe fluid flow paths and operating parameters associated with the system.
Describe the basic purpose of the intermediate pressure (IP) steam system in a triple-pressure reheat HRSG.
Identify and describe components of the IP steam system, and describe fluid flow paths and operating parameters associated with the system.
Describe the basic purpose of the high pressure (HP) steam system and the reheat steam system in a triple-pressure reheat HRSG.
Identify and describe components of the HP steam system and the reheat steam system, and describe fluid flow paths and operating parameters associated with the systems.
Describe some common structural components of a typical HRSG.
Describe the purpose and operation of duct burners in a HRSG.
Describe some common CO and NOx emissions equipment and control system components found in a HRSG.

SUBJECTS

HRSG Fundamentals

Purpose and Types
Basic Design and Operation

HRSG Sections

LP Steam System
IP Steam System
HP and Reheat Steam Systems
Other Components

NORMAL OPERATIONS
(AOCCN)

OVERVIEW

This program explains the operations standards of the combined cycle power plant, including system startup and shutdown, as well as plant monitoring and maintenance.

OBJECTIVES

Systems Overview

Identify and describe the major components of a combined cycle power plant.

Describe how control system components and operating set points are often adjusted to enable operators to achieve normal operating conditions in a combined cycle power plant.

Plant Startup And Shutdown

Identify and describe preliminary checks that are typically performed prior to a combined cycle plant startup.

Describe the procedures involved in starting up the combustion turbine, the heat recovery steam generator (HRSG) and the steam turbine in a combined cycle power plant.

Describe the procedures involved in shutting down the heat recovery steam generator (HRSG), the steam turbine and the combustion turbine in a combined cycle power plant.

Monitoring And Maintaining

Describe how a distributed control system (DCS) is used to monitor and control the plant during normal operation to maximize efficiency.

Describe how a distributed control system (DCS) is used to perform routine operational checks and maintenance during normal operation.

SUBJECTS

Systems Overview

Plant Components
Plant Control

Plant Startup And Shutdown

Pre-Startup Checks
Startup
Shutdown

Monitoring And Maintaining

Monitoring Plant Operation
Operational Maintenance

ABNORMAL OPERATIONS
(A0CA0)

OVERVIEW

Learn to troubleshoot problems in operating a simple cycle combustion turbine. This program covers startup/shutdown difficulties and some typical problems associated with other plant systems.

OBJECTIVES

Startup and Shutdown Problems

- Identify and describe some problems that can occur during startup of a simple cycle combustion turbine, and describe how operators can deal with these problems.
- Identify and describe some problems that can occur during shutdown of a simple cycle combustion turbine, and describe how operators can deal with these problems.
- Identify and describe conditions that can cause automatic shutdown of a simple cycle combustion turbine.
- Identify and describe conditions that can make it necessary for an operator to make a manual emergency shutdown of a simple cycle combustion turbine.
- Describe operator responsibilities that are associated with automatic shutdowns and with manual emergency shutdowns.

Abnormal Conditions

- Identify and describe abnormal conditions that may be associated with the inlet air system and the compressor section of a simple cycle combustion turbine, and describe how operators can deal with these conditions.
- Identify and describe abnormal conditions that may be associated with the fuel system and the combustion section of a simple cycle combustion turbine, and describe how operators can deal with these conditions.
- Identify and describe abnormal conditions that may be associated with the turbine section and the electric generator in a simple cycle application, and describe how operators can deal with these conditions.
- Identify and describe abnormal conditions that may be associated with the lube oil, fire protection, environmental, and control systems of a simple cycle combustion turbine, and describe how operators can deal with these conditions.

SUBJECTS

Startup and Shutdown Problems

- Startup
- Shutdown

Abnormal Conditions

- Inlet Air System and Compressor
- Fuel System and Combustion
- Turbine and Generator
- Other Support Systems

COMPONENTS
(AOCCO)

OVERVIEW

This program thoroughly explains the compression, combustion, and expansion and exhaust components of a combustion turbine, as well their operations.

OBJECTIVES

Compression

Describe the basic function of the compressor of a combustion turbine.
Identify and describe the basic components of the compressor.
Describe the operation of variable inlet guide vanes (VIGVs).
Describe common operating problems associated with a combustion turbine compressor.
Describe the purpose and operation of compressor washes.

Combustion

Describe the basic function of the combustor of a combustion turbine.
Identify and describe common types of combustors.
Describe factors associated with the combustion process in a combustion turbine.
Describe methods used to minimize the production of NOx emissions in the combustion section.

Expansion and Exhaust

Describe the basic function of the turbine section of a combustion turbine.
Identify and describe the basic components of the turbine section.
Describe factors that affect the operation of the turbine section of a combustion turbine.

SUBJECTS

Compression

Compressor Components
Compressor Operation

Combustion

Combustor Components
Combustor Operation

Expansion and Exhaust

Turbine Components
Turbine Operation

NORMAL OPERATIONS
(AOCNO)

OVERVIEW

This program explains the operations standards of the simple cycle combustion power plant, including system startup and shutdown, as well as plant monitoring and maintenance.

OBJECTIVES

Startup and Shutdown

Identify safety precautions that should be observed during a pre-startup inspection of a combustion turbine.
Describe checks and inspections that an operator should make before starting up a simple cycle combustion turbine.
Describe procedures for starting up a simple cycle combustion turbine.
Identify, in order, the major events that happen during the startup of a simple cycle combustion turbine.
Identify conditions that are monitored during the startup of a simple cycle combustion turbine.
Describe procedures for shutting down a simple cycle combustion turbine.
Identify, in order, the major events that happen during the shutdown of a simple cycle combustion turbine.
Identify conditions that are monitored during the shutdown of a simple cycle combustion turbine.

Monitoring and Maintenance

Identify and describe equipment and conditions that operators typically monitor during normal operation of a simple cycle combustion turbine.
Describe inspection and maintenance tasks that operators typically perform to keep a combustion turbine in good working order.

SUBJECTS

Startup and Shutdown

Pre-Startup Checks
Startup Procedures
Shutdown Procedures

Monitoring and Maintenance

Monitoring Normal Operations
Maintaining System Components

PRINCIPLES
(AOCPR)

OVERVIEW

This program explains the scientific and engineering principles necessary to understand combustion turbine operations. The program also covers maximizing turbine efficiency and adapting power generation to various applications.

OBJECTIVES

Fundamentals

Describe how Newton's third law of motion applies to the operation of a combustion turbine.

Describe how modern stationary combustion turbines for electric power generation evolved from jet engine technology and identify key developments associated with this evolution.

Identify concerns that have been driving forces in the increasing use of combustion turbines for electric power generation and describe some advantages of using combustion turbines for this purpose.

Describe the basic function of a combustion turbine and identify and describe its operating cycle.

Identify and describe the basic functions of the major components of a combustion turbine.

Describe the processes of the Brayton cycle as they are applied in a combustion turbine and represented on a Brayton cycle pressure/volume diagram.

Identify and describe the basic functions, components, and substances associated with the support systems for a combustion turbine.

Efficiency and Applications

Describe how combustion turbine efficiency is measured.

Identify and describe the effects of several factors that influence combustion turbine efficiency.

Identify and describe actions that may be taken and methods that may be used to maximize combustion turbine performance and minimize efficiency losses.

Identify and describe combustion turbines and associated equipment arrangements that are used for different types of power generation applications.

SUBJECTS

Fundamentals

History
Operating Principles
Support Systems

Efficiency and Applications

Efficiency
Applications

SUPPORT SYSTEMS I
(A0CS1)

OVERVIEW

Part I of a two-segment examination of combustion turbine support systems. This program looks in-depth at the inlet air system, lube oil and starting system, and fuel system.

OBJECTIVES

Inlet Air System

Describe the basic function of the inlet air system of a combustion turbine.
Identify and describe common components of an inlet air system.
Describe how changes in inlet air temperatures can affect the operation of a combustion turbine.

Lube Oil and Starting System

Describe the basic function of the lubricating oil system of a combustion turbine.
Identify and describe components of a lubricating oil system.
Describe the basic function of the starting system of a combustion turbine.
Identify and describe components of a starting system.

Fuel Systems

Describe the basic function of the fuel gas system of a combustion turbine.
Identify and describe components of a fuel gas system.
Describe the basic function of the fuel oil system of a combustion turbine.
Identify and describe components of a fuel oil system.
Describe common applications of a dual fuel (fuel gas / fuel oil) system in a combustion turbine.
Identify and describe components of a dual fuel system.

SUBJECTS

Inlet Air System

Components
Preheating and Cooling

Lube Oil and Starting System

Lube Oil System
Starting System

Fuel Systems

Fuel Gas System
Fuel Oil System
Dual Fuel System

SUPPORT SYSTEMS II
(AOCS2)

OVERVIEW

Part II of a two-segment examination of combustion turbine support systems. This program looks in-depth at the control system, fire protection system, and environmental system.

OBJECTIVES

Control System

Identify general functions performed by and describe the basic operation of the control system for a combustion turbine.
Identify and describe the functions of components that typically make up a combustion turbine's control system.
Identify and describe the alarm level features of the protective function of a combustion turbine's control system.
Identify four operating parameters and associated operating variables that influence the operation of a combustion turbine's control system.
Describe how a typical combustion turbine's control system controls output shaft speed.
Describe how a typical combustion turbine's control system controls pressure and temperature during startup.

Fire Protection System

Explain why fire is a hazard in combustion turbine installations.
Identify and describe types of fire detectors that are commonly associated with a combustion turbine.
Identify means that are commonly used to activate fire alarms and fight fires in combustion turbine installations.
Identify the components and describe the basic operation of a high-pressure carbon dioxide fire protection system for a combustion turbine installation.
Identify the components and describe the basic operation of a low-pressure carbon dioxide fire protection system for a combustion turbine installation.
Identify and describe concerns that are associated with the use of a carbon dioxide fire protection system.

Environmental System

Identify the chief air pollutants associated with combustion turbine operation.
Identify and describe the functions and basic operation of combustion turbine components that are commonly associated with controlling NOx production during combustion.
Describe how the type of fuel that a combustion turbine burns affects the air pollutants associated with the operation of the turbine.
Identify combustion-related conditions that affect the operation of a combustion turbine's environmental system and describe how these conditions influence operation of the environmental system.

SUBJECTS

Control System

Components
Operation

Fire Protection System

Fire Detection

Compressors

INTRODUCTION
(AOCIN)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the operation of compressors and compressed gas systems. After completing this unit, trainees should be able to describe two general types of compressors and the components and operation of a typical compressed air system. They should also be able to explain the hazards and safety precautions of compressors and compressed gas systems. In addition, trainees should be able to describe the functions of systems and devices that are commonly used with compressors and compressed gas systems.

OBJECTIVES

Compressors and Systems

Describe two general types of compressors.
Describe some characteristics that all compressors share.
Identify the components of a typical compressed air system.
Describe the operation of a typical compressed air system.
Describe hazards and safety precautions associated with compressors.
Describe hazards and safety precautions associated with compressed gas systems.

System Components

Describe the function of a filter.
Describe the function of an air cooling system and a water cooling system.
Describe the function of a lubrication system.
Describe the function of an oil separator.
Describe the function of a demister.
Describe the function of a dryer.
Describe the function of a receiver.
Describe the function of an unloader.
Describe the function of safety valves.

SUBJECTS

Compressors and Systems

Compressors
Compressed Air Systems
Compressor Hazards

System Components

Filtering, Cooling, and Lubrication
System Auxiliaries

POSITIVE DISPLACEMENT
(AOCPD)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with the operation of positive displacement compressors. After completing this unit, trainees should be able to identify the main parts and describe the general operation of various types of reciprocating and rotary compressors. They should also be able to identify operator responsibilities associated with starting up, operating, and shutting down compressors.

OBJECTIVES

Compressor Types

Identify the main parts of a reciprocating compressor.
Describe the general operation of a reciprocating compressor.
Identify different types of reciprocating compressors and describe their operation.
Identify the main parts of a typical rotary compressor.
Describe the general operation of different types of rotary compressors.

Compressor Operations

Describe general checks that should be made before a compressor is started.
Describe general procedures for starting up a compressor.
Describe general checks that should be made while a compressor is running.
Describe general procedures for shutting down a compressor.
Describe general procedures for putting a portable compressor in operation.

SUBJECTS

Compressor Types

Reciprocating Compressors
Reciprocating Compressor Variations
Rotary Compressors

Compressor Operations

Pre-Startup Checks
Startup, Operation, and Shutdown
Portable Compressors

CENTRIFUGAL AND AXIAL
(AOCCA)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with the parts and operation of centrifugal and axial compressors. After completing this unit, trainees should be able to describe the main parts and the general operation of single-stage centrifugal compressors, multistage centrifugal compressors, and axial compressors. They should also be able to describe the functions of compressor lubrication systems, seals, bearings, and common auxiliary devices.

OBJECTIVES

Compressor Types

Describe the basic operation of a centrifugal compressor.
Describe the basic operation of an axial compressor.
Describe the components and operation of a single-stage centrifugal compressor.
Describe the components and operation of a multistage centrifugal compressor.
Describe the components and operation of an axial compressor.

System Components

Describe the function of a compressor lubrication system.
Describe the functions of compressor seals and a seal oil system.
Describe the function of bearings.
Describe how drivers and couplings are used with compressors.
Describe the function of an aftercooler.
Describe the function of safety valves and receivers in compressor systems.

SUBJECTS

Compressor Types

Introduction
Centrifugal Compressors
Axial Compressors

System Components

Lubrication, Seals, and Bearings
Auxiliary Devices

OPERATION OF CENTRIFUGAL AND AXIAL TYPES

(AOCOC)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with the startup, operation, and shutdown of centrifugal and axial compressors. After completing this unit, trainees should be able to describe the general functions of instrumentation and control devices used with centrifugal and axial compressors. They should also be able to identify operator responsibilities associated with starting up, operating, and shutting down centrifugal and axial compressors.

OBJECTIVES

Instrumentation and Control

State the general features of instrumentation and control devices used with centrifugal and axial compressors.
Describe how instrumentation and control devices can maintain the values of a compressor's process variables.
Describe how instrumentation and control devices can keep a compressor operating within a stable operating range.

Operation

Describe the general steps involved in preparing a compressor for startup.
Describe the general steps involved in warming up a compressor.
Describe the general steps in starting gas flow to a compressor and bringing a compressor up to operating speed.
Describe typical compressor operating checks.
Describe some of the general steps involved in a compressor shutdown.

SUBJECTS

Instrumentation and Control

Functions
Surge Control

Operation

Startup
Operation and Shutdown

Diagrams

BASIC DIAGRAMS AND SYMBOLS I

(A0DB1)

OVERVIEW

This interactive training unit is designed to introduce trainees to plant system diagrams and diagram symbols. After completing this unit, trainees should be able to identify and describe the purpose of several kinds of system diagrams, and be able to describe the information found on each type. Trainees should also be able to identify symbols commonly used on flow diagrams, and how to use a flow diagram to trace the flow paths of a system.

OBJECTIVES

Types of Diagrams

Identify and describe the purpose of equipment arrangement diagrams, elevation drawings, piping system (flow) diagrams, piping and instrumentation diagrams (P&IDs), electrical diagrams, and legends.

In general terms, describe the information found on each type of diagram.

Flow Diagram Symbols

Identify some basic symbols associated with flow diagrams.

Identify symbols commonly used to represent components in flow diagrams.

Describe the basic operation of the components typically found in a fluid system.

Reading Diagram Symbols

Identify the four basic parts of a system.

Identify the components of a typical fluid system and relate them to their symbols and functions.

SUBJECTS

Types of Diagrams

Equipment Location Diagrams

System Diagrams

Flow Diagram Symbols

Tanks, Pumps, and Valves

Actuators

Heat Exchangers

Reading Diagram Symbols

Block Diagrams

Flow Diagrams

BASIC DIAGRAMS AND SYMBOLS 2

(A0DB2)

OVERVIEW

This interactive training unit is designed to familiarize trainees with symbols commonly used on piping and instrumentation diagrams (P&IDs) and electrical one-line diagrams. After completing this unit, trainees should be able to identify instrument symbols and line symbols used in P&IDs, describe the types of information typically found on a legend, and use a P&ID to locate the components of a system. They should also be able to identify symbols used on electrical one-line diagrams.

OBJECTIVES

Piping and Instrumentation Diagrams

Identify instruments using an identification chart.
Identify line and instrument symbols used in piping and instrumentation diagrams.

