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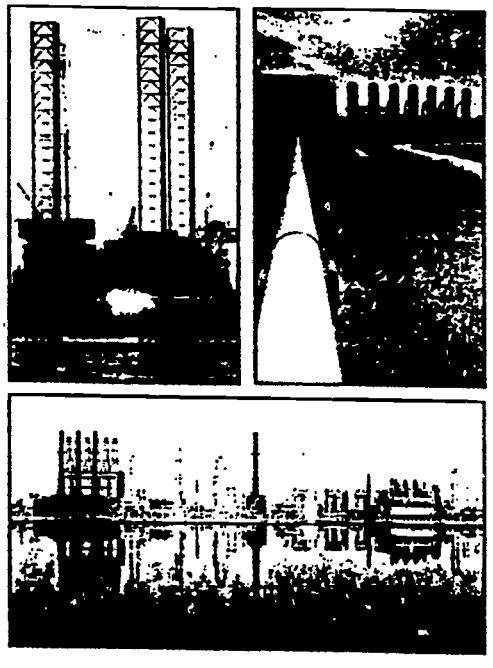
ABSTRACT

This program guide provides materials to prepare learners for employment as Process Plant Operators through classroom instruction and practical shop experience. Contents include instructional goal and subgoals, an instructional analysis that describes development of the materials and instructional equipment and supplies and facilities requirements, and learner entry behaviors and characteristics. Instructional plans are provided for 27 units. Components of each unit include the following: cluster name/number; unit name/number; learning domain; learning environment; instructional strategy; length in hours; unit description; unit objectives; and list of available materials. Unit topics are as follows: basic plant operations; basic operator responsibilities; safety procedures; environmental safety; applied mathematics; applied physics; process chemistry; applied communication; electrical fundamentals; reading diagrams and prints; computer fundamentals; furnace operations; instrumentation; water treatment; boiler operations; refrigeration; distillation; pumps; cooling towers; turbines; drive train equipment; materials handling; valves; heat exchangers; compressors; piping systems; and hand tools. Appendixes contain listings of learning domains, learning environments, and instructional strategies and a 16-item bibliography. (YLB)

A COMPETENCY-BASED INSTRUCTIONAL PROGRAM FOR PLANT PROCESS OPERATIONS

Developed by:

Joy McDaniel
Steven Mills



June 30, 1992

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Developed by:

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Based on a Grant Awarded to:

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INSTRUCTIONAL GOAL

This program prepares learners for employment as a Process Plant Operator. Specifically, this instructional program utilizes specialized classroom instruction and practical shop experience to achieve the following subgoals:

- Provide a standard knowledge and skill level for Plant Operators. This program is made up of general industry accepted concepts of what a Process Plant Operator should know before he/she is assigned to a specific job. This program focuses primarily on the fundamental verbal, cognitive, and psychomotor skills required of a plant operator.

- Provide Plant Operators--experienced and new hires--with the same fundamental training.

- Provide a springboard into a comprehensive training program (a catalyst for change) for persons previously or currently employed as a Process Plant Operator.

- Identify learning problem areas and provide correction or remediation.

INSTRUCTIONAL ANALYSIS

Needs Analysis

Four occupational clusters that are supplied by this training program include Petroleum Technology, Chemical Technology, Stationary Engineering Technology, and Waste and Wastewater Technology. The 1989 Work Force Oklahoma Labor Supply and Demand Report projected 1992 demand for these occupations as 8,060 with an average annual growth of 80 jobs. On the supply side for these occupations there were only 3 completers in 1989 for programs which supply these occupations. A composite report is provided in Appendix A.

A need for a program to train Plant Process Operations Technicians and update and supplement the skills of existing Process Operations Technicians has been identified by a least three processing plants in Southern Oklahoma. Total Petroleum, Inc. of Ardmore, Kerr-McGee Corporation of Wynnewood, and U.S. Silica of Mill Creek, have all expressed the need to develop such a training program in Southern Oklahoma. These companies are currently providing "in-house" training programs. Since the plant operator must demonstrate a high degree of technical skills, these "in-house" training programs are lengthy and generate a considerable expense and loss of labor for these companies.