Using a System Diagram

Describe the types of information typically found on a legend.
Locate the components in a boiler fuel oil system by identifying the symbols used to represent them.

Electrical Diagrams

Identify symbols commonly found on one-line electrical diagrams.
Trace out a typical one-line diagram and briefly describe its connections.

SUBJECTS

Piping and Instrumentation Diagrams

Instrument Symbols
Reading a P&ID

Using a System Diagram

Legends
Using a System Diagram

Electrical Diagrams

Main Transformer Section
Load Center Section

FLOW AND ELECTRICAL
(AODUF)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the use of flow diagrams and electrical one-line diagrams. After completing this unit, trainees should be able to use a flow diagram to trace the flow of materials through a system, and use a flow diagram and a valve lineup checklist to line up valves in a system. They should also be able to use an electrical one-line diagram to learn the components and layout of an electrical system, and to determine how to isolate a piece of equipment for maintenance or repair.

OBJECTIVES

Using Flow Diagrams

Describe how flow diagrams can be used to become familiar with a system.
Describe how flow diagrams can be used to line up valves.
Describe the relationship between flow diagrams and valve lineup checklists.

Using Electrical Diagrams

Describe how electrical one-line diagrams can be used to learn the components and layouts of electrical systems.
Describe how electrical one-line diagrams can be used to determine how to isolate equipment for maintenance and repairs.

SUBJECTS

Using Flow Diagrams

Learning a Plant System
Lining Up Valves

Using Electrical Diagrams

Learning an Electrical System
Isolating Equipment

PIPING AND INSTRUMENTATION

(AODUI)

OVERVIEW

This interactive training unit is designed to make trainees familiar with the use of piping and instrumentation diagrams (P&IDs). After completing this unit, trainees should be able to describe the kinds of information that can be found on a P&ID and explain why this information is useful. They should also be able to explain how to use P&IDs to troubleshoot system problems.

OBJECTIVES

Introduction

Describe the types of information provided by P&IDs and explain why this information is useful.

Describe how a P&ID can be used to become familiar with the instrumentation associated with a system.

Troubleshooting

Describe how P&IDs can be useful in troubleshooting problems.

SUBJECTS

Introduction

Information on P&IDs

Learning a System

Troubleshooting

Water Treatment System Problem

De-Aerator System Problem

Distillation

BASIC PRINCIPLES
(AODBP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic principles of the distillation process. After completing this unit, trainees should be able to explain how changes in the state of matter relate to the distillation process and how these changes are affected by temperature and pressure. They should also be able to explain how a liquid mixture can be separated into lighter and heavier components by distillation, and be able to describe the basic operation of single-batch distillation systems, successive-batch distillation systems, and continuous distillation systems.

OBJECTIVES

Principles of Distillation

Explain how changes in temperature and pressure affect the boiling point of a substance.
Define *distillation*.
Explain how changes in the state of matter relate to the distillation process.
Define: *sensible heat, initial boiling point, boiling range, final boiling point*, and *latent heat*.
Define: *vapor pressure, external pressure, partial pressure*, and *relative volatility*.
Explain the relationship between vapor pressure and the following: boiling point, temperature, and external pressure.

Distillation Processes

Explain how a liquid mixture can be separated into lighter and heavier components by distillation.
Describe the characteristics of liquid mixtures that make distillation possible.
Describe the basic operation of single-batch, successive-batch, and continuous distillation systems.

SUBJECTS

Principles of Distillation

States of Matter
Heat
Pressure

Distillation Processes

Separation of Liquid Mixtures
Batch
Continuous

BASIC SYSTEM COMPONENTS AND OPERATION
(AODBS)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic components and operation of a typical distillation system. After completing the unit, trainees should be able to describe the functions of the major components of a distillation system and describe how the distillation process occurs in a distillation tower. They should also be able to explain how refluxing and reboiling affect product purity and how bubble caps and packing affect the distillation process in distillation towers. In addition, trainees should be able to explain why it is important to monitor and control distillation tower temperatures and pressures.

OBJECTIVES

Basic Distillation System

List and explain major equipment functions in a typical distillation system.
Define *overhead product, bottoms product*, and *boil-up*.
Describe the basic operation of a distillation tower.
Explain how a typical sieve-type distillation tower operates.
List and explain the purpose of the three sections of a distillation tower.
Define *fractionation*.
Explain how refluxing and reboiling help minimize overlap.
Define *external reflux* and *internal reflux*.
Explain how packed towers differ from distillation towers using bubble caps.
Compare and contrast the operation of bubble caps and packing grids.

Temperature and Pressure

Describe adjustments made when product purity is unacceptable.
Identify critical temperature points in a distillation tower.
Describe the effects of incorrect temperatures at various points in a distillation tower.
Explain what a temperature gradient is and how it is measured.
Explain how temperatures can be controlled in a basic system.
Identify critical pressure points in a basic system.
Describe the effects of incorrect pressures in a system.

SUBJECTS

Basic Distillation System

Introduction to Distillation Systems
Tower Operation
Refluxing and Reboiling
Bubble Caps and Packing

Temperature and Pressure

Temperature
Pressure

TOWERS, REBOILERS AND CONDENSERS
(AODTR)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic principles of operation of distillation towers, reboilers, and condensers. After completing this unit, trainees should be able to describe the difference between a binary tower and a multidraw tower and explain why the physical dimensions of a tower can vary. They should also be able to explain why vacuum distillation and azeotropic distillation are used, and how various types of reboilers and condensers are used in distillation systems.

OBJECTIVES

Towers and Processes

Describe the major difference between a binary tower and a multidraw tower.
Describe the basic operation of a side-draw tower.
Describe three factors that affect the physical dimensions of a distillation tower.
Given the name of a distillation tower, describe the tower's main function.
Give three basic reasons why vacuum distillation is used.
Explain what an azeotropic mixture is and identify two methods of azeotropic distillation.

Reboilers and Condensers

Explain the difference between the following types of reboilers: forced versus natural circulation and external versus internal.
Describe two ways that condensers can be categorized in overhead systems.

SUBJECTS

Towers and Processes

Multidraw Towers
Tower Variations
Vacuum Towers
Azeotropic Distillation

Reboilers and Condensers

Reboilers
Condensers

CONTROL SYSTEMS
(AODCS)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic principles of operation of systems that control distillation processes. After completing this unit, trainees should be able to describe typical material balance and energy balance control loops and explain how these control loops respond to process disturbances. They should also be able to describe how a distillation tower is operated to maintain product specifications.

OBJECTIVES

Balances

Explain what is meant by material balance and identify typical variables.
Explain what is meant by energy balance and identify typical variables.
Describe typical material balance and energy balance control loops.
Define *steady state operation* and *process disturbance*.
Describe how a typical distillation tower control system responds to a process disturbance (change in feed composition).

Process Temperatures

Describe how a typical distillation tower control system responds to an increase in bottom temperature.
Explain how the following conditions affect the composition of a distillation system's overhead and bottom products: increase in bottom temperature, decrease in bottom temperature, and change in external reflux.

Product Composition

Explain the difference between direct and indirect composition measurements.
Explain what is meant by *product giveaway*.
Describe how a typical distillation tower is operated to maintain product specifications.
Explain what is meant by *process lag*.

SUBJECTS

Balances

Material Balance
Energy Balance
Process Disturbances

Process Temperatures

Bottom Temperature
External Reflux

Product Composition

Product Specifications
Maintaining Specifications

SYSTEM STARTUP AND SHUTDOWN
(A0DSS)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic procedures for starting up and shutting down a distillation system. After completing this unit, trainees should be able to describe pre-startup checks that are commonly made on a vacuum distillation system and describe what takes place during a typical startup procedure. They should also be able to describe general procedures for short-term, emergency, and long-term shutdowns.

OBJECTIVES

Startup

Briefly describe the distillation process.
State the purpose of pre-startup checks.
List pre-startup checks commonly made on a vacuum distillation system.
Describe what takes place during a distillation startup procedure.

Shutdown

Describe a typical short-term shutdown procedure.
Describe a typical emergency shutdown procedure.
Describe a typical long-term shutdown procedure.

SUBJECTS

Startup

System Overview
Pre-Startup Checks
Startup Procedures

Shutdown

Short-Term Shutdown
Long-Term Shutdown

OPERATING PROBLEMS
(AODOP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with some of the problems that can occur during the operation of distillation systems. After completing this unit, trainees should be able to describe problems that can occur when the amount of reflux going back to the column is incorrect, and when the reboiler in a distillation system is operated improperly.

OBJECTIVES

Feed Problems

Explain the role of the feed rate in maintaining column equilibrium.
Identify problems that can occur when the feed rate is incorrect.
Describe conditions that can lead to three operating problems: overloading, flooding, and puking.
Describe some mechanical causes of overloading.
Explain how to identify a flooded condition in a distillation tower.
Explain how a liquid flood can be broken.
Explain how flooding can be prevented or controlled.
Identify process disturbances that can result from changes in the feed to a distillation tower.
Identify problems that can show up during startup.

Reflux Problems

Define *reflux*.
Describe what can happen if the amount of reflux going back to the column is not correct.
Identify typical disturbances that can occur in shell and tube condensers and fin-fan condensers.

Reboiler Problems

Describe sources of heat input for a distillation tower.
Explain the role of reboiler operation in maintaining column equilibrium.
Identify problems that can occur when the reboiler is operated incorrectly.
Identify typical disturbances that can occur in shell and tube reboilers and fired reboilers.
Define *overfractionation*.

SUBJECTS

Feed Problems

Feed Control
Overloading
Other Problems

Reflux Problems

Improper Reflux
Condenser Problems

Reboiler Problems

Reboiler Purpose
Improper Operation
Overfractionation

ELECTRICAL PRODUCTION AND DISTRIBUTION
(A0EEP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with the production and distribution of electric power for use by process systems. After completing this unit, trainees should be able to identify and explain the functions of the major components in an electrical distribution system. In addition, trainees should be able to describe general hazards associated with these systems and how to minimize the possible effects of the hazards.

OBJECTIVES

Power Generation

In general terms, explain how power comes into an industrial facility from an off-site source.
List three sources of on-site power generation.

Power Distribution

Identify and explain the function of the major components in a typical electrical power distribution system.
Identify general hazards associated with electrical distribution systems.
Describe, in general terms, how to aid a victim of electrical shock.
Describe, in general terms, how to extinguish an electrical fire.

SUBJECTS

Power Generation

Off-Site Power Generation
On-Site Power Generation

Power Distribution

System Components
Safety

TRANSFORMERS, BREAKERS AND SWITCHES

(A0EBS)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the operation of transformers, circuit breakers, and various types of switches. After completing this unit, trainees should be able to explain the principles of transformer operation, identify some of the basic components of a transformer, and describe checks that are generally made during a transformer inspection. They should also be able to describe the general operation of a circuit breaker, explain how to reset a tripped circuit breaker and rack out a circuit breaker, and describe the basic operation of pushbotton switches and rotary switches.

OBJECTIVES

Transformers

Explain the function of a transformer.
Describe, in general terms, how a transformer works.
Identify and describe some of the basic components of transformers.
Describe checks that should be made when a transformer is inspected.

Breakers and Switches

Describe the general operation of a circuit breaker.
List general steps associated with resetting a circuit breaker that has tripped.
List general steps associated with racking out a circuit breaker.
Describe the general function of a switch.
Explain how different types of pushbotton switches and rotary switches operate.

SUBJECTS

Transformers

Operating Principles
Transformer Components
Transformer Inspection

Breakers and Switches

Circuit Breaker Operation
Resetting and Racking Out
Switches

AC AND DC MOTORS
(AOEAC)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with the operation of electric motors. After completing this unit, trainees should be able to explain the basic principles of motor operation and describe the basic operation of a simple AC motor and a simple DC motor. They should also be able to identify and describe the function of each part of a typical AC motor and a typical DC motor.

OBJECTIVES

Motor Fundamentals

Explain the purpose of a motor.
Explain what is meant by *motor action*.
Explain the basic principles of motor operation.
Define the following terms: *alternating current, rotor,* and *stator*.
Describe how a simple AC motor operates.
Describe how a simple DC motor operates.

Motor Parts

Identify the parts of a typical AC motor and describe the function of each part.
Identify the parts of a typical DC motor and describe the function of each part.

SUBJECTS

Motor Fundamentals

Basic Motor Theory
AC Motor Fundamentals
DC Motor Fundamentals

Motor Parts

AC Motors
DC Motors

MOTOR CONTROLLERS AND OPERATION

(AOEMC)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with what motor controllers do and how they do it. Typical steps for starting up, checking, and shutting down motors are also covered. After completing this unit, trainees should be able to explain how motor controllers control and protect motors. They should also be able to describe how to start up a motor, perform operating checks on a motor, and shut down a motor.

OBJECTIVES

Motor Controllers

- Explain the purpose of a motor controller.
- Describe the features of a typical AC motor controller contactor.
- Describe how a motor controller can protect a motor.
- Using an electrical diagram, identify the parts of a typical AC motor controller and describe the function of each part.
- State the purpose of overload devices.
- Explain the difference between thermal and magnetic overload devices.
- Identify the parts of typical overload devices and describe their operation.

Motor Operation

- List typical steps for starting up a motor.
- Describe normal operating checks associated with motor operation.
- List typical steps for shutting down a motor.

SUBJECTS

Motor Controllers

- Fundamentals
- AC Controllers
- Overload Devices

Motor Operation

- Startup
- Operations
- Switches

AIR POLLUTION
(A0EAP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with what air pollution is and how it can be controlled. After completing this unit, trainees should be able to explain what air pollution is, where it comes from, and how it can be monitored. They should also be able to explain how air pollution from industrial facilities can be controlled.

OBJECTIVES

Introduction to Pollution

Explain what air pollution is and how it can be harmful.
List two sources of air pollution and name one way in which air pollution is monitored.
Give an example of a unit used to measure pollutant concentrations in the air.

Controlling Air Pollution

Describe one way of preventing particulates from getting into the air.
Provide a basic description of how a process can be modified to reduce air pollution from gases.
Explain how material substitution can reduce air pollution.
Identify four devices that can be used to remove particulates from a stream of exhaust of air or gases.
Explain how an electrostatic precipitator can capture particulates and remove them from a stream of exhaust gases.
Give a basic description of a method to capture a potentially polluting vapor for reuse in a process.
Name two ways to destroy waste gases.
Explain how a scrubber that captures gases operates.

SUBJECTS

Introduction to Pollution

What is Pollution?
Sources of Air Pollution

Controlling Air Pollution

Prevention
Removal of Particulates
Removal of Gases

WATER POLLUTION AND WASTE DISPOSAL
(A0EWP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic principles of preventing pollutants from getting into plant wastewater and removing pollutants from plant wastewater before the water is released into the environment. Also covered are methods of waste disposal and general considerations associated with hazardous wastes. After completing this unit, trainees should be able to identify sources of water pollution and explain how pollutants are kept out of plant wastewater. They should also be able to describe wastewater treatment methods and waste disposal methods.

OBJECTIVES

Introduction to Water Pollution

List two sources of water pollution.
Name one way that water pollution is monitored.
Name a unit used to measure pollutant concentrations in water.
List two ways to keep pollutants from getting into wastewater.
Explain the purpose of a retention pond.

Wastewater Treatment

Explain why removing inorganic chemicals from wastewater requires flocculation and settling.
List how bacteria use oxygen to break down organic chemicals.
Describe a typical organic waste treatment facility that includes biological (bacterial) treatment.
Explain what happens in anthracite and activated carbon filters used to remove organic chemicals from wastewater.
Describe the flow of air and water through a typical cooling tower.

Waste Disposal

List two ways of disposing of wastes.
List why hazardous waste disposal must be carefully controlled.
Explain what a *manifest* is and how using a manifest helps keep hazardous wastes out of the environment.

SUBJECTS

Introduction to Water Pollution

Sources of Water Pollution
Containment

Wastewater Treatment

Treatment Methods
Filters
Cooling Towers

Waste Disposal

Disposal
Hazardous Waste

Equipment Drive Components

COUPLINGS
(AOEBP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with the general operation of equipment drive components, in particular, couplings and clutches. After completing this unit, trainees should be able to describe the general function of equipment drive components and some general operator checks and safety concerns related to equipment drive components. They should also be able to identify and describe various types of couplings and a typical clutch, as well as describe common operator checks and concerns that apply to these particular equipment drive components.

OBJECTIVES

Introduction

Explain what equipment drive components are and state some of their functions.
Describe general operator checks and safety concerns related to drive components.
Explain why different types of drive components may be used together in some instances.
Describe basic operating characteristics that affect the operation of rotating equipment and define the following terms: *endplay, torque, torque surge*, and *shock load*.

Couplings

Explain what a coupling is and describe its general function.
Identify and describe some commonly used fixed speed couplings.
Describe common operator checks and concerns that apply to fixed speed couplings.
Explain what a variable speed coupling is, and describe its general function.
Define *slip*.
Identify and describe some commonly used variable speed couplings.
Describe common operator checks and concerns that apply to variable speed couplings.

Clutches

Explain what a clutch is, and its general function.
Describe one type of disc clutch.
Describe some general operator checks and concerns that apply to a typical clutch.

SUBJECTS

Introduction

Drive Components
Characteristics

Couplings

Fixed Speed Couplings
Variable Speed Couplings

Clutches

Clutch Fundamentals
Operator Checks

GEAR, BELT AND CHAIN DRIVES

(AOEGB)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with the operation of gear drives, belt drives, and chain drives. After completing this unit, trainees should be able to describe the general function of gear drives, belt drives, and chain drives, and explain how each of these equipment drive components operates to transfer power from a driver to a piece of driven equipment. They should also be able to describe operator checks that are commonly performed on gear drives, belt drives, and chain drives.

OBJECTIVES

Gears

Explain what a gear drive is, and its general function.
Identify the major components of a typical gearbox.
Describe typical operator checks and concerns that apply to gear drives.

Belts and Chains

Explain what a belt is and describe its general function.
Describe typical single and multiple V-belt drives.
Explain what a chain drive is and its general function.
Describe a typical chain drive and some common ways that chain drives are lubricated.
Describe typical operator checks and concerns that apply to belt drives.
Describe typical operator checks and concerns that apply to chain drives.

SUBJECTS

Gears

Function
Operator Checks

Belts and Chains

Belt Drives
Chain Drives
Operator Checks

LUBRICANTS AND BEARINGS

(A0ELB)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the types of lubricants and bearings used in industrial facilities. After completing this unit, trainees should be able to explain how lubricants reduce friction, describe the characteristics of oil and grease, and describe applications in which oils and greases are used as lubricants. Trainees should also be able to name several solid lubricants, and give an example of a synthetic lubricant. In addition, trainees should be able to describe sleeve bearings, rolling element bearings, and radial loads and thrust loads on shafts and bearings.

OBJECTIVES

Oils and Greases

Define *friction* and explain how lubricants reduce it.
Define *viscosity* and describe the effect of temperature on it.
Define *oil* and explain when it is a better lubricant than grease.
Define *grease* and describe its consistency and how it is indicated.
Describe when grease is a better lubricant than oil.

Solids, Additives, and Synthetics

List three solid lubricants.
Explain how extreme-pressure lubricants protect gears.
Explain why lubricant oxidation is harmful.
Name two harmful substances formed from lubricant oxidation.
State a function of detergents and dispersants in lubricants.
Name a synthetic lubricant.

Bearings

Describe lubricant action in sleeve bearings.
Describe how rolling elements help reduce friction.
Describe thrust loads and radial loads on shafts and bearings.

SUBJECTS

Oils and Greases

Friction
Oil
Grease

Solids, Additives, and Synthetics

Solid Lubricants
Additives and Synthetics

Bearings

Sleeve Bearings
Rolling Element Bearings

USING LUBRICANTS
(AOEUL)

OVERVIEW

This interactive training unit is designed to familiarize trainees with some of the methods and devices used to lubricate equipment components such as bearings. After completing this unit, trainees should be able to describe the use of hand grease guns, pneumatic grease guns, grease cups, and centralized lubricators. They should also be able to explain the basic operation of drip-feed oilers, oil baths, bottle oilers, ring oilers, and circulating oil systems. In addition, trainees should be able to describe the use of contact seals, labyrinth seals, and mechanical seals, and to describe how valve packing is lubricated.

OBJECTIVES

Lubricating with Grease

Describe two ways in which hand grease guns can be filled.
Explain why bearing housings should be checked for overheating before greasing.
Describe how to grease a bearing with a drain hole.
Describe a pneumatic grease gun.
Name two types of automatic grease lubricators.

Lubricating with Oil

List four items on a typical lubrication schedule or chart.
Name two ways that oil is dispensed from large drums.
Describe the operation of a drip-feed oiler.
Explain how an oil bath lubricates bearings and gears.
Name three ways to check oil level.
Explain how a bottle oiler maintains constant oil level.
Explain how a ring oiler works.
Describe a typical circulating oil system.
List three things to check in a circulating oil system.

Seals and Packing

State two reasons for using seals.
Define: *contact seals, labyrinth seals*, and *mechanical seals*.
Explain why a noticeable amount of leakage from a seal can be harmful.
Explain how valve packing prevents leakage.
Explain why grease guns and lubricators are used on valves.

SUBJECTS

Lubricating with Grease

Grease Guns
Automatic Grease Lubricators

Lubricating with Oil

Lubrication Schedules
Lubricating Devices
Circulating Oil Systems

Seals and Packing

Seals
Packing Lubrication

Furnaces

INTRODUCTION
(AOFIN)

OVERVIEW

This interactive training unit is designed to introduce trainees to the basic concepts associated with furnace operation. After completing the unit, trainees should be able to identify the major parts of a furnace and describe, in general terms, how a furnace produces heat. They should also be able to explain how heat transfer occurs in a furnace, and how air, combustion gases, and process fluid moves through different types of furnaces.

OBJECTIVES

Fundamentals
- Identify the major parts of a furnace.
- Identify the major furnace systems.
- Explain how a furnace produces heat.

Combustion
- State the requirements for combustion.
- Identify three types of heat transfer and how they occur in a furnace.

Furnace Flow Paths
- Define *draft*.
- Describe the basic operating principles of natural draft furnaces, forced draft furnaces, and balanced draft furnaces.
- Explain how draft is controlled in a natural draft furnace.
- Explain how process fluid circulates in a furnace.
- Identify problems associated with improper process fluid flow.

SUBJECTS

Fundamentals
- Components
- Operation

Combustion
- Fundamentals
- Heat Transfer

Furnace Flow Paths
- Draft
- Process Fluid

STARTUP AND SHUTDOWN
(AOFSS)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic procedures for starting up and shutting down a furnace. After completing this unit, trainees should be able to describe basic procedures for preparing a furnace for startup, establishing the flow of process fluid, and lighting the burners. They should also be able to describe general considerations and basic procedures associated with planned furnace shutdowns and unplanned, or emergency, furnace shutdowns.

OBJECTIVES

Startup

Describe the major operator responsibilities involved in preparing furnace startup.
Explain how and why a furnace is purged.
Describe how to establish the flow of process fluid in a furnace.
Describe how to light gas burners, oil burners, and combination burners.
Describe a typical startup procedure for natural draft and balanced draft furnaces.

Shutdown

Describe a typical planned shutdown procedure.
Identify furnace conditions that may require an emergency, or unplanned shutdown.
Identify typical emergency shutdown systems and equipment.

SUBJECTS

Startup

Preparations
Establishing Flow
Lighting Burners

Shutdown

Planned Shutdown
Emergency Shutdown

OPERATING CONDITIONS
(A0F0C)

OVERVIEW

This interactive training unit is designed to familiarize trainees with general operator responsibilities associated with operating a furnace. After completing this unit, trainees should be able to identify instrumentation used to monitor furnace temperature control systems and process fluid control systems. They should also be able to identify conditions that should be checked during furnace operations, and explain how to detect and respond to abnormal conditions.

OBJECTIVES

Instrumentation and Control

Identify the instrumentation used to monitor furnace operating conditions.
Describe the basic operating principles of furnace temperature control systems and process fluid control systems.

Inspection and Adjustments

Identify conditions that should be inspected during furnace operation.
Explain how to detect burner problems and make the appropriate burner adjustments.

Abnormal Conditions

Explain how to detect and respond to these furnace air flow problems: air leaks, insufficient air flow, and afterburning.
Explain how to operate a furnace at reduced firing rates.
Explain how to detect and respond to freeze-ups in the fuel supply system and process fluid system.

SUBJECTS

Instrumentation and Control

Instrumentation and Process Variables
Control Systems

Inspection and Adjustments

Furnace Inspection
Burner Adjustments

Abnormal Conditions

Air Flow Problems
Fuel System Problems
Process Fluid Problems

Heat Exchangers

INTRODUCTION
(AOHIN)

OVERVIEW

This interactive training unit is designed to introduce trainees to basic principles of heat transfer and the components and operating principles of shell and tube, and plate heat exchangers. After completing this unit, trainees should be able to explain what heat is, and describe three ways that heat transfer can occur in a heat exchanger. They should also be able to describe the basic operation and components of a shell and tube heat exchanger, and identify auxiliary equipment that is commonly used with heat exchangers. Finally, trainees should be able to explain how a plate heat exchanger operates and identify its components.

OBJECTIVES

Principles

Define *heat*.
Explain heat transfer by conduction, convection, and radiation.
Explain how heat is transferred in a typical heat exchanger.
Explain how various factors can affect heat transfer.

Shell and Tube

Describe the operation of typical shell and tube heat exchangers.
Explain how heat exchangers are used as coolers and heaters.
Describe the functions of the auxiliary components used with heat exchangers.
Describe the different flow paths fluids take in shell and tube heat exchangers.

Plate

Describe the basic operation of a plate heat exchanger.
Identify the components of a typical plate heat exchanger.

SUBJECTS

Principles

Heat and Heat Transfer
Heat Transfer Factors

Shell and Tube

Basic Operation
Auxiliary Equipment
Flow Paths

Plate

Operation
Components

OPERATION OF SHELL AND TUBE TYPES
(AOHOS)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the startup, operation, and shutdown of shell and tube heat exchangers. After completing this unit, trainees should be able to describe general procedures for the startup and shutdown of a shell and tube heat exchanger and identify some of the operator responsibilities associated with their operation. Trainees should also be able to identify basic operating problems that may be associated with shell and tube heat exchangers, and explain how they can be corrected.

OBJECTIVES

Startup and Shutdown

Describe a general procedure for starting up a shell and tube heat exchanger.
Describe a general procedure for shutting down a shell and tube heat exchanger.
Describe general operator responsibilities associated with the operation of a shell and tube heat exchanger.

Heat Exchanger Problems

Explain what fouling is and how it can be corrected.
Explain what leakage is and how it can be corrected.
Explain what air or vapor binding is and how it can be corrected.

SUBJECTS

Startup and Shutdown

Startup
Shutdown
Operator Responsibilities

Heat Exchanger Problems

Fouling
Tube Leaks
Air and Vapor Binding

COOLING TOWERS
(AOHCT)

OVERVIEW

This interactive training unit is designed to introduce trainees to the basic operation of a cooling water system and various types of cooling towers. After completing this unit, trainees should be able to explain how cooling occurs in a cooling tower, and describe the general design and operation of natural-draft and mechanical-draft cooling towers. They should also be able to describe general procedures for shutting down and starting up one cell of a multicell cooling tower. In addition, trainees should be able to describe operator checks that are typically performed on cooling towers, the effects of contaminants on cooling water, and how chemicals can be safely added to cooling water systems.

OBJECTIVES

Introduction

Describe the operation of a basic cooling water system.
Describe what occurs in the tower during the cooling process.
Describe the general operation of a natural-draft cooling tower and the two types of mechanical-draft cooling towers: induced-draft towers and forced-draft towers.

Operation

Describe a typical shutdown and startup procedure for one cell of a multicell cooling tower.
Describe typical operator checks for cooling towers.

Chemistry

Explain what suspended and dissolved solids are and how they affect a cooling water system.
Explain how problems caused by suspended and dissolved solids can be minimized.
Explain what dissolved gases and micro-organisms are, how they affect cooling water systems, and how their effects can be minimized.
Describe ways chemicals are added to cooling water systems.
Describe precautions when working with hazardous chemicals.

SUBJECTS

Introduction

Cooling Systems
Cooling Tower Design

Operation

Cell Shutdown and Startup
Operator Checks

Chemistry

Cooling Water Contamination
Chemical Addition

CONDENSERS AND REBOILERS

(AOHCR)

OVERVIEW

This interactive training unit is designed to introduce trainees to the basic operation of condensers and reboilers. After completing this unit, trainees should be able to describe the function and operation of a typical condenser, basic procedures for starting up and shutting down a condenser, and some operator checks that are typically performed during condenser operation. They should also be able to explain the operation of kettle-type and thermosiphon reboilers, and identify some operator responsibilities associated with reboiler operation.

OBJECTIVES

Condensers

Describe the function of condensers.
Describe the operation of a typical condenser.
Describe the startup procedure for a typical condenser.
Describe a general condenser shutdown procedure.
Describe some checks made during the operation of a condenser.

Reboilers

Describe how a kettle-type reboiler operates.
Describe how a thermosiphon reboiler operates.
Describe some operator responsibilities associated with reboiler operation.

SUBJECTS

Condensers

Condenser Operation
Condenser Startups and Shutdowns
Operator Checks

Reboilers

Kettle-Type Reboilers
Thermosiphon Reboilers
Operator Responsibilities

BASIC OPERATIONS I

(A01B1)

OVERVIEW

This interactive training unit is designed to introduce trainees to the basic principles of addition, subtraction, multiplication, and division. After completing this unit, trainees should be able to describe how to add, subtract, and multiply numbers in vertical columns, and how to do short and long division. They should also be able to explain powers of numbers and roots of numbers, as well as shortcuts for multiplying and dividing with multiples of ten.

OBJECTIVES

Addition and Subtraction

Define *number line*.
Describe the basic principles of addition and subtraction.
Describe the base 10 number system.
Describe how to add and subtract numbers in vertical columns.

Multiplication

Describe the basic principles of multiplication.
Explain how to use a multiplication table.
Describe how to multiply numbers in vertical columns.
Describe a shortcut for multiplying with multiples of ten.
Explain powers of numbers.
Explain roots of numbers.

Division

Describe the basic principles of division.
Explain how short division is done.
Explain how long division is done.
Describe a shortcut for dividing with multiples of ten.
Describe a shortcut for dividing with powers of numbers.

SUBJECTS

Addition and Subtraction

Number Line
Addition in Vertical Columns
Subtraction in Vertical Columns

Multiplication

Principles of Multiplication
Multiplication in Vertical Columns
Powers and Roots

Division

Principles of Division
Long Division

BASIC OPERATIONS 2
(A01B2)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic mathematical operations involving signed numbers, averaging, rates, fractions, decimals, and conversions. After completing this unit, trainees should be able to perform basic mathematical operations with signed numbers, perform combined operations in the proper order, find the average of a group of numbers, and calculate rates. They should also be able to add, subtract, multiply, and divide with fractions and decimals. Finally, trainees should be able to convert between fractions, decimals, and percents; write numbers using scientific notation; and use conversion tables.

OBJECTIVES

Math Operations
- Explain how to do basic math operations with signed numbers.
- Define *grouping symbols*.
- Explain the order in which combined operations are performed.
- Explain how to calculate averages and rates.

Fractions
- Explain what a fraction is, and how to add and subtract them.
- Describe how to get common denominators, and what a lowest common denominator is.
- Explain how to multiply and divide fractions.
- Explain how to express a fraction in simplest terms.
- Explain what a mixed number is, and how to convert whole and mixed numbers to fractions.

Decimals and Conversions
- Define *decimal*.
- Describe basic math operations involving decimals.
- Describe how to convert between fractions and decimals.
- Describe how to write numbers using scientific notation.
- Explain what percents are.
- List how to convert between fractions, decimals, and percents.
- Describe conversion tables: factor-type and equivalents-type.

SUBJECTS

Math Operations
- Signed Numbers
- Combined Operations
- Averaging
- Rates

Fractions
- Add and Subtract
- Multiply and Divide
- Mixed Numbers

Decimals and Conversions
- Decimals
- Number Conversions
- Conversion Tables

ALGEBRA
(AOIAL)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic concepts of algebra. After completing this unit, trainees should be able to define terms commonly associated with the use of algebra, isolate an unknown in an equation, and use the processes of distribution and factoring. They should also be able to explain what ratios and proportions are, and the difference between a direct proportion and an inverse proportion. Finally, trainees should be able to use a calculator to solve math problems.