A preliminary investigation of existing training programs for Process Operations Technicians revealed the existence of four such programs in the United States and Canada. Junior college programs are available at Bismarck State College, Bismarck, North Dakota, and Lambton College, Sarnia, Ontario, Canada. Vocational-technical training programs are available at Mindian Vo-Tech Center, Louisiana, and Pioneer Area Vo-Tech, Ponca City, Oklahoma (industry-specific for Conoco). Additionally, U.S. Silica has written a first draft course outline for an in-plant training program for Process Operations. The junior college programs could not be easily adapted to a vo-tech curriculum and the program at Pioneer Area Vo-Tech was focused on specific training for Conoco and was not developed to provide training for the general occupation of process operations.

Several "programmed learning" programs have been produced by professional training organizations to provide training for process operations technicians. Howell Training Systems has developed a program in conjunction with the American Petroleum Institute which trains operators primarily for petro-chemical processing plants. NUS/Halliburton has developed quite sophisticated video-based programs that train process operators. TPC Training Systems has developed a short program that is oriented toward water treatment plants. All of these professionally produced programs are behavioral based--they use a "programmed learning" approach and are quite expensive and beyond the range of any school budget.

Based on the needs of industries and a review of current resources. it is determined that this project should proceed and should synthesize the actual training needs and qualifications of employers, labor market data, and existing curricula in order to develop a comprehensive training program.

Characteristics and Background of the Instructor

The instructor has a variety of experiences in a chemical or petro-chemical processing plant. The instructor may have a bachelors degree in an engineering field such as chemical engineering. The instructor has five or more years experience as a process operator or engineer and has served in a supervisory capacity.

Scope and Sequence of Existing Curricula

Curricula which is currently available fits into one of two categories:

(1) **Junior College Programs**

These programs were developed to provide training for process operations at the Associate Degree level. These programs are few in number and diverse in approach although there are similarities in content.

(2) **Professionally-Produced Programs**

These programs were developed by professional training organizations or consortiums and generally use a "programmed learning" approach to facilitate "on-the-job" training. However, there are similarities in content.

Instructional Equipment and Supplies

The program requires equipment and supplies to perform basic lab experiments in the areas of physics, chemistry, and electricity. Equipment and supplies may be provided or donated by a local processing plant and/or purchased by the school.

Facilities

The program requires a standard classroom learning area which contains a chalkboard or whiteboard, overhead projector, and VCR/monitor. A lab area equipped with individual workstations for each learner is required. Some field training may take place at a local processing plant.

Instructional Analysis

A survey was mailed to fifty processing plants across the state of Oklahoma. This list of processing plants was obtained from the 1990 Oklahoma Directory of Manufacturers and Processors. The survey consisted of a list of tasks performed by process operators. The list was derived from outlines of the existing curricula, descriptions of the professionally-produced programs, and interviews with potential employers. Responsible persons at the processing plants were requested to check those tasks that process operators perform and to specify other required tasks or skill areas that may not be included on the list.

The surveys were analyzed and the results were incorporated into an instructional analysis. The analysis was performed primarily at a macro- or program-level. However, goals, objectives, and criterion-referenced test questions are developed at the unit-level.

Units of instruction are clustered about four specific areas:

(1) Plant Operator Responsibilities

(2) Basic Theory and Concepts

(3) Plant Operations and Processes

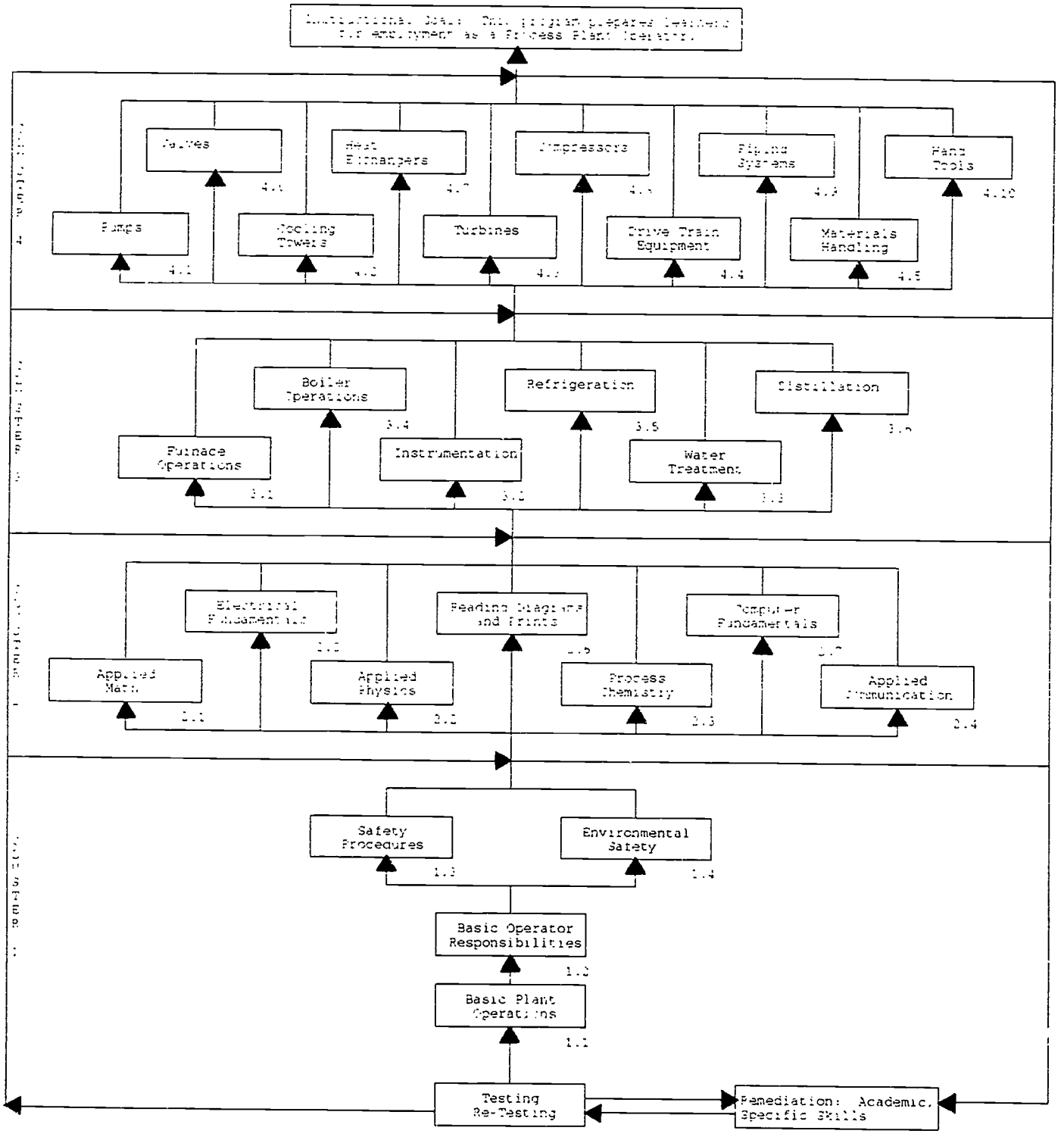
(4) Plant Equipment and Maintenance

It was determined that the program should be competency-based (outcome-based). Learners are initially tested before entering the program. If the test results indicate that the learner has the academic ability (achievement level) and aptitude to benefit from the program, the learner begins the program. If the learner does not demonstrate the academic ability and aptitude to succeed in the program, the learner is referred for remediation to a basic skills lab (reading, writing, math).

The learner performs classroom and laboratory activities for each unit of instruction and is administered a criterion-referenced test for each cluster. If a student does not achieve mastery level for a cluster, the student is referred for remediation to a specific skills lab. The criterion-refererced tests indicate which units the student has not mastered.

Cluster 1 is primarily verbal information. Cluster 2 is primarily cognitive or intellectual skills. Clusters 3 and 4 are primarily cognitive and psychomotor skills. Clusters 3 and 4 utilize field training as necessary.