OBJECTIVES

Introduction to Algebra

State the difference between arithmetic and algebraic operations.
Define the terms: *constant, unknown, variable,* and *equation*.
Describe how equations are used to solve an arithmetic or algebraic problem.
Explain how to maintain an equation's balance.
Describe how the unknown in an equation can be isolated.
Describe the operation of distribution.
Describe the operation of factoring.

Ratios and Proportions

Explain what a ratio is and how ratios can be expressed.
Explain the difference between a direct proportion and an inverse proportion.

Calculators

Explain how to use a calculator.

SUBJECTS

Introduction to Algebra

Basic Principles
Isolating an Unknown
Distribution
Factoring

Ratios and Proportions

Calculators

Parts of a Calculator
Types of Logic

FORMULAS, GRAPHS AND TRENDS

(A01FC)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic principles associated with using formulas, reading and interpreting graphs, and detecting and analyzing trends. After completing this unit, trainees should be able to explain what a formula is and how to use formulas to find areas, volumes, and volumetric flow rates. They should also be able to describe how graphs and charts can provide information about process variables. In addition, trainees should be able to describe basic procedures for detecting and analyzing trends.

OBJECTIVES

Formulas

Define *formula*.
Describe how formulas can be used to find areas.
Describe how formulas can be used to find volumes.
Define *flow rate*.
Describe how to use volumetric flow rate formulas.

Graphs, Charts, and Trends

Describe how graphs can provide information about process variables.
Describe how charts can provide information about process variables.
Describe what a trend is and explain the difference between expected trends and unexpected trends.
Describe some basic procedures for detecting a trend.
Describe some basic procedures for analyzing a trend.

SUBJECTS

Formulas

Area
Volume
Volumetric Flow Rate

Graphs, Charts, and Trends

Graphs
Charts
Trends

MEASUREMENT OF PRESSURE AND TEMPERATURE

(A01MP)

OVERVIEW

This interactive training unit is designed to introduce trainees to some of the fundamental aspects of process variable measurement and to some of the basic instruments used for pressure and temperature measurement. After completing this unit, trainees should be able to describe the function of process instrumentation and how to obtain accurate readings from instruments such as gauges, indicators, and recorders. They should also be able to explain what pressure and temperature are and how they are expressed, and the operation of several pressure and temperature measuring devices.

OBJECTIVES

Measuring Process Variables

State the general function of process instrumentation.
List four process variables monitored by process instrumentation.
Explain how parallax can affect an instrument reading.
Explain how to use a multiplication factor when reading an instrument.
Describe how to read gauges, indicators, recorders, and digital meters.

Pressure Measurement

Define *pressure* in terms of solids, liquids, and gases.
Describe three types of scales used to indicate pressure.
List basic units of measurement for pressure.
Describe three types of manometers.
Describe the basic operation of Bourdon tube, bellows, and diaphragm pressure elements.
Describe the basic operation of a pressure transmitter.

Temperature Measurement

Explain the general relationship between heat and temperature.
List basic units of measurement for temperature.
Describe the basic operation of a fluid thermometer, bimetallic thermometer, thermocouple, and Resistance Temperature Detector (RTD).

SUBJECTS

Measuring Process Variables

Process Variables and Instrumentation
Reading Instruments

Pressure Measurement

Pressure and Pressure Scales
Manometers
Pressure Elements and Transmitters

Temperature Measurement

Temperature and Temperature Scales
Thermometers
Thermocouples and RTDs

MEASUREMENT OF LEVEL AND FLOW

(A01ML)

OVERVIEW

This interactive training unit is designed to introduce trainees to instruments that measure level and flow. After completing this unit, trainees should be able to explain what level is and describe the basic operation of various direct and indirect level measurement devices. They should also be able to explain what fluid flow, flow rate, and total flow are and describe some common examples of direct and indirect flow measurements.

OBJECTIVES

Level Measurement

Define: *level, continuous level measurement*, and *single-point level detection*.
Describe basic operation of the following level measurement devices: plumb bob, gauge glass, float and tape, and conductivity probes.
Describe the basic operation of these level measurement devices: pressure gauge, bubbler system, and D/P cell.

Flow Measurement

Define *fluid flow, flow rate*, and *total flow*.
List basic units of measurement for flow rate.
Describe common examples of direct flow measurement.
Describe common examples of indirect flow measurement.

SUBJECTS

Level Measurement

Principles of Level Measurement
Direct Level Measurement Devices
Indirect Level Measurement Devices

Flow Measurement

Principles of Flow Measurement
Direct Flow Measurement Devices
Indirect Flow Measurement Devices

MEASUREMENT OF CONCENTRATION

(AOIMC)

OVERVIEW

This interactive training unit is designed to introduce trainees to some information about analytical variables and to some methods for measuring concentration in liquids and gases. After completing this unit, trainees should be able to define five analytical variables that are commonly measured in plants, and explain how and why analytical variables are measured. They should also be able to describe the basic operation of several different types of analyzers that can be used to measure liquid and gas concentrations.

OBJECTIVES

Introduction to Analytical Measurement

State the general purpose of analytical measurements.
Define: *concentration, density, clarity, humidity, moisture,* and *analyzer*.

Liquid Concentration Analysis

Explain what pH measurements represent.
Explain how a pH scale is structured and how to interpret pH values.
Describe the basic operation of a typical pH analyzer and a typical electrical conductivity measuring device.

Gas Concentration Analysis

Describe the basic operation of a paramagnetic oxygen analyzer, a thermal conductivity gas analyzer, and a chromatograph.

SUBJECTS

Introduction to Analytical Measurement

Analytical Variables
Measuring Analytical Variables

Liquid Concentration Analysis

What is Concentration?
pH Measurements
pH Analyzer Operation
Conductivity Measurements

Gas Concentration Analysis

Oxygen Concentration Measurement
Non-Oxygen Gas Concentration Measurement
Complex Gas Concentration Measurement

MEASUREMENT OF DENSITY, CLARITY AND MOISTURE

(A0IDC)

OVERVIEW

This interactive training unit is designed to introduce trainees to some devices that can be used to measure density, clarity, and moisture. After completing this unit, trainees should be able to define various terms associated with density, clarity, and moisture, and describe the basic operation of devices used to measure density, clarity, humidity, and moisture.

OBJECTIVES

Density Measurement

Define *density*.
Explain the difference between density and specific gravity.
Describe the basic operation of a hydrometer.
Describe the use of a bubbler system to measure density.
Describe the operation of a radioactive density analyzer.

Clarity Measurement

Define *clarity*.
Describe the basic operation of a colorimeter, a turbidity meter, and an opacity meter.

Moisture Measurement

Define *humidity* and *moisture*.
Describe the basic operation of a sling psychrometer.
Describe the basic operation of a wet and dry bulb recording psychrometer.
Describe the basic operation of a hygrometer.
Describe the basic operation of an infrared moisture analyzer.

SUBJECTS

Density Measurement

Density and Specific Gravity
Hydrometers
Density Bubbler System
Radioactive Density Analyzer

Clarity Measurement

Principles of Clarity Analysis
Colorimeter
Turbidity Meter
Opacity Meter

Moisture Measurement

Humidity and Moisture
Measuring Humidity
Measuring Moisture

AUTOMATIC PROCESS CONTROL I

(A01A1)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with automatic control of process systems. After completing this unit, trainees should be able to describe the functions of the four basic elements of an automatic process control system and explain how a process disturbance can affect a process control system. They should also be able to explain how feedback control and feedforward control can be used in process control systems. In addition, trainees should be able to explain how resistance, capacitance, dead time, and lag time can affect a process control system.

OBJECTIVES

Control Methods

State the function of a process control system.
Describe the functions of the four basic elements of an automated process control system.
Explain what a process disturbance is and how it can affect a process control system.
Describe feedback and feedforward control and explain how they can be used in a process control system.

Process Dynamics

Define *resistance* and *capacitance*.
Define *dead time* and *lag time*.
Explain how resistance, capacitance, dead time, and lag time can affect a process control system.

SUBJECTS

Control Methods

Automatic Control Systems
Feedback Control
Feedforward Control

Process Dynamics

Process Characteristics
System Responses

AUTOMATIC PROCESS CONTROL 2

(A0IA2)

OVERVIEW

This interactive training unit is designed to familiarize trainees with control modes used with automatic process control systems. After completing this unit, trainees should be able to describe two-position control, proportional control, reset control, rate control, and PID control and explain how each of these control modes works in a control system. They should also be able to explain how proportional band applies to a control system.

OBJECTIVES

Two-Position and Proportional

Describe two-position control and explain how it works in a control system.
Describe proportional control and explain how it works in a control system.
Explain how proportional band applies to a control system.

Reset, Rate, and PID

Describe reset control and explain how it works in a control system.
Describe rate control and explain how it works in a control system.
Describe PID control and explain how it works in a control system.

SUBJECTS

Two-Position and Proportional

Two-Position Control
Proportional Control
Proportional Band

Reset, Rate, and PID

Reset Control
Rate Control
PID Control

INTRODUCTION TO CONTROL AND DATA SYSTEMS
(ACCIC)

OVERVIEW

The Introduction to Control and Data Systems training program, or unit, is designed to familiarize trainees with the role of information systems in plant operations and the elements of modern information systems. After completing this program, the trainees should be able to identify the information needs of typical plant functional elements and explain how information gets into an information system. They should also be able to describe system architecture and explain how to use environment software and application software.

OBJECTIVES

List the information needs of typical plant functional elements.
Explain how alarms work in modern plants.
List the routes by which information gets into the system.
Explain I/O bus, LAN, WAN, client-server, and the role of network standards.
Explain the function of an operating system.
Describe the characteristics of common operating systems.
Explain the role of operating system and network software.
Explain virtual instrumentation.
Explain programmable logic controller (PLC) program creation.
Describe how to use graphical objects to create the system data structure and HMI.
Describe password hierarchy and the need for security.
Describe the functions and architecture of a SCADA system.

SUBJECTS

Information and Plant Operations
Information Needs
Information Sources

Information Systems
System Architecture
Environment Software
Application Software

INTRODUCTION TO PROCESS CONTROL
(ACCIN)

OVERVIEW

The Introduction training program, or unit, is designed to familiarize trainees with the basic elements, terminology, and functions of control systems. After completing this program, the trainees should be able to identify and describe various types of input and output devices that are commonly used with automated control systems. They should also be able to identify and describe common types of control devices and control loop arrangement

OBJECTIVES

Define terms commonly associated with the input side of a control system.
Identify and describe common types of temperature sensors that provide input information to a control system.
Identify and describe common types of position sensors.
Identify and describe common types of pressure sensors, flow sensors, and level sensors.
Identify and describe common types of electric instruments, timers, counters, recorders, and pneumatic sensors.
Identify and describe common actuating devices used in the output side of a control system.
Describe common decision-making devices that connect the input and output elements in a control system.
Describe common control loop arrangements used in automatic control systems.

SUBJECTS

Input Elements
- Terminology
- Temperature Sensors
- Position Sensors
- Pressure, Flow, and Level Sensors
- Other Input Devices

Output Elements
- Actuating Devices

Control Elements
- Decision-Making Devices
- Control Loops

THE HUMAN-MACHINE INTERFACE
(ACCHM)

OVERVIEW

The The Human-Machine Interface training program, or unit, is designed to familiarize trainees with the different types of HMIs that are likely to be found in a modern plant. After completing this program, the trainees should be able to obtain process information using typical instruments, operate typical switch controls, use smart I/O devices and controller interfaces, and perform common computer operations.

OBJECTIVES

Read typical instruments.
Use typical switch controls.
Configure smart I/O devices.
Operate portable instruments.
Operate and program a variable frequency drive.
Take readings from and program a loop controller.
Use dedicated graphics terminals.
Describe the role of software in computer operation.
Describe the main functional components of a computer.
Use common DOS and character-based keyboard/screen functions.
Use common GUI keyboard/screen functions.
Turn a computer on and log on.
Find and run a program, enter data, save, print, exit, and shut down a computer.

SUBJECTS

Traditional Equipment Interfaces
Instruments
Controls

Microprocessor-Based HMIs
Smart I/O Interfaces
Controller Interfaces

The Computer Interface
Basic Computer Hardware and Operation
The Human-Computer Interface
Common Computer Operations

TANK TRUCKS
(AOMTT)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts of material handling using tank trucks. After completing this unit, trainees should be able to describe characteristics of liquids that can affect liquid handling operations. They should also be able to describe precautions, procedures, and equipment associated with handling hazardous liquids. Trainees should also be able to describe features of a typical tank truck and typical procedures for its loading and unloading.

OBJECTIVES

General Concerns

Explain how toxicity, viscosity, volatility, temperature, and pressure can affect liquid handling operations.
Describe how static electricity can affect the handling of bulk liquids.
Describe how operators can identify hazardous materials.
Identify precautions, procedures, and equipment associated with handling hazardous chemicals.

Loading and Unloading

Describe the major features of a typical tank truck.
Identify associated equipment used with tanks during liquid transfers.
Identify equipment commonly associated with tank trucks.
Identify methods of transferring bulk liquids.
Describe the basic tasks involved in transferring bulk liquids.
Identify items that should be checked during pre-transfer and post-transfer inspections.
Describe typical procedures for top-loading a tank truck.
Describe how bottom-loading a tank truck differs from top-loading a tank truck.
Describe typical procedures for pressurized top unloading from a tank truck by pressurizing with air.
Describe common safety concerns and regulations associated with tank trucks.

SUBJECTS

General Concerns

Characteristics of Liquids
Handling Hazardous Materials

Loading and Unloading

Tank Truck Features
Loading a Tank Truck
Unloading a Tank Truck

On-the-Job Training

PREPARATION
(A00PR)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with on-the-job training (OJT) of plant operators. After completing this unit, trainees should be able to compare OJT and classroom training, and describe the basic steps in a formalized OJT program. They should also be able to explain how to determine specific training needs for a trainee, and describe training materials that are commonly used for OJT.

OBJECTIVES

What is OJT?
- Compare OJT and classroom training.
- List advantages and disadvantages of OJT.
- Identify the basic steps included in a formal OJT program.

Training Needs
- Identify sources of information for analyzing an operator's job.
- Explain what a job and task analysis is.
- Describe how to profile the trainee and tailor training according to individual needs.
- Describe how to determine training needs that are to be met specifically through OJT.

Training Materials
- Explain what a performance objective is.
- Describe the use of an OJT training checklist.
- Identify some training aids that can be used for OJT.

SUBJECTS

What is OJT?
- OJT vs. Classroom Training
- Pros and Cons
- Basic Steps

Training Needs
- Job and Task Analysis
- Trainee Profile
- Determining Training Methods

Training Materials
- Objectives and Checklists
- Training Aids

IMPLEMENTATION AND EVALUATION

(A00IE)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with on-the-job training (OJT) of plant operators. After completing this unit, trainees should be able to identify qualities that an effective OJT instructor should possess, and describe considerations associated with scheduling, planning for, and conducting OJT. They should also be able to describe how the trainee, the instructor, and the overall OJT program can be evaluated.

OBJECTIVES

Implementation

Identify qualities and characteristics of an effective OJT instructor.
Identify some training strategies that an instructor can use during OJT.
Describe considerations involved in scheduling OJT.
Identify preparations that should be made before OJT is implemented.
Describe methods of conducting OJT.
Describe coaching skills that an instructor can use during OJT.

Evaluation

Describe how a trainee's performance can be evaluated.
Describe how on-the-job training instructors can evaluate themselves and the OJT program.
Review the main steps and principles of a typical OJT program.

SUBJECTS

Implementation

The OJT Instructor
Planning for OJT
OJT Methods

Evaluation

Trainee Evaluation
Program Evaluation
OJT Review

Operator Responsibilities

INTRODUCTION
(A00TC)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the general responsibilities of an operator in an industrial facility. After completing this unit, trainees should be able to describe operator responsibilities associated with process control, safety, and communication. They should also be able to describe an outside operator's responsibilities during inspections and routine operations, and the general responsibilities of a control room operator. They should also be able to describe the effects that changing weather conditions have on system operation.

OBJECTIVES

Overview

Describe operator responsibilities associated with controlling a production process, safe operation of a facility, and fire and accident prevention.
Explain why good communications are important in an industrial facility.
Identify the types of information that an oncoming operator should find out during a shift change.

Plant Operators

Describe an outside operator's responsibilities during inspections.
Describe an outside operator's responsibilities during routine operations.
Describe the general responsibilities of a control room operator.
Describe the effects of changing weather conditions on system operation.

SUBJECTS

Overview

The Operator's Role

Plant Operators

Outside Operators
Control Room Operators

TRENDS, MAINTENANCE AND EMERGENCIES

(A001M)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic operator responsibilities associated with trend analysis, equipment maintenance, and emergency situations. After completing this unit, trainees should be able to describe ways to detect and analyze trends, explain how work orders are used, and describe how to perform some minor maintenance tasks. They should also be able to explain how operators can prepare for emergency situations and describe operator responsibilities during emergencies.

OBJECTIVES

Trends

Describe how trends can be detected.
Describe a four-step approach to analyzing trends.

Maintaining Equipment

Explain the purpose of work orders.
Describe how valve packing can be adjusted.
Describe how to safely reset a tripped circuit breaker.
Describe how to change a strainer basket in a duplex strainer.

Emergency Situations

Explain how operators can prepare for emergency situations.
Describe general operator responsibilities during emergency situations.
Describe general operator responsibilities during fire emergency situations.

SUBJECTS

Trends

Trend Detection
Trend Analysis

Maintaining Equipment

Work Orders
Operator Tasks

Emergency Situations

Preparing for Emergencies
Responding to Emergencies

PLANT PRODUCTION AND SAFETY
(A00PP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with operator responsibilities during routine plant production operations and for ensuring safety during all phases of plant operation. After completing this unit, trainees should be able to describe operator responsibilities associated with routine production duties, preventive maintenance, and troubleshooting. They should also be able to describe operator safety responsibilities for normal and abnormal operations and during scheduled startups and shutdowns. In addition, they should be able to describe the operator's role with respect to permit procedures and government regulations.

OBJECTIVES

Production

Describe operator responsibilities associated with routine production duties, data interpretation, waste disposal, and vapor emissions monitoring.
Describe operator responsibilities associated with preventive maintenance.
Describe operator responsibilities associated with troubleshooting.

Safety

Describe operator safety responsibilities associated with normal plant conditions.
Describe operator safety responsibilities associated with abnormal plant conditions.
Describe operator safety responsibilities associated with scheduled plant startups and shutdowns.
Describe the operator's role in lockout/tagout procedures and confined space procedures.
Explain, in simple terms, the purposes of the following regulations: HAZCOM, HAZWOPER, and SARA III.

SUBJECTS

Production

Operator Duties
Preventive Maintenance and Troubleshooting

Safety

Normal and Abnormal Conditions
Startups and Shutdowns
Permits and Regulations

COMMUNICATION
(A00C0)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic operator responsibilities associated with interpersonal relationships and data collection and use. After completing this unit, trainees should be able to describe the components of a basic communication model and an operator's responsibilities for communicating with other plant personnel, customers, and members of the surrounding community. They should also be able to describe operator responsibilities associated with collecting and using written data and participating in effective shift changes.

OBJECTIVES

Interpersonal Responsibilities

Describe the components of a basic communication model.
Describe basic operator interpersonal responsibilities with the company, peers, supervisory personnel, personnel in other departments, and new operators.
Identify the four steps in an on-the-job training program for new operators.
Describe basic operator interpersonal responsibilities with customers and the community.

Data Collection and Use

Describe operator responsibilities associated with scheduled readings, statistical process control (SPC) charts, sample and laboratory analysis reports and logs.
Identify three characteristics of an effective relief.

SUBJECTS

Interpersonal Responsibilities

The Communication Model
Inside the Plant
Outside the Plant

Data Collection and Use

Written Data
Oral Data

Piping and Auxiliaries

BASIC COMPONENTS AND FUNCTIONS
(AOPAB)

OVERVIEW

This interactive training unit is designed to familiarize trainees with some of the basic components commonly found in piping systems. After completing this unit, trainees should be able to state the purpose of piping and pipe fittings, and be able to list some common types of pipe fittings. They should also be able to describe devices that are used to accommodate the weight and movement of piping, and to explain how insulation and heat tracing help to control temperatures in piping systems.

OBJECTIVES

Pipes and Pipe Fittings
- State the purpose of piping.
- State the purpose of pipe fittings.
- Describe the following types of pipe fittings: *nipple, coupling, union, flange, elbow, tee, Y, bell reducer, bushing, plug,* and *cap*.

Pipe Weight and Movement
- Explain why piping moves and why this movement needs to be controlled.
- State the functions of pipe hangers and supports.
- State the functions of expansion joints and expansion loops.

Insulation and Heat Tracing
- Explain why piping is insulated.
- Describe how steam and electrical heat tracing methods work.

SUBJECTS

Pipes and Pipe Fittings
- Pipes and Connections
- Types of Pipe Fittings

Pipe Weight and Movement
- Pipe Supports
- Expansion Devices

Insulation and Heat Tracing
- Insulation
- Heat Tracing

SYSTEM COMPONENTS AND OPERATION
(AOPAS)

OVERVIEW

This interactive training unit is designed to familiarize trainees with some of the auxiliary components commonly found in piping systems. After completing this unit, trainees should be able to describe the function and operation of rupture discs, relief valves, safety valves, and some common types of steam traps. They should also be able to describe basic procedures for draining liquid systems and some typical operator checks for fluid systems.

OBJECTIVES

Protective Devices
- Describe the function and operation of a rupture disc.
- Describe the function and operation of a relief valve.
- Describe the function and operation of a safety valve.

Steam Traps
- Describe the function of a steam trap.
- Describe the operation of the following types of mechanical steam traps: *float traps* and *inverted bucket traps*.
- Describe the operation of a thermostatic steam trap.
- Describe some typical operator checks for steam traps.

System Operation
- Describe basic procedures for draining liquid systems.
- Describe basic procedures for filling liquid systems.
- Describe typical operator checks for fluid systems.

SUBJECTS

Protective Devices
- Rupture Discs
- Relief Valves
- Safety Valves

Steam Traps
- Mechanical Steam Traps
- Thermostatic Steam Traps
- Operator Checks

System Operation
- Draining Liquid Systems
- Filling Liquid Systems
- Operator Checks

BASIC PRINCIPLES
(AOPBP)

OVERVIEW

This interactive training unit is designed to introduce trainees to scientific principles associated with units of measurement and with force and motion. After completing this unit, trainees should be able to identify fundamental units of measurement for length, time, and mass, and identify fundamental units of measurement for pressure, temperature, flow, and level. They should also be able to explain the relationship between force and motion and describe the three laws of force and motion.

OBJECTIVES

Unit of Measurement

Identify fundamental units of measurement for length, time, and mass.
Identify fundamental units of measurement for the process variables pressure, temperature, flow, and level.

Force and Motion

Explain the relationship between force and motion.
State the three laws of force and motion.
Define *inertia*.
Define *acceleration*.

SUBJECTS

Units of Measurement

Fundamental Dimensions
Process Variable Measurements

Force and Motion

Introduction
Laws of Force and Motion

FORCES AND MACHINES

(AOPLM)

OVERVIEW

This interactive training unit is designed to introduce trainees to scientific principles associated with applied forces and the operation of basic machines. After completing this unit, trainees should be able to define work, power, and efficiency, and explain the mechanical advantage of the inclined plane and the lever. They should also be able to explain the hydraulic principle and the relationship between friction and the operation of machines.

OBJECTIVES

Work, Power, and Efficiency

Define *work* and explain its relationship to energy.
Define *power*.
Explain why efficiency is important to plant operation.

Basic Machines

Define *mechanical advantage*.
Explain the mechanical advantage of the inclined plane.
Explain the mechanical advantage of the lever.
Explain the hydraulic principle and give examples of where it applies.
Discuss some of the effects of friction.

SUBJECTS

Work, Power, and Efficiency

Work
Power
Efficiency

Basic Machines

The Inclined Plane
The Lever
The Hydraulic Principle
Friction

SOLIDS AND LIQUIDS
(AOPSL)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic scientific principles that relate to solids and liquids. After completing this unit, trainees should be able to describe the general molecular structure of solids, liquids, and gases. They should also be able to describe specific properties attributed to solids and liquids.

OBJECTIVES

Forms of Matter

Identify the three forms of matter and explain how they are structured.
Give a general description of the molecular structure and the characteristics of solids, liquids, and gases.
Compare and contrast the molecular structures of different solids.
Explain why liquids can flow.

Solids

Define *mass, density*, and *stress*.
Identify five types of stress and their effects on solids.
Define *elasticity* and *temperature*.
Describe the effects of temperature on solids.

Liquids

Describe how liquids seek their own level.
Define *viscosity*.
Describe the property of wetting and explain why it occurs.
Describe buoyancy and explain why it occurs.
Describe specific gravity and how it relates to density.
Describe the effects of temperature and pressure on liquids.

SUBJECTS

Forms of Matter

Solids

Mass and Density
Stress and Elasticity
Temperature Effects

Liquids

Properties of Liquids
Temperature and Pressure Effects

GASES AND FLOWING LIQUIDS

(AOPGF)

OVERVIEW

This interactive training unit is designed to familiarize trainees with general concepts associated with the properties of gases and flowing liquids. After completing this unit, trainees should be able to describe the major properties of gases and explain how these properties are related. They should also be able to explain how pressure can be measured and the effects of flow, velocity, and friction on the head pressure of a liquid.

OBJECTIVES

Gas Properties

Describe the effects of temperature and pressure on gases.
Explain how Boyle's Law and Charles' Law relate to the pressure and volume of gases.
Explain how the General Gas Law relates to temperature, pressure and volume of a gas.

Measuring Pressure

Explain how atmospheric pressure can be measured.
Describe the effects of pressure on a manometer.
Explain how various scales can be used to measure pressure.

Flowing Liquids

Define: *flow, flow rate, steady-state conditions, static conditions, head*, and *head pressure*.
Describe the effects of flow on pressure.
Describe the effects of velocity on pressure.
Describe the effects of friction on pressure.

SUBJECTS

Gas Properties

Temperature and Pressure Effects
Gas Laws

Measuring Pressure

Atmospheric Pressure
Manometers
Pressure Scales

Flowing Liquids

Flow and Flow Rate
Effects of Flowing Liquids

HEAT
(AOPHE)

OVERVIEW

This interactive training unit is designed to introduce trainees to some of the basic principles associated with heat and heat transfer. After completing this unit, trainees should be able to describe some of the effects of heat, the relationship between temperature and thermal energy, and the Law of Energy Conservation. Trainees should also be able to define terms *sensible heat* and *latent heat* and to describe the effects of pressure on the temperature at which a substance undergoes a phase change.

OBJECTIVES

What Is Heat?

Describe some of the effects of heat.
Describe the relationship between temperature and thermal energy.
Describe the Law of Energy Conservation.

Phase Changes

Define *sensible heat* and *latent heat*.
Describe the effects of pressure on the temperature at which a substance undergoes a phase change.

SUBJECTS

What is Heat?

Effects of Heat
Temperature and Thermal Energy
The Law of Energy Conservation

Phase Changes

Sensible Heat and Latent Heat
Temperature and Pressure

HEAT TRANSFER
(AOPHT)

OVERVIEW

This interactive training unit is designed to introduce trainees to the fundamentals of heat transfer and the basic operation of a typical heat exchanger. After completing this unit, trainees should be able to describe the effects of a temperature difference on heat transfer and the three modes of heat transfer. They should also be able to describe the basic operation of a shell and tube heat exchanger and identify problems that can occur in a heat exchanger.

OBJECTIVES

Heat Transfer Fundamentals
- Describe the effects of temperature difference on heat transfer.
- Define *specific heat* and give examples.
- Recognize the formula for heat transfer.

Modes of Heat Transfer
- List and describe the three modes of heat transfer.
- Describe conduction heat transfer.
- Describe natural convection and forced convection.
- Describe how heat transfer takes place between two fluids separated by a solid boundary.
- Describe what affects heat transfer between two fluids.
- Describe radiation heat transfer.

Heat Exchanger Operation
- Describe the general operation of a shell and tube heat exchanger.
- Describe the operation of a lube oil cooler.
- Describe problems that can occur in heat exchangers and explain how these problems can be minimized.
- Describe the insulating effects of rust and scale buildup.

SUBJECTS

Heat Transfer Fundamentals
- The Process of Heat Transfer
- Specific Heat
- Heat Transfer Formula

Modes of Heat Transfer
- Conduction
- Convection
- Radiation

Heat Exchanger Operation
- Shell and Tube Heat Exchangers
- Heat Exchanger Problems

FLUID SYSTEMS
(A0PFS)

OVERVIEW

This interactive training unit is designed to introduce trainees to the characteristics, components, and operation of fluid systems. After completing this unit, trainees should be able to explain, in general terms, what a plant system is, and what a fluid is. They should also be able to explain the basic layout of a liquid system and describe energy conversions in a liquid system. Trainees should also be able to describe the basic parts of a compressed air system and the basic operation of several gas and vapor system devices.

OBJECTIVES

Liquid Systems

Explain, in general terms, what a plant system is.
Explain what a fluid is.
Describe the effects of pressure changes on a static fluid.
Describe the four basic parts of a liquid system.
Describe the effects of energy conversions on a fluid under steady-state conditions.
Describe some of the energy conversions that take place in liquid systems.

Gas and Vapor Systems

Describe the basic parts of a typical compressed air system.
Describe the operation of a jet pump.
Describe the operation of a nozzle.
Describe the operation of a condenser.

SUBJECTS

Liquid Systems

Systems and Fluids
Basic System Layout
Energy Conversions

Gas and Vapor Systems

Compressed Air System
Gas and Vapor System Devices

PROCESS DYNAMICS AND MEASUREMENT

(AOPPD)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the characteristics of dynamic process operation and with devices that are commonly used to measure process variables. After completing this unit, trainees should be able to explain what resistance and capacitance are in process systems and to describe factors that affect the response of a process system to operating changes and process disturbances. Trainees should also be able to describe devices that can be used to measure pressure, flow, level, and temperature.

OBJECTIVES

Dynamic Operation

Describe resistance and capacitance in process systems.
Describe and give examples of system characteristics between periods of steady-state conditions when changes occur.

Process Variable Measurement

Describe ways that pressure can be measured.
Describe ways that flow can be measured.
Describe ways that level can be measured.
Describe ways that temperature can be measured.

SUBJECTS

Dynamic Operation

Resistance and Capacitance
System Response to Changes

Process Variable Measurement

Pressure Measurement Devices
Flow Measurement Devices
Level Measurement Devices
Temperature Measurement Devices

BASIC ELECTRICAL PRINCIPLES
(AOPBE)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic principles of electricity and the basic operation of electric motors. After completing this unit, trainees should be able to explain what electricity is, and how it can be produced by chemical action, heat, light, and magnetic effects. They should also be able to describe the basic operation of a DC motor, a single-phase AC motor, and a three-phase AC motor.

OBJECTIVES

Electricity

Define the following terms: *electrical potential, current*, and *voltage*.
Describe three sources of electrical potential: *chemical action, heat*, and *light*.
List the three elements necessary to create an electrical potential using magnetic effects.
Recognize and describe a sine wave.
Explain the basic differences between single-phase power and three-phase power.

Electric Motors

Describe basic motor action.
Describe the principle of operation of a DC motor.
Describe the principle of operation of an AC motor.

SUBJECTS

Electricity

What is Electricity?
Chemical Action, Heat, and Light
Electricity, Magnetism, and Alternating Current

Electric Motors

Basic Motor Operation
DC Motor Operation
AC Motor Operation

BASIC ELECTRICAL CIRCUITS

(AOPBC)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic principles associated with the parts and operation of electrical circuits. After completing this unit, trainees should be able to identify the parts of a basic circuit, describe the relationships between voltage, current, and resistance in a circuit, explain how current flows through series circuits and parallel circuits, describe the basic operation of transformers, fuses, circuit breakers, and solenoids, and explain how voltmeters and ammeters can help operators detect electrical problems.

OBJECTIVES

Basic Circuits

List the parts of a basic circuit.
Explain how Ohm's Law describes the relationships between current, voltage, and resistance in a circuit.
Explain the basic difference between series circuits and parallel circuits with respect to current flow.
Describe the basic operation of a transformer.
Explain the difference between a step-up transformer and a step-down transformer.

Protection and Indicators

State the general function of fuses and circuit breakers.
Describe the basic operation of a fuse.
Describe the basic operation of a circuit breaker.
Describe the basic operation of a solenoid.
Explain how voltmeters and ammeters can help personnel spot electrical problems before equipment damage occurs.