Instructional Analysis Chart



INSTRUCTIONAL UNITS:

(1) Plant Operator Responsibilities
(2) Basic Theory and Concepts
(3) Plant Operations and Processes
(4) Plant Equipment and Maintenance

LEARNER ENTRY BEHAVIORS AND CHARACTERISTICS

General Characteristics

- Learners are adults who must demonstrate evidence of the ability to benefit from the training program by completion of a high school diploma or a G.E.D. certificate. Additionally, the achievement and aptitude of learners is assessed. Learners who do not demonstrate average academic ability (50 percentile or higher on standardized tests) are provided remediation options which improve math, science, or reading levels.

- Learners are enrolled in this program as a matter of preference or choice. Learners intend to take the skills obtained in this program to fulfill career objectives.

- Learners have been employed or are currently employed on a full- or part-time basis. Learners have jobs that pay at a minimum wage level or slightly higher and little or no benefits. Learners are looking for more substantial employment opportunities.

- Learners are enrolled in this program to change careers or improve job prospects. Therefore, learners are highly motivated to be successful in the program.

Specific Entry Behaviors

- Most learners have little or no experience in process operations and may not comprehend the content of the curriculum (although they recognize the instructional goal of the program). Since learners are determined to be academically or aptitudinally appropriate for this program through an assessment process, they share similar academic backgrounds, experiences, and achievement levels.

- Learners have a common range of reading ability which is minimally set at the ninth grade level.

- Learners have a common range of mathematics ability which is minimally set at the sixth grade level.

- Learners have common academic backgrounds in general science and mathematics courses. Their academic backgrounds may not include higher level mathematics and science courses such as Algebra II, Chemistry, or Physics. These skills are incorporated into the training program as needed.

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATOR RESPONSIBILITIES (1.0)

UNIT NAME/NO.: BASIC PLANT OPERATIONS (1.1)

LEARNING DOMAIN: VERBAL INFORMATION

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE, DISCUSSION

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

This unit serves as an introduction to the refinery industry. It provides the student with background information about refinery operations and process terminology. This unit also includes an overview of the function of refineries and descriptions of refinery equipment and systems. Operator duties and the role in maintaining safety is discussed.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Describe the function of the process plant.
2. Identify various plant equipment.
3. Identify types of plant systems.
4. Identify types of process systems.
5. Define control room duties and responsibilities.
6. Describe operator responsibilities in various processing plant environments.
7. Define the operator's role in plant safety.

AVAILABLE MATERIALS

Basic Chemical Plant Operations, NUS (COBCP)

Basic Refinery Operations, NUS (ROBRO)

Power Plant Fundamentals, CORD (FS-01)

Refinery Basics, NUS (ROCRC)

Video-Based Training Partner Program Library, NUS
- Chemical Operations
- Pulp and Paper Operations
- Refinery Operations

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATOR RESPONSIBILITIES (1.0)

UNIT NAME/NO.: BASIC OPERATOR RESPONSIBILITIES (1.2)

LEARNING DOMAIN: VERBAL INFORMATION

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE, DISCUSSION

LENGTH IN HOURS: 3 HOURS

UNIT DESCRIPTION

This unit presents a description of the operator's role in industrial processes and covers the general duties of control room operators and outside operators, with an emphasis on the importance of proper communications. Simple maintenance tasks that operators perform are addressed, as are trends and how operators detect and use them. This unit also discusses abnormal and emergency situations and stresses the importance of good operating practices and safety precautions.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Describe the occupation of a process operator.
2. Identify environmental responsibilities of plant operators.
3. Identify potential job titles and descriptions in various processing plant environments.
4. Describe the role of operators in process system operation.
5. List and explain general types of control room and outside operator duties.
6. Explain the importance of product sampling and communicating with others.

7. Describe the operator's roles in the areas of personal safety, equipment safety, accident prevention and the safety of others.

8. Describe the operator's responsibility in reference to teamwork, human relations and the work ethic.

9. Detect and analyze trends.

AVAILABLE MATERIALS

Basic Operator Responsibilities, NUS (OTBOR)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATOR RESPONSIBILITIES (1.0)

UNIT NAME/NO.: SAFETY PROCEDURES (1.3)

LEARNING DOMAIN: VERBAL INFORMATION

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATIONS

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

The purpose of this unit is to describe the importance of industrial safety and the proper function and use of personal safety equipment. This unit explains how an individual can minimize the chance of an accident by identifying hazards and developing ways of preventing accidents on the job. The importance of individual attitudes and responsibilities regarding safety is also emphasized. This unit also describes proper tool use, fire prevention, and correct material handling procedures.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify various Federal laws and regulations governing plan operations - OSHA laws, Process Hazard Management.

2. Identify terms associated with safety such as decibels, noise measurements, job safety analysis, and behavior modification.

3. Identify personal safety regulations concerning hearing conservation, radiation safety, trenching and shoring, hazardous communication, electrical safety, and fire prevention.

4. Identify, use, and maintain safety equipment - personal protective equipment, respirators, selection and use of, etc.

5. Describe the purpose of various permits.

6. Explain the use of vapor testers in different situations such as fire prevention, detecting hazardous chemicals, safe environments, etc.

7. Identify hazards associated with collecting samples.

8. Identify and perform personal and plant safety procedures - plant specific safety procedures, evacuation, reporting fire or explosion, power loss, human safety, plant procedures manual.

9. Explain why safety procedures must be followed and against what hazards an operator must protect himself or herself.

10. Describe good housekeeping tactics.

11. Identify proper lifting techniques - Ergonomics, the necessity of, etc.

12. Identify correct material handling procedures.

13. Identify safety procedures for the handling of Light Ends.

14. Identify safe tank cleaning methods.

AVAILABLE MATERIALS

Accident Control Techniques, Howell (API, 1120)

Industrial Hygienist, The, Howell (API, 3601), Video

Industrial Safety, NUS (OTISA)

Safe Tank Cleaning, Howell, (API, 3401), Video

Safety on the Job, ODVTE

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATOR RESPONSIBILITIES (1.0)

UNIT NAME/NO.: ENVIRONMENTAL SAFETY (1.4)

LEARNING DOMAIN: VERBAL INFORMATION

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE, DISCUSSION

LENGTH IN HOURS: 3 HOURS

UNIT DESCRIPTION

This unit defines and describes pollution including air and water pollution control devices and air and water pollution avoidance techniques. Hazardous waste disposal techniques are also explained.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Define pollution.
2. Describe devices and techniques used to avoid or control air and water pollution.
3. Identify hazardous waste handling procedures.

AVAILABLE MATERIALS

Environmental Protection, NUS (OTEPR)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: BASIC THEORY AND CONCEPTS (2.0)

UNIT NAME/NO.: APPLIED MATHEMATICS (2.1)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, SKILLS LAB

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, PROBLEM SOLVING, SKILLS PRACTICE

LENGTH IN HOURS: 12 HOURS

UNIT DESCRIPTION

The purpose of this unit is to review the concepts of basic math and algebra and to describe common industrial units of measure, such as those used for flow, velocity, concentration, and volume. This unit also describes how calculators can be used to solve industrial math problems. Specific examples of solving process problems by using math principles are presented. Reading process indications and using basic math steps to solve process-related problems are emphasized.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Perform basic mathematical computations using whole numbers - addition, subtraction, multiplication and division.
2. Perform basic mathematical computations with fractions.
3. Use geometry to determine areas and volumes.
4. Solve problems using US Standard and Metric System Units of Measurement.
5. Solve problems using base, rate and percentage.
6. Solve problems involving ratio and proportion.

7. Read and interpret graphs.

8. Use various linear measuring instruments.

9. Perform basic algebra and algebraic formula calculations.

AVAILABLE MATERIALS

Applied Mathematics--Using Graphs, Charts, and Tables. CCRD

Applied Mathematics--Using Ratios and Proportions, CORD

Fractions, Decimals & Proportions, (API, 1130)

Industrial Math 1, NUS (OTIM1)

Industrial Math 2, NUS (OTIM2)