SUBJECTS

Basic Circuits

Parts of a Circuit
Ohm's Law
Series and Parallel Circuits
Transformers

Protection and Indicators

Protective Equipment
Voltmeters and Ammeters

ABNORMAL CONDITIONS AND EMERGENCIES

(A0BAC)

OVERVIEW

This is an interactive training module designed to familiarize trainees with some abnormal operating conditions that a boiler operator may encounter on the job. Specific attention is directed to typical procedures used by plants to handle these situations and to the methods and means available to the operator to anticipate problems and to minimize the chances of their occurring.

OBJECTIVES

Common Problems

Describe typical procedures for dealing with the loss of certain boiler auxiliaries.
Describe basic procedures for dealing with leaks that occur inside and outside a boiler.
Describe how safety valves are used to protect boilers against overpressure.
Describe what boiler operators should do to deal with leaking safety valves.
Describe basic procedures for dealing with fires in coal yards, bunkers, feeders, pulverizers, and air preheaters.
Explain how equipment fires start and identify actions that operators should avoid when equipment fires occur.

Boiler Explosions

Describe some of the basic causes of boiler explosions.
Explain what operators can do to help prevent boiler explosions.
Describe some situations that can cause a loss of all boiler flame.
Describe some basic procedures for preventing a loss of all boiler flame.

SUBJECTS

Common Problems

Loss of Auxiliaries
Leaks
Overpressure
Equipment Fires

Boiler Explosions

Causes of Explosions
Loss of Flame

COMBUSTION AND OPERATION

(A0BC0)

OVERVIEW

The requirements for combustion in a boiler are identified and described. This unit traces the air and gas flow path through a typical boiler and describes the functions of the components in the flow path. Principles of boiler operation from an operator's point of view are identified and described.

OBJECTIVES

Combustion

List elements needed for combustion in a boiler.
Describe the parts and function of a typical burner in a boiler furnace and how the burner helps to satisfy the elements of combustion in a boiler.
Describe the fuel system for a typical coal-fired boiler.
Describe a typical burner for an oil-fired boiler.
Describe a typical burner for a gas-fired boiler.
Define the following terms: *fuel/air ratio, excess air*, and *excess oxygen*.
Describe operator responsibilities associated with maintaining the correct fuel/air ratio.

Air and Gas

Trace the air and gas flow path through a boiler.
Explain how hot combustion gases are used to increase boiler efficiency.
Describe the basic operation of two types of air preheaters.
Describe some of the harmful effects that can be caused by combustion gas by-products.
Describe equipment commonly used to remove particulates and harmful gases from combustion gases.

Boiler Operation

Describe the location and purpose of boiler vents.
Describe the location and purpose of boiler drains.
Explain what blowdown valves are.
State the purpose of soot blowing.
Describe the operation of a typical soot blower.

SUBJECTS

Combustion

Elements of Combustion
Boiler Fuel Systems
Fuel/Air Ratio

Air and Gas

Air and Gas Flow Path
Pollution Controls

Boiler Operation

Vents, Drains, and Blowdown Valves
Soot blowing

NORMAL OPERATIONS
(A0BN0)

OVERVIEW

This is an interactive module designed to present an overview of the basic procedures for normal operations of a drum-type boiler. Trainees will learn what is meant by steady state conditions and efficiency, the basic instrumentation used to monitor the operation of a boiler, how steam temperature is controlled, and the basic procedures for ash handling.

OBJECTIVES

Overview

Explain what steady state conditions for a boiler are.
Describe some of the systems and components that must be monitored during boiler operation under steady state conditions.
Describe typical operator concerns associated with the energy losses that occur during normal operation of a boiler.

Monitoring and Controlling Operations

Describe basic operator responsibilities for monitoring a boiler's steam/water circuit.
Describe typical control room instrumentation that is used to monitor a boiler's steam/water circuit.
Describe basic operator responsibilities for monitoring combustion and the air/gas circuit for a boiler.
Describe typical control room instrumentation that is used to monitor combustion and the air/gas circuit for a boiler.
Describe some of the basic systems and components checks that operators perform during normal boiler operation.
Describe five methods that are used in power plants for controlling steam temperature.

Ash Handling

Describe the basic procedures for removing bottom ash.
Describe the basic procedures for removing fly ash.

SUBJECTS

Overview

Steady State Conditions
Energy Losses

Monitoring and Controlling Operations

The Steam/Water Circuit
The Air/Gas Circuit
Steam Temperature

Ash Handling

Bottom Ash
Fly Ash

STARTUP AND SHUTDOWN
(AOBSS)

OVERVIEW

This is an interactive training module designed to familiarize trainees with basic techniques for starting up and shutting down drum-type boilers. After completing this module, the trainees should be able to describe basic procedures for performing a cold startup of a drum-type boiler, lighting off the furnace, warming up the boiler and establishing the boiler flame. They should also be able to describe basic procedures for shutting down a typical drum-type boiler. In addition, the trainees should be able to compare and contrast the startup and shutdown of a drum-type boiler with the startup and shutdown of a once-through boiler.

OBJECTIVES

Basic Procedures

Describe basic checks that boiler operators make during an initial pre-startup walkthrough.
Describe typical procedures for a cold startup of a controlled circulation, drum-type boiler.
Describe basic preparations for lighting off the furnace, how light-off is initiated, and how a typical boiler is warmed up.
Describe how pulverizers are started up and controlled.
Describe how the main coal burners are ignited and controlled.
Describe the basic procedures for shutting down a typical drum-type boiler.

Once-Through Boilers

Describe the basic differences and similarities between the operation of a once-through boiler and a drum-type boiler.
Describe how a steam/water separation system is used during the startup and the shutdown of a once-through boiler.

SUBJECTS

Basic Procedures

Cold Startup
Light-off and Warmup
Establishing a Boiler Flame
Shutdown

Once-Through Boilers

Basic Operations
Steam/Water Separation

WATER AND STEAM
(A0BWS)

OVERVIEW

This unit begins by explaining why water circulates in a boiler, and describes the flow path of water through a typical drum-type boiler. Differences between natural circulation and controlled circulation are explained, and the components and functions of a typical boiler drum are examined. The unit goes on to explain how the components found in a steam flow path affect the production and use of steam. The unit concludes with a look at what the critical point is, and why some boilers operate at or above critical conditions. Also covered is the operator's role in maintaining the correct steam pressure in drum-type and once-through boilers.

OBJECTIVES

Water

State the purposes of water circulation in a boiler.
Describe the water flow path through a typical drum-type boiler.
Describe the basic principle of natural circulation and two factors that can affect it.
Describe the differences between natural and controlled circulations.
Describe the functions and components of a typical boiler drum.

Steam

Define: *boiling, saturation, temperature,* and *superheat*.
Describe the steam flow path from the boiler to the condenser in a typical generating unit.
State the function of a superheater and describe how superheaters can be classified.
State the function of a desuperheater.
State the function of a reheater and describe how reheaters can be classified.
Describe the basic operation of a condenser.

Supercritical Boilers

Define *critical point*.
Explain why some boilers operate above the critical point.
Describe the flow path of water in a once-through boiler.
State the advantages and disadvantages of a once-through supercritical boiler.
Explain how steam pressure is maintained in drum-type and once-through boilers.

SUBJECTS

Water

Water Flow Path
Circulation
Boiler Drum

Steam

Introduction
Steam Flow Path

Supercritical Boilers

Critical Conditions
Once-Through Boilers
Boiler Operations

BASIC PRINCIPLES
(A00BP)

OVERVIEW

At the completion of this instructional unit, trainees will be able to describe how plant systems respond to changes in load on a unit, and list operator responsibilities during load changes. In addition, trainees will be able to describe the functions of bearings, operation of sliding surface bearings and rolling contact bearings, operator responsibilities associated with bearings, and how bearings are lubricated.

OBJECTIVES

Load Changes

Describe how a plant responds to changes in load on a unit.
Describe the basic responsibilities of an operator during a load change.

Bearings and Lubrication

Describe two major types of bearings.
Describe the basic functions of all bearings.
Describe the operation of a typical sliding surface bearing.
Describe the operation of rolling contact bearings.
Describe some of the basic bearing checks operators perform.
Describe how grease is used as a lubricant.
Describe how oil is used as a lubricant.

SUBJECTS

Load Changes

Plant Responses
Operator Responses

Bearings and Lubrication

Bearings
Lubrication

SAFETY AND POLLUTION CONTROL
(A00SP)

OVERVIEW

Trainees are introduced to plant safety concepts through a discussion of how a combination of plant procedures and common sense are used to protect operators on the job. They are also introduced to potential pollution problems in a power plant and the equipment used to deal with these potential problems.

OBJECTIVES

Plant Safety

Describe some of the basic protective equipment that operators commonly use.
Describe how a tagging system is used to provide protection to personnel working on plant equipment.

Pollution Control

Identify a source of air pollution in a power plant.
Describe some of the techniques used to control air pollution released by a plant.
Identify a source of thermal pollution in a power plant.
Describe operator responsibilities for monitoring thermal pollution leaving the plant.
Identify a major source of water pollution in a power plant.
Describe operator responsibilities for monitoring wastewater leaving the plant.
Describe some of the equipment that can be used to minimize the effects of noise pollution.

SUBJECTS

Plant Safety

Personal Protection
Plant Safety

Pollution Control

Air Pollution
Thermal Pollution
Water Pollution
Noise Pollution

BOILER AND TURBINE PROTECTION

(AOPPB)

OVERVIEW

This unit describes the basic operation and startup requirements of a balanced-draft, controlled circulation, drum-type boiler. It also identifies common problems that affect the combustion side of a boiler and the water and steam side of a boiler, and it describes automatic controls and operator actions that address those problems. The unit goes on to describe common turbine problems, including temperature- and pressure-related problems, overspeed, vibration and eccentricity. Automatic protective devices and operator actions that address those problems are also described.

OBJECTIVES

Boilers

Describe the basic operation of a balanced-draft, controlled circulation, drum-type boiler.
Identify and describe the basic requirements for starting up a boiler.
Identify common boiler combustion problems.
Describe automatic controls that regulate the combustion process.
Describe actions that operators can take to address combustion problems.
Identify automatic protective devices associated with the combustion process.
Identify common problems that occur on the water and steam side of a boiler.
Describe actions that operators can take to address water and steam problems.
Identify automatic protective devices associated with the boiler steam/water cycle.

Turbines

Identify common temperature-related and pressure-related turbine problems.
Describe actions that operators can take to address turbine problems related to temperature and pressure.
Identify automatic protective devices associated with temperature and pressure problems.
Describe turbine problems associated with overspeed, vibration and eccentricity.
Describe actions that operators can take to address overspeed, vibration and eccentricity problems.
Identify automatic protective devices associated with overspeed, vibration and eccentricity problems.

SUBJECTS

Boilers

Basic Operation and Startup
Combustion Problems
Water and Steam Problems

Turbines

Temperature and Pressure Problems
Overspeed, Vibration and Eccentricity

FUNDAMENTALS
(A0PPF)

OVERVIEW

This interactive training unit is designed to familiarize trainees with various types of hazards that may exist in a power plant. After completing this unit, the trainees should be able to identify common types of mechanical and electrical hazards, temperature and pressure hazards, and fire and chemical hazards. They should also be able to describe devices and techniques that can be used to prevent or minimize these hazards.

OBJECTIVES

Mechanical & Electrical
- Describe conditions that commonly lead to material and equipment failure.
- Identify ways to detect equipment failure.
- Describe common electrical hazards in a power plant.
- Identify devices used to prevent or minimize electrical hazards.

Temperature & Pressure
- Identify devices used to prevent abnormal temperature conditions.
- Identify devices used to prevent abnormal pressure conditions.

Chemical & Fire
- Identify common chemical hazards in a power plant
- Identify ways to prevent chemical hazards.
- Describe fire protection systems commonly found in power plants.

SUBJECTS

Mechanical & Electrical
- Equipment Failure
- Electrical Hazards

Temperature & Pressure
- Abnormal Temperature
- Abnormal Pressure

Chemical & Fire
- Chemical Hazards
- Fire Protection

INTEGRATED SYSTEMS
(AOPPI)

OVERVIEW

In this unit, trainees will learn what logic diagrams are and how they are used to represent the functions carried out by plant protection equipment. Common types of logic gates are identified and described, and interlock logic is examined. The unit also describes how logic diagrams can be used to represent conditions that cause boiler trips, turbine trips and generator trips, and it explains how the protection systems for boilers, turbines and generators are interrelated.

OBJECTIVES

Logic Diagrams

Describe what logic diagrams are and how they can be used to represent functions carried out by plant protection equipment.
Describe the functions of AND gates, OR gates, NOT gates and time delay (TD) gates in logic circuits.
Describe what interlocks are and how the actions of interlocks associated with boiler operations are represented in logic diagrams.

Trip Logic

Describe how logic diagrams can be used to represent conditions that cause equipment trips.
Identify conditions that can cause a boiler trip and describe how a logic diagram can be used to illustrate those conditions.
Identify conditions that can cause a turbine trip and describe how a logic diagram can be used to illustrate those conditions.
Identify conditions that can cause a generator trip and describe how a logic diagram can be used to illustrate those conditions.
Describe how the protection systems for boilers, turbines and generators are interrelated.

SUBJECTS

Logic Diagrams

Overview
Logic Gates
Interlock Logic

Trip Logic

Boiler Trips
Turbine Trips
Generator Trips
Integrated Protection

CONDENSATE AND FEEDWATER SYSTEMS

(A0CFS)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic layout of a typical condensate and feedwater system and the basic operation of the system's individual components. After completing this unit, trainees should be able to identify the components in a condensate and feedwater system and describe the basic operation of each component. They should also be able to explain how the system normally operates, describe operator responsibilities associated with normal operation, and identify some common operating problems.

OBJECTIVES

System Overview

Describe the basic layout of a typical condensate and feedwater system.

Describe the basic function and operation of the individual components in a typical condensate and feedwater system.

System Operation

Describe the normal operation of a typical condensate and feedwater system and identify typical operator responsibilities that are associated with normal operation.

Identify and describe some common operating problems that may occur in a condensate and feedwater system and describe basic steps for dealing with these problems.

SUBJECTS

System Overview

System Layout
System Components

System Operation

Normal Operation
Operating Problems

CONDENSER AND CIRCULATING WATER

(AOPPC)

OVERVIEW

This training unit provides basic information about the design and function of power plant condensers and circulating water systems. It describes the operation of a single-pass condenser and a two-pass condenser, as well as various air removal system components. The unit also covers the basic operation of a once-through circulating water system, and it describes how mechanical draft cooling towers and natural draft cooling towers work.

OBJECTIVES

Condensers

Describe the basic function of a condenser.
Describe the operation of a single-pass condenser and a two-pass condenser.
Describe the basic function of an air removal system.
Describe the operation of a reciprocating vacuum pump, a rotary vacuum pump and an air ejector.
Identify and describe routine checks that operators should perform on a condenser.

Circulating Water Systems

Describe the basic operation of a once-through circulating water system.
Describe how mechanical draft cooling towers and natural draft cooling towers function.

SUBJECTS

Condensers

Function and Design
Air Removal Systems
Condenser Operation

Circulating Water Systems

Once-Through Systems
Cooling Towers

POWER AND ENERGY
(A0PPE)

OVERVIEW

This unit will introduce trainees to basic components of a power system and describe how these components are arranged to deliver power to customers. It will also examine the energy conversions that are necessary to produce power in a power plant and discuss basic principles of how an operator responds to emergency conditions.

OBJECTIVES

The Power System

State the function of a generator.
Define the following terms: *unit, watt,* and *megawatt*.
Describe how power is typically distributed to customers.
Define the following terms: *switchyard, substations,* and *power system*.
Define *demand*.
Describe the function of the load dispatcher.
Explain why there are variations in demand.
Explain why supply must always equal demand.

Energy Conversion

Explain how energy is converted to produce electricity in fossil fuel plants.
State some of the advantages and disadvantages of fossil fuel plants.
Explain how energy is converted to produce electricity in gas turbine plants.
State some of the advantages and disadvantages of gas turbine plants.
Explain how energy is converted to produce electricity in nuclear plants.
State some of the advantages and disadvantages of nuclear plants.