Using Mathematics in the Plant, TPC (103)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.:	BASIC THEORY AND CONCEPTS (2.0)
UNIT NAME/NO.:	APPLIED PHYSICS (2.2)
LEARNING DOMAIN:	VERBAL INFORMATION. INTELLECTUAL SKILLS
LEARNING ENVIRONMENT:	CLASSROOM, SKILLS LAB
INSTRUCTIONAL STRATEGY:	LECTURE, DEMONSTRATION, PROBLEM SOLVING SKILLS LAB
LENGTH IN HOURS:	18 HOURS

UNIT DESCRIPTION

The purpose of this unit is to introduce students to basic scientific principles and their applications in the process plant. Fundamental units of measure for length, time, and mass, and units of measurement related to pressure, temperature, flow, and level are introduced. Additionally, this unit introduces the nature of fluids which includes fluids and force, phase changes, temperature measurement, pressure measurement, density, specific gravity and viscosity. The prediction of pressure, temperature, and volume changes that occur in the compressions and storage of gases is presented. The relations between force and motion and the laws that apply to force and motion are presented including the definition of work and its relation to energy. This unit introduces basic machines and the mechanical advantage of the inclined plane and the lever, with examples of where the mechanical advantage of these basic machines is used in process equipment. A basic background in the area of static and the use of static pressure is included.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Solve problems involving pressure.

2. Describe properties of matter associated with solids, liquids, gases and flowing fluids.

3. Understand molecular structures and related characteristics of solids, liquids and gases.

4. Define mass, weight, density, specific gravity, buoyancy, viscosity and elasticity.

5. Describe how the properties of the three states of matter relate to the operations of process equipment.

6. Define Heat.

7. Define Fluids

8. Identify major components of fluid system.

9. Identify phase change of fluids.

10. Identify measurement devices.

11. Define and apply Boyles Law.

12. Define and apply Charles Law.

13. Define and apply General Gas Law.

AVAILABLE MATERIALS

Heat Transfer and Fluid Flow, CORD

Introduction to Fluids, Howell, (API, 2501), Video

Mechanics of Fluids, 1-3, (API)

Nature of Heat, 1-3, (API)

Plant Science 1, NUS (OTPS1)

Plant Science 2, NUS (OTPS2)

Plant Science 3, NUS (OTPS3)

Plant Science 4, NUS (OTPS4)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: BASIC THEORY AND CONCEPTS (2.0)

UNIT NAME/NO.: PROCESS CHEMISTRY (2.3)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, SKILLS LAB

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, PROBLEM SOLVING, SKILLS PRACTICE

LENGTH IN HOURS: 18 HOURS

UNIT DESCRIPTION

This unit concentrates on the fundamentals of chemistry that apply to process operations. Topics to be presented include basic atomic theory, atomic structure, chemical compounds, mixtures, and chemical reactions. Chemical equations and material balancing are covered, too, including the effects of solutions and chemical concentrations on material balancing. This unit concludes with a focus on basic organic chemistry and nomenclature.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Describe the properties of matter.
2. Identify and define chemical terms such as elements, molecules, chemical reactions, bonding, compounds, mixtures, and be familiar with the periodic table.
3. Differentiate between and describe the characteristics of acids, bases, minerals, and salts.
4. Differentiate between and describe the characteristics of organic and inorganic material.
5. Identify various common chemical processes and procedures that are controlled or monitored.

6. Describe the basic structure of an atom.

7. Describe chemical equations and explain basic material balancing including the effects of chemical concentrations and solutions.

8. Calculate the amounts of reactants and products in a process reaction when given the weight of one of the reactants, determine the limiting factor for a process systems, and calculate the amounts of reactants to use according to that limiting factor using ratios and proportions.

9. Explain how process variables and catalysts can affect reaction rates and how process variables affect equilibrium reactions.

AVAILABLE MATERIALS

Chemistry Fundamentals, NUS (OTCFU)

Chemistry for Power Plant Technicians, CORD

Plant Science 2, NUS (OTPS2)

Process Chemistry, NUS (RCTPR)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: BASIC THEORY AND CONCEPTS (2.0)

UNIT NAME/NO.: APPLIED COMMUNICATION (2.4)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE, DISCUSSION, SMALL GROUP/COOPERATIVE LEARNING

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

The purpose of this unit is to present basic workplace communication skills. This unit teaches communication and language arts skills as they apply to reading and understanding technical manuals, writing effective communications and technical reports, and making short public presentations.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify terms and definitions.
2. Identify characteristics of a good employee.
3. Demonstrate effective oral and written communication.