SUBJECTS

The Power System

Generating Power
Distributing Power
Demand

Energy Conversion

Fossil Fuel Plants
Gas Turbine Plants
Hydroelectric Plants
Nuclear Power Plants

POWER GENERATION
(AOPGE)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic operation of an AC generator and auxiliary systems and components associated with it. After completing this unit, trainees should be able to explain how voltage is induced in an AC generator, how an AC generator produces current, and how an AC generator can be cooled.

OBJECTIVES

Generating Electricity

Name the basic parts of a generator and describe the function of each in inducing voltage.
Describe the primary difference between a single-phase generator and a three-phase generator.
Name two factors that determine the frequency of the current produced by a generator.
Explain why the frequency of a generator's output must be controlled.
Explain the function of the exciter in a generator.
Name the parts of a DC exciter and the parts of a brushless exciter and describe their functions.

Generator Cooling

Explain why a large generator is typically cooled with hydrogen instead of air.
Explain the function of an oil seal in a hydrogen-cooled generator.
Describe how hydrogen is supplied to a generator cooling system.
Explain the purpose of each of the following components in a hydrogen generator cooling system: purity analyzer, core monitor, hydrogen dryer, liquid detector.
Explain how carbon dioxide and air are used to purge a generator cooling system.
Describe the flow of water in a typical stator cooling system.
Describe the function of each of the following components in a typical stator cooling system: temperature control valve, pressure control valve, demineralizer.

SUBJECTS

Generating Electricity

Principles of Induction
Output Frequency
Generator Excitation

Generator Cooling

Hydrogen Cooling
Cooling Auxiliary Systems
Gas Purging
Stator Cooling System

STEAM CYCLE
(A0PSC)

OVERVIEW

In this unit, main components of the steam cycle in a fossil fuel fired power plant will be identified. The unit will also trace the order in which steam and water flow through these components in order to show how the components are arranged.

OBJECTIVES

Components

Describe how a boiler works.
Describe how fuel and air are supplied to a boiler.
Describe how a turbine works.
Describe how a condenser works.
Describe the function of the condensate-feedwater system.
Describe the function of the circulating water system.
Describe the function of the makeup water system.

Flow

Describe how steam and water move through the steam cycle.
Describe how the flow of steam and the flow of water are controlled.
Describe how the flow of fuel to the boiler can be controlled.
Describe three general actions that must be taken during any emergency.
Describe the emergency actions that must be taken if there is a loss of flame in the boiler.

SUBJECTS

Components

Boilers
Turbines
Condensers

Flow

Movement of Steam and Water
Steam and Water Flow Control
Fuel Flow Control
Emergencies

STEAM SYSTEMS
(AOPPS)

OVERVIEW

This is an interactive training module designed to present basic information on the steam/water cycle in a power plant. Specific attention is directed to the main steam system, the reheat steam system, the extraction steam system and the auxiliary steam system. Basic procedures for a plant startup and several operator checks on steam systems and components are also included.

OBJECTIVES

Systems and Components

Describe how steam flows through the various steam systems that make up a typical power plant's steam/water cycle.
Identify the components of a main steam system and describe their functions.
Identify the components of a reheat steam system and describe their functions.
Explain why steam piping contains expansion loops and bends.
Identify the components of an extraction steam system and describe their functions.
Explain how an extraction steam system improves plant efficiency.
Describe typical uses of auxiliary steam in a power plant.
Identify some typical components of an auxiliary steam system and describe their functions.
Describe how the components that control the pressure and temperature of auxiliary steam operate.

Systems Operations

Describe some basic procedures for removing accumulated condensate and gradually warming up steam systems components during a plant startup.
Describe some basic checks that operators should make to ensure that steam systems and their components are operating properly.

SUBJECTS

Systems and Components

Steam/Water Cycle
Main Steam System
Reheat Steam System
Extraction Steam System
Auxiliary Steam System

Systems Operations

Plant Startup
Systems Inspections

BEARINGS AND OPERATION

(A0TB0)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic principles associated with turbine shaft bearing lubrication, turbine speed control, and turbine operation. After completing this unit, trainees should be able to identify and describe the functions of the components of a typical turbine lube oil system. They should also be able to describe the basic components and operation of a typical turbine speed control system. In addition, they should be able to describe operator responsibilities associated with turbine startup, operation, and shutdown.

OBJECTIVES

Bearing Lubrication

State the functions of the following basic components typically found in a turbine lube oil system: reservoir, main lube oil pump, booster pump, and lube oil coolers.

State the functions of the following additional components typically found in a turbine lube oil system: AC auxiliary pump, DC emergency pump, AC turning gear pump, and vapor extractor.

Explain why it is important to make sure that the controllers for the standby oil pumps are in the *standby* or *automatic* positions.

Describe a situation in which increase in bearing oil temperature could indicate a problem.

Describe a situation in which an increase in bearing oil temperature is considered normal.

Turbine Control

Identify two major systems commonly used to control turbine speed.

Describe the basic components of a turbine speed control system.

Describe how turbine speed is controlled by a mechanical-hydraulic control system with a flyweight governor.

Describe what happens when a turbine trip occurs.

Turbine Operation

Explain why the warmup period is important.

Explain why it is important to prevent water buildup and describe how this is done.

Describe the steps involved in a typical shutdown procedure.

SUBJECTS

Bearing Lubrication

Basic Components
Additional Components
Operator Responsibilities

Turbine Control

Basics
Example

Turbine Operation

Startup
Normal Operation and Shutdown

STEAM FLOW
(AOTSF)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic principles associated with the construction and operation of steam turbines. After completing this unit, trainees should be able to state the functions of the main parts of a typical turbine and describe how steam causes impulse blades and reaction blades to turn a turbine's wheels. They should also be able to describe the purpose and operation of a gland steam seal system, a gland steam seal exhaust system, a carbon seal, and a water seal.

OBJECTIVES

Construction and Rotation

State the functions of the following turbine parts: *wheels, blades, diaphragms, steam chest, nozzle block,* and *rotor.*
State the functions of stop valves and control valves.
Describe how steam causes impulse blades to turn a turbine's wheels.
Describe how steam causes reaction blades to turn a turbine's wheels.
State the functions of reheat stop valves and intercept valves.
Define a turbine trip and describe how it protects a turbine.

Sealing Systems

Describe the purpose for and operation of a gland steam seal system.
Describe the purpose for and operation of a gland steam seal exhaust system.
Describe the operation of a carbon seal.
Describe the operation of a water seal.

SUBJECTS

Construction and Rotation

Construction
Rotation

Sealing Systems

Steam Seals
Carbon and Water Seals

Process Sampling

OBTAINING SAMPLES
(A0P0S)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic concepts associated with obtaining samples of process materials. After completing this unit, trainees should be able to describe hazards associated with sampling and the precautions that may be required. They should also be able to take contaminant-free representative samples of process liquids, solids, and gases.

OBJECTIVES

Introduction

Explain why samples are taken in process systems.
Describe some hazards associated with sampling materials.
Describe protective clothing that should be worn when taking samples of hazardous and non-hazardous materials.
Describe two types of respirators worn when sampling involves materials that produce harmful dust particles or toxic fumes.

Liquids

Describe how to keep liquid samples from being contaminated when they are taken.
Explain how to make sure that a representative sample of a liquid is obtained.
Describe information typically included on a sample label.

Solids and Gases

Describe how to obtain contaminant-free representative samples of process solids.
Describe how to obtain contaminant-free representative samples of process gases.

SUBJECTS

Introduction

Basic Principles
Protective Clothing
Respirators

Liquids

Preparing to Sample
Obtaining a Sample
Labeling a Sample

Solids and Gases

Sampling Solids
Sampling Gases

TESTING SAMPLES
(AOPTS)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic procedures for performing tests on samples of process materials and products. After completing this unit, trainees should be able to describe how to perform a pH test, a percent solids test, a specific gravity test, and a titration. They should also be able to describe the operation of a gas chromatograph and how it is used to perform tests on complex gas mixtures or solutions.

OBJECTIVES

pH and Percent Solids
Describe how a pH test is performed.
Describe how a percent solids test is performed.

Specific Gravities and Titrations
Describe how a specific gravity test is performed.
Describe how a titration is performed.

Gas Chromatographs
Describe how a gas chromatograph operates.
Describe how to perform a gas chromatograph test.

SUBJECTS

pH and Percent Solids
pH Tests
Percent Solids Tests

Specific Gravities and Titrations
Specific Gravity Tests
Titrations

Gas Chromatographs
Operation
Performing a Test

Pumps

BASIC TYPES AND OPERATION
(A0PBT)

OVERVIEW

This interactive training unit is designed to introduce trainees to the basic components and operation of positive displacement pumps and centrifugal pumps. After completing this unit, trainees should be able to explain how pumps can be identified, identify the basic components of a pump, and describe the functions of various types of pump auxiliary equipment and systems. They should also be able to describe the general operation of reciprocating and rotary positive displacement pumps, and single-stage and multistage centrifugal pumps.

OBJECTIVES

Pump Fundamentals

Given a simple system diagram, locate each pump, tell what it does, and identify it by one or more names.
Identify the casing, the inlet, and the outlet on a pump.
Name two general categories of pumps.
Explain the functions of the following types of pump auxiliary equipment and systems drivers, couplings, strainers, lubricating systems, packing, and mechanical seals.

Positive Displacement Pumps

Describe the general operation of a reciprocating positive displacement pump.
Describe the general operation of a rotary positive displacement pump.

Centrifugal Pumps

Describe the general operation of a single-stage centrifugal pump.
Describe the general operation of a multistage centrifugal pump.

SUBJECTS

Pump Fundamentals

Pump Identification
Pump Components
Auxiliary Equipment

Positive Displacement Pumps

Reciprocating Pumps
Rotary Pumps

Centrifugal Pumps

Single-Stage Pumps
Multistage Pumps

PERFORMANCE AND INSPECTION

(AOPER)

OVERVIEW

This interactive training unit is designed to introduce trainees to factors that affect the performance of pumps and some of the symptoms of improper pump operation. After completing this unit, trainees should be able to identify and explain the relationship between various factors that affect pump performance, and to explain how pump performance can be evaluated. They should also be able to identify symptoms of some common pump problems and explain how to check a pump for signs of problems such as leaks and cavitation.

OBJECTIVES

Pump Performance

Define and explain the relationship between the following: *static head, dynamic head, suction head, discharge head*, and *total head*.
Describe some basic ways pump performance can be determined.
Explain the relationship between minimum net positive suction head and cavitation.

Pump Inspection

Identify symptoms that may indicate abnormal pump operation.
Identify pump components that should be checked for leaks.
Describe common symptoms of cavitation.
List some ways to stop or minimize cavitation.

SUBJECTS

Pump Performance

Head
Suction Head and Cavitation

Pump Inspection

Symptoms of Pump Problems
Checking for Leaks
Checking for Cavitation

RECIPROCATING POSITIVE AND DISPLACEMENT TYPES
(AOPRE)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic parts and operation of several types of reciprocating positive displacement pumps. After completing this unit, trainees should be able to describe the general operation of the following types of pumps: single-acting piston pumps, single-acting plunger pumps, double-acting piston pumps, duplex piston pumps, motor-driven diaphragm pumps, and air-operated diaphragm pumps. Trainees should also be able to describe a general procedure for starting up and shutting down a typical reciprocating pump, and to explain the function and operation of a relief valve.

OBJECTIVES

Piston and Plunger Pumps
- Describe the general operation of a single-acting piston pump.
- Describe the general operation of a plunger pump.
- Describe the general operation of a double-acting piston pump.
- Describe the general operation and an advantage of a duplex piston pump.

Diaphragm Pumps
- Describe the general operation of a motor-driven diaphragm pump.
- Describe the general operation of an air-operated diaphragm pump.

Pump Operation
- Describe a general procedure for starting up a reciprocating pump.
- Describe a general procedure for shutting down a reciprocating pump.
- Explain the purpose of a relief valve.

SUBJECTS

Piston and Plunger Pumps
- Single-Acting Pumps
- Double-Acting Pumps
- Duplex Pumps

Diaphragm Pumps
- Motor-Driven Diaphragm Pumps
- Air-Operated Diaphragm Pumps

Pump Operation
- Pump Startup and Shutdown
- Relief Valves

ROTARY POSITIVE DISPLACEMENT TYPES

(AOPRP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic parts and operation of several types of rotary positive displacement pumps. After completing this unit, trainees should be able to describe the general operation of the following types of pumps: screw pumps, gear pumps, lobe pumps, vane pumps, and tubing pumps. They should also be able to describe a general procedure for starting up and shutting down a typical rotary pump, and to explain the function and operation of a relief valve.

OBJECTIVES

Types of Rotary Pumps

Describe the general operation of a progressive cavity pump.
Describe the general operation of a two-screw pump.
Describe the general operation of an external gear pump and an internal gear pump.
Describe the general operation of a lobe pump.
Describe the general operation of a sliding vane pump and a flexible vane pump.
Describe the general operation of a tubing pump.

Operating Procedures

Describe procedures involved in starting up a rotary positive displacement pump.
Describe procedures involved in shutting down a rotary positive displacement pump.
Explain the purpose of a relief valve.

SUBJECTS

Types of Rotary Pumps

Screw Pumps
Gear and Lobe Pumps
Vane Pumps
Tubing Pumps

Operating Procedures

Rotary Pump Startup and Shutdown
Relief Valves

FUNDAMENTALS OF CENTRIFUGAL TYPES
(A0PFC)

OVERVIEW

This interactive training unit is designed to introduce trainees to the fundamental operating principles of single-stage and multistage centrifugal pumps. After completing this unit, trainees should be able to describe the general operating principles of a centrifugal pump. Specifically, they should be able to describe the differences between radial, axial, and mixed flow pumps, and describe the basic operation of a vertically-mounted and multistage pump. Trainees should also be able to describe the purpose and the basic operation of a mechanical seal flush system.

OBJECTIVES

Centrifugal Pump Operation

Describe general operating principles of a centrifugal pump.
Explain differences between radial flow, axial flow, and mixed flow pumps.
Explain the principles of operation of a vertically mounted centrifugal pump.
Describe the basic operation of a typical multistage centrifugal pump.
Describe two ways that multistage centrifugal pumps can minimize axial thrust.

Centrifugal Pump Components

Explain the differences between an open impeller, a closed impeller, and a semi-open impeller.
Compare and contrast a single-suction impeller and a double-suction impeller.
Describe the general design and function of a diffuser.
Describe the purpose and basic operation of a mechanical seal flush system.

SUBJECTS

Centrifugal Pump Operation

Principles of Operation
Vertical Pumps
Multistage Pumps

Centrifugal Pump Components

Impellers and Diffusers
Mechanical Seal Systems

OPERATION OF CENTRIFUGAL TYPES

(AOPOC)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic operation of centrifugal pumps. After completing this unit, trainees should be able to describe techniques for priming a centrifugal pump and explain general procedures for starting and shutting down a pump. Trainees should also be able to describe some general checks that may be made on an operating pump and describe operator concerns related to air and vapor binding in a centrifugal pump.

OBJECTIVES

Startup and Shutdown

Describe techniques used to prime a centrifugal pump.
Describe a procedure for starting up a centrifugal pump.
Describe a procedure for shutting down a centrifugal pump.

Pump Operation

Describe checks that should be made on an operating centrifugal pump and its auxiliary equipment.
Describe indications of air binding and vapor binding in a pump and some of the possible sources of in-leakage to a pump.

SUBJECTS

Startup and Shutdown

Priming
Pump Startup and Shutdown

Pump Operation

Operator Checks
Air Binding and Vapor Binding

Refrigeration Systems

BASIC CONCEPTS

(AORBC)

OVERVIEW

This interactive training unit is designed to introduce trainees to some of the basic principles of refrigeration system operation. After completing this unit, trainees should be able to explain what refrigeration is and how heat transfer occurs in a refrigeration system. They should also be able to describe the basic parts, or steps, of a refrigeration cycle and explain how these steps can be carried out by specific refrigeration system components.

OBJECTIVES

Fundamentals

Define *refrigeration*.
Explain what a refrigerant is.
Explain the basic difference between sensible heat transfer and latent heat transfer.
Describe how pressure and temperature can affect heat transfer.
Define *heat source* and *heat sink*.

Refrigeration Systems

Describe the processes involved in a typical refrigeration cycle.
Describe the devices that accomplish the basic functions of a typical refrigeration cycle.
Explain how a refrigeration system can be used with a secondary cooling system.