AVAILABLE MATERIALS

Applied Communication--Communicating in the Workplace, AIT

Applied Communication--Following and Giving Directions, AIT

Applied Communication--Making and Responding to Requests

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: BASIC THEORY AND CONCEPTS (2.0)

UNIT NAME/NO.: ELECTRICAL FUNDAMENTALS (2.5)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS, PSYCHOMOTOR SKILLS

LEARNING ENVIRONMENT: CLASSROOM, SKILLS LAB

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, SKILLS PRACTICE

LENGTH IN HOURS: 12 HOURS

UNIT DESCRIPTION

The purpose of this unit is to present fundamental electrical concepts. This unit includes instruction about the nature of electricity, the six major sources of electricity, basic electrical quantities, series and parallel circuits, Ohm's Law, electromagnetism, inductance, and capacitance..

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify types and sources of electricity.
2. Identify the elements of Ohm's Law and describe relationship among the elements.
3. Identify and apply electrical theory--flow of electricity, determining voltage, current, resistance, power, electromotive force, induction, and motor action using Ohm's Law.
4. Describe the interaction between electricity and magnetism, particularly in relation to the operation of electric motors and generators.
5. Identify various types of electrical/electronic devices such as automatic/remote electrical start-up systems, alarms and interlocks, and the operation of a transformer and a solenoid.

6. Identify and explain the basic parts and functions of an electrical system: energy source, power path, transmission path, control devices, and load.

7. Describe how motors convert electrical energy into mechanical energy.

8. Explain the differences between AC motors and DC motors.

9. Describe the operation of motor controllers and control circuits.

10. Describe the basic operation of electrical systems.

11. Identify various types of emergency power sources.

12. Define the following terms: electromagnetism, induction, self-induction, and capacitance.

13. Identify electrical safety precautions.

AVAILABLE MATERIALS

AC Motors, Howell, (API, 1081)

Electrical Equipment, NUS (OTEE1)

Electrical Equipment, NUS (OTEE2)

Electrical Safety, (ITC), Video

Fundamentals of Electricity and Electronics, CORD

Plant Science 5, NUS (OTPS5)

Understanding Basic Electricity and Electronics, TPC (201)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: BASIC THEORY AND CONCEPTS (2.0)

UNIT NAME/NO.: READING DIAGRAMS AND PRINTS (2.6)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION

LENGTH IN HOURS: 3 HOURS

UNIT DESCRIPTION

Learners learn about the various types of diagrams associated with process operations and the information presented on these diagrams, including commonly used symbols and abbreviations and legend data. This unit also shows how various diagrams, such as flow diagrams and piping and instrumentation diagrams, can be used to understand process interrelationships.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Read and interpret machine drawings.
2. Read and interpret basic hydraulic and pneumatic drawings.
3. Read and interpret instrument drawings.
4. Read and interpret electrical drawings--one line.
5. Read and interpret Process Flow drawings.
6. Read and interpret P & ID's--diagrams that are commonly used in process facilities.
7. Locate individual pieces of equipment in a process.

8. Identify and explain the types of information found on the following types of diagrams: floor plans, elevation plans, flow diagrams, piping and instrumentation diagrams, and electrical diagrams.

9. Identify commonly used symbols and typical diagram abbreviations.

10. Explain how to trace out diagrams and how to use diagrams to locate actual components.

AVAILABLE MATERIALS

Reading Blueprints, TPC (101)

Reading Diagrams, NUS (OTRD1)

Reading Schematics and Symbols, TPC (102)

Using System Diagrams, NUS (OTUSD)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: BASIC THEORY AND CONCEPTS (2.0)

UNIT NAME/NO.: COMPUTER FUNDAMENTALS (2.7)

LEARNING DOMAIN: PSYCHOMOTOR SKILLS

LEARNING ENVIRONMENT: SKILLS LAB

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, SKILLS PRACTICE

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

The purpose of this unit is to provide the student with basic computer skills. Upon completion students should have a good understanding of the components of a computer system, basic keyboarding skills, and Disk Operating System commands.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify the components of a computer system.
2. Identify computer terminology.
3. Explain system software and applications software and identify popular applications software packages.
4. Perform basic disk operating system commands.