SUBJECTS

Fundamentals

Introduction to Refrigeration
Heat Transfer

Refrigeration Systems

Basic Refrigeration Cycle
Refrigeration Components
Secondary Cooling Systems

OPERATION
(AOROP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the operation of vapor compression refrigeration systems and absorption refrigeration systems. After completing this unit, trainees should be able to describe the components and operations of a vapor compression system and an absorption system. They should also be able to describe control devices, indicating instruments, and operator checks associated with these systems, and identify some operating problems that may occur.

OBJECTIVES

Types of Systems

Identify the components of a typical vapor compression refrigeration system.
Describe the operation of a vapor compression refrigeration system.
Describe the operation of one type of absorption refrigeration system.

System Operation

Describe some control devices commonly used with refrigeration systems.
Describe some monitoring and indicating instruments commonly used with refrigeration systems.
Describe some operator checks commonly performed on a refrigeration system.
Identify some operating problems that may occur in a typical refrigeration system.

SUBJECTS

Types of Systems

Vapor Compression System
Absorption System

System Operation

Controls
Indicators and Checks
Operating Problems

Statistical Process Control

INTRODUCTION
(AOSIN)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the basic principles of Statistical Process Control (SPC). After completing this unit, trainees should be able to explain what SPC is and how it can be applied to a process. They should also be able to describe the basic elements of an SPC control chart and relate an SPC control chart to an X-Y graph and to a normal distribution curve.

OBJECTIVES

What is SPC?
- Define quality in terms of the process industry.
- Explain what Statistical Process Control (SPC) is.
- Describe the benefits of SPC.
- Describe how SPC was developed.

Applying SPC
- Describe what a process is.
- Identify factors that affect a process.
- Describe the two basic types of variation in a process.
- Identify factors that affect how SPC is applied to a process.

Charts
- Describe how to plot values on a basic X-Y graph.
- Explain what a histogram is and how it relates to SPC control charts.
- Explain what a standard deviation is.
- Identify the basic elements of a typical Shewhart control chart.
- Relate a Shewhart control chart to a normal distribution curve.

SUBJECTS

What is SPC?
- SPC and Product Quality
- Origin of SPC

Applying SPC
- Factors Affecting a Process
- Application to a Process

Charts
- X-Y Graph
- Histogram
- Shewhart Control Chart

BASIC CONTROL CHARTS
(AOSBC)

OVERVIEW

This interactive training unit is designed to familiarize trainees with some of the basic control charts used in Statistical Process Control (SPC). After completing this unit, trainees should be able to describe the characteristics of X charts, R charts, moving X charts, moving R charts, and individual X charts. They should also be able to explain what each chart represents and how to plot values on each chart.

OBJECTIVES

Control Charts - 1

Describe how SPC is helpful in responding to an out-of-control process.
Explain what X charts represent.
Describe how to plot values on an X chart.
Explain what R charts represent.
Describe how to plot values on an R chart.
Explain why an X and an R chart are commonly used together.
Describe how to recognize abnormal variations on X charts and R charts.

Control Charts - 2

Describe the characteristics of moving X charts.
Describe how to plot values on a moving X chart.
Describe the characteristics of moving R charts.
Describe how to plot values on a moving R chart.
Describe the characteristics of individual X charts.
Describe how to plot values on an individual X chart.

SUBJECTS

Control Charts - 1

SPC and Control Charts
X Charts
R Charts
Examples

Control Charts - 2

Moving X Charts
Moving R Charts
Individual X Charts

PROCESS VARIATIONS
(AOSPV)

OVERVIEW

This interactive training unit is designed to familiarize trainees with some basic techniques for using Statistical Process Control (SPC) to recognize and respond to variations in plant processes. After completing this unit, trainees should be able to describe how plotted values on control charts can be interpreted, describe how an operator can use SPC to recognize and respond to out-of-control conditions and process instability, describe basic considerations for using SPC with a computer, and explain how to use various types of attribute charts.

OBJECTIVES

Control Charts

Describe how plotted values on control charts can be interpreted.
Describe common patterns of instability and identify conditions that can cause these patterns to occur.

Operating with SPC

Describe how an operator can use SPC to recognize and respond to problems in a process.
Define CUSUM and explain how it can be used.
Describe how using CUSUM compares to using control charts.
Describe two common causes of an off-aim condition.
Describe how to reset CUSUM and how to set a new aim.

Attribute Charts

Define the terms *defect* and *defective product*.
Describe how to use C charts, U Charts, NP charts, and P charts.

SUBJECTS

Control Charts

Interpreting Charts
Recognizing Patterns

Operating With SPC

Using SPC
CUSUM

Attribute Charts

Types of Charts

Troubleshooting

BASIC CONCEPTS

(AOPOB)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with troubleshooting a problem in a process system. After completing this unit, trainees should be able to explain what troubleshooting is, and how it can be carried out as a systematic, logical procedure. They should also be able to explain how to apply the major steps of a basic troubleshooting procedure to a problem in a process.

OBJECTIVES

Introduction

Define *troubleshooting*.
Identify and describe the main steps involved in troubleshooting.
Identify various sources of information that can be used for troubleshooting.
Explain how the following process of elimination methods are applied in troubleshooting: input/output testing, bracketing, the serial method, and the half-splitting method.

Troubleshooting

Describe a basic wastewater treatment process.
Describe how to troubleshoot a problem in a wastewater treatment process.

SUBJECTS

Introduction

What is Troubleshooting?
Process of Elimination

Troubleshooting

Process
Problem

PROCESS EXAMPLES
(AOPOP)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with troubleshooting problems in process systems. After completing this unit, trainees should be able to follow a logical, systematic troubleshooting procedure to identify and correct process problems.

OBJECTIVES

Exercise 1 - Tank Level

Describe how troubleshooting techniques can be used to find and correct a problem in a process system. The system in this example transfers liquid from a storage tank to a process feed tank.

Exercise 2 - Fluid Transfer

Describe how troubleshooting techniques can be used to find and correct a problem in a process system. The system used in this example transfers feed material to a distillation process.

Exercise 3 - Process Column

Describe how troubleshooting techniques can be used to find and correct a problem in a process system. The system used in this example is a distillation process.

SUBJECTS

Exercise 1 - Tank Level

Exercise 2 - Fluid Transfer

Exercise 3 - Process Column

Valves

BASIC TYPES AND OPERATION I

(AOVB1)

OVERVIEW

This interactive training unit is designed to introduce trainees to the basic parts and operation of valves commonly used in process systems. After completing this unit, trainees should be able to describe the purpose and uses of valves in process systems, identify the main parts of a typical valve, and describe the function of each part. They should also be able to describe the specific uses, parts, and operation of gate valves, globe valves, plug valves, ball valves, and butterfly valves.

OBJECTIVES

Introduction to Valves

Describe purposes and uses of valves in process systems.
Describe how valves are lined up.
Identify main parts of a typical valve and their functions.
Describe flanged, threaded, and welded methods of attaching valves to piping systems.
Describe the locations of typical valve leaks and how to stop a packing leak.
Describe one method of lubricating a typical valve.

Valve Types

Describe the function and operation of gate valves.
Describe typical applications of gate valves.
Describe the functions and operation of globe and needle valves and their typical applications.
Identify a plug valve and describe its function and operation.
Identify a three-way and a four-way valve and describe their function and operation.
Describe typical applications of plug valves.
Identify a ball valve and describe its function and operation.
Describe typical applications of ball valves.
Identify a butterfly valve and describe its function and operation.
Describe typical applications of butterfly valves.

SUBJECTS

Introduction to Valves

Valves and the Process System
Valve Parts
Valve Problems and Maintenance

Valve Types

Gate Valves
Glove Valves
Plug Valves
Ball Valves
Butterfly Valves

BASIC TYPES AND OPERATION 2

(AOVB2)

OVERVIEW

This interactive training unit is designed to introduce trainees to some valves that are commonly used to isolate components, to throttle flow, to prevent reverse flow through a process system, and to protect systems from overpressure conditions. After completing this unit, trainees should be able to identify and describe the basic functions and operation of diaphragm valves, pinch valves, and check valves. They should also be able to explain how relief valves and safety valves protect system equipment and piping from excessive pressure.

OBJECTIVES

Valve Types

Identify a diaphragm valve and describe its functions and operation.
Identify a pinch valve and describe its functions and operation.
Identify swing check valves, lift check valves, and ball check valves, and describe their functions and operation.

Relief and Safety Valves

Describe the function and operation of relief valves.
Describe typical uses of relief valves.
Describe the function and operation of safety valves.
Describe typical uses of safety valves.

SUBJECTS

Valve Types

Diaphragm Valves
Pinch Valves
Check Valves

Relief and Safety Valves

Relief Valves
Safety Valves

INTRODUCTION TO ACTUATORS

(AOVIA)

OVERVIEW

This interactive training unit is designed to introduce trainees to actuators in general, and pneumatic actuators, in particular. After completing this unit, trainees should be able to identify and describe three basic types of actuators and explain how actuators position control valves. They should also be able to describe the basic design and operation of single- and double-acting diaphragm actuators, single- and double-acting piston actuators, van actuators, and positioners. Finally, trainees should be able to describe some common actuator problems.

OBJECTIVES

Actuators and Control Valves

Define *actuator* and describe three basic types of actuators.
Describe the function of an actuator.
Describe the function of a controller.
Describe the function of a control valve.

Pneumatic Actuators

Describe the basic design and operation of single-acting diaphragm and double-acting actuators.
Describe the basic operation of single-acting and double-acting piston actuators.
Describe the basic operation of a vane actuator.
Describe the function and basic operation of a positioner.
Describe some ways to identify actuator problems.
Describe some ways that an operator can identify actuator problems.
Describe a general procedure for handling a control valve failure.

SUBJECTS

Actuators and Control Valves

Types of Actuators
Control Valves

Pneumatic Actuators

Single-Acting Diaphragm Actuators
Double-Acting Diaphragm Actuators
Single- and Double-Acting Piston Actuators
Van Actuators
Positioners
Actuator Problems

ELECTRIC AND HYDRAULIC ACTUATORS

(AOVEH)

OVERVIEW

This interactive training unit is designed to introduce trainees to various types of electric and hydraulic actuators that are used to control valves in process systems. After completing this unit, trainees should be able to describe the basic operation of solenoid actuators, motor-operated actuators, and various types of hydraulic actuators. They should also be able to explain the function of a pilot valve and describe problems associated with hydraulic actuators.

OBJECTIVES

Electric Actuators

Describe the basic operation of a solenoid actuator.
Describe the basic operation of a motor-operated actuator.
Describe the function of torque switches.
Describe the function of limit switches.

Hydraulic Actuators

Describe the operation of a single-acting, spring-return hydraulic actuator.
Describe the basic operation of a double-acting hydraulic actuator.
Describe the function of a pilot valve.
Describe some ways to identify actuator problems.

SUBJECTS

Electric Actuators

Solenoid Actuators
Motor-Operated Actuators

Hydraulic Actuators

Single-Acting Hydraulic Actuators
Double-Acting Hydraulic Actuators
Pilot Valves
Hydraulic Actuator Problems

Water Treatment

WATER FOR PLANT SYSTEMS I
(A0WW1)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with primary water treatment and chlorination. After completing this unit, trainees should be able to describe problems that can be caused by impurities in the water used in plant systems and explain how some of these impurities can be removed by screens, clarifiers, and filters. They should also be able to explain why and how chlorine is used in water treatment.

OBJECTIVES

Primary Water Treatment

Describe primary and secondary water treatment and the uses of water after each treatment.
Describe problems with plant equipment that can be caused by dissolved solids, dissolved gases, and suspended solids.
Describe organic and inorganic suspended solids.
Describe the function and operation of screens.
Describe the function and operation of clarifiers.
Describe the coagulation, flocculation, and settling stages of clarification.
Describe the function and operation of filters.

Chlorination

Describe some of the effects that micro-organisms can have on plant equipment.
Describe the functions and operation of a typical chlorine evaporator and a typical chlorinator.
Describe safety precautions associated with operations involving chlorine.

SUBJECTS

Primary Water Treatment

Introduction
Screens
Clarifiers
Filters

Chlorination

Micro-Organisms
Chlorine Addition Equipment
Safety Precautions

WATER FOR PLANT SYSTEMS 2

(A0WW2)

OVERVIEW

This interactive training unit is designed to familiarize trainees with the process of removing dissolved solids and gases from water, and with the safe use of chemicals in water treatment. After completing this unit, trainees should be able to describe ways in which dissolved solids and gases can cause problems in plant equipment. They should also be able to describe how these impurities can be removed by devices such as water softeners, demineralizers, activated carbon filters, aerators, and de-aerators. In addition, trainees should be able to explain how chemicals are used in water treatment and identify safety precautions for the use of chemicals.

OBJECTIVES

Dissolved Solids Removal

Describe ways in which dissolved solids can cause problems in plant equipment.
Describe the general function and operation of a water softener.
Describe the general function and operation of a demineralizer.

Dissolved Gas Removal

Describe ways in which dissolved gases can cause problems in plant equipment.
Describe how gases such as oxygen, carbon dioxide, and hydrogen sulfide become dissolved in water.
Describe ways that corrosion can be prevented or controlled.
Describe the general function and operation of an activated carbon filter.
Describe the general function and operation of an aerator.
Describe the general function and operation of a de-aerator.

Chemical Treatment

Describe how corrosion inhibitors, scale inhibitors, and other chemicals are used in treating water.
Describe the general operation of a chemical injection pump.
Describe safety precautions that should be taken when working around chemicals.

SUBJECTS

Dissolved Solids Removal

Dissolved Solids
Water Softeners
Demineralizers

Dissolved Gas Removal

Dissolved Gases
Carbon Filters
Aerators
De-aerators

Chemical Treatment

Chemicals in Water Treatment
Chemical Safety

WASTEWATER I
(AOWTI)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with treating industrial wastewater to prepare it for safe discharge and reuse. After completing this unit, trainees should be able to describe processes and equipment typically used for wastewater collection and primary treatment, describe the use of chemical precipitation and dissolved air flotation in intermediate treatment, and describe the use of activated sludge in secondary treatment.

OBJECTIVES

Primary Treatment

Explain what wastewater is, where it comes from, and why it must be treated.
Define the following terms: *sewer, sewage*, and *effluent*.
Describe processes and equipment typically used in wastewater collection and primary treatment.
Explain why the pH of water may have to be adjusted.
Describe the process of clarification and explain how an upflow clarifier works.

Intermediate Treatment

Describe how clarification is used with chemical precipitation to remove some types of dissolved materials.
Describe the principles of operation for dissolved air flotation.

Secondary Treatment

Define the following terms: *micro-organisms, return activated sludge, waste activated sludge*, and *mixed liquor*.
Describe the activated sludge process.
Explain the basic requirements that must be met in order for micro-organisms to work efficiently in the activated sludge process.
Define *sludge handling*.
Describe some typical methods of sludge handling.

SUBJECTS

Primary Treatment

Introduction to Wastewater
Wastewater Flow and Screening
Equalization and pH Adjustment
Clarification

Intermediate Treatment

Chemical Precipitation
Dissolved Air Flotation

Secondary Treatment

The Activated Sludge Process
Sludge Handling

WASTEWATER 2
(A0WT2)

OVERVIEW

This interactive training unit is designed to familiarize trainees with basic concepts associated with treating industrial wastewater so that it can be safely reused or discharged into the environment. After completing this unit, trainees should be able to describe how filtration and activated carbon adsorption can be used in tertiary treatment, and how final effluent quality standards affect the discharge of wastewater from an industrial facility. They should also be able to describe general operator responsibilities associated with wastewater treatment and specific operator responsibilities associated with activated sludge systems.

OBJECTIVES

Tertiary Treatment

Explain how filtration can be used in tertiary treatment.
Explain how activated carbon adsorption can be used in tertiary treatment.
Describe how established quality standards affect the discharge of wastewater from an industrial facility.

Operator Responsibilities

Describe tasks that an operator routinely performs to make sure that equipment used in wastewater treatment is functioning properly.
Describe the purpose of sampling and analysis programs for wastewater treatment units.
Describe the role of safety in wastewater treatment unit operations.
Identify process variables that operators monitor and adjust when operating wastewater treatment systems.
Define the following terms: *sludge blanket level, biochemical oxygen demand, food to micro-organisms ratio, mean cell residence time,* and *shock*.

SUBJECTS

Tertiary Treatment

Filtration and Activated Carbon Adsorption
Final Effluent Quality Standards

Operator Responsibilities

General Responsibilities
Secondary Treatment Responsibilities

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