AVAILABLE MATERIALS

Microcomputer Operations and DOS LAPS, SOAVTC

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATIONS AND PROCESSES (3.0)

UNIT NAME/NO.: FURNACE OPERATIONS (3.1)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

This unit presents principles of heat transfer by conduction, convection and radiation. Major topics include types of furnaces, performance monitoring, and start-up and shutdown procedures.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify terms and definitions.
2. Identify various types of furnaces used in process operations.
3. Identify the parts of a furnace.
4. Identify safety, start-up and shut-down devices.
5. Describe proper furnace operations.
6. Identify various types of furnace draft systems.
7. Interpret an analysis of flue gases.
8. Describe economizing equipment used in furnace operations.

9. Perform routine inspection and shut-down maintenance.

10. Interpret draft gauge readings.

11. Identify and activate emergency shut-down devices.

AVAILABLE MATERIALS

Furnace Fundamentals, NUS (OTFFU)

Furnace Operations, NUS (OTFOP)

Furnace Operations, 1-4, Howell, (API, 1C32)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATIONS AND PROCESSES (3.0)

UNIT NAME/NO.: INSTRUMENTATION (3.2)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION

LENGTH IN HOURS: 9 HOURS

UNIT DESCRIPTION

This unit presents the principles of instrumentation used in process operation. Major topics of instruction include the construction and operation of measuring instruments, control systems, and the operating principles of measuring instruments and control systems.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify various types of instruments.
2. Identify the functions of various types of instruments.
3. Describe the operation and use of various types of instruments.
4. Identify control mode and sketch control loop.
5. Identify various types and applications of computers and input/output control devices.
6. Identify malfunctions of instruments.
7. Identify alarm and shutdown points.

8. Read various types of instruments.

9. Operate pressure and temperature measuring devices.

AVAILABLE MATERIALS

Fundamentals of Instrumentation and Control, CORD

Instrumentation and Control, 1, 2, 3, 4 & 5, NUS (OTIC1-5)

Instrumentation and Process Control, TPC (220)

Instrumentation for Operators, 1 & 2, Howell, (API, 1062 & 1063)

Introduction to Process Instrumentation, Howell, (API, 2201), Video

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATIONS AND PROCESSES (3.0)

UNIT NAME/NO.: WATER TREATMENT (3.3)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE

LENGTH IN HOURS: 9 HOURS

UNIT DESCRIPTION

The purpose of this unit is to present the origins and types of contaminants found in water and to familiarize them with the functions and operations of equipment used to remove these contaminants. Major topics of instruction include primary water treatment, chlorination, dissolved solids and gases, water softeners and demineralizes, carbon filter, aerators, and de-aerators, and chemical treatment and safety.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Describe the types of contaminants removed in primary and secondary water treatment.
2. Describe the functions and operation of equipment used to treat raw water.
3. Describe how chemicals are used in water treatment.
4. Describe precautions associated with the safe handling of chemicals.
5. Describe the equipment and processes used in the different stages of wastewater treatment.
6. Identify the responsibilities of operators who work with wastewater treatment plants.

AVAILABLE MATERIALS

Refining Wastewater Treatment, Howell, (API, 2701), Video

Water Treatment, CORD

Water Treatment, 1 & 2, NUS (OTWT1&2)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATIONS AND PROCESSES (3.0)

UNIT NAME/NO.: BOILER OPERATIONS (3.4)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

This unit presents the fundamental principles of boiler operation, with emphasis on the basic requirements for steam production and combustion. Major topics of instruction include the basic design and operation of water tube boilers and fire tube boilers, the concept of heat transfer, how heat transfer occurs, and the concepts of natural circulations and forced circulation.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify steam producing equipment.
2. Identify the applications of various steam systems and morally used pressure.
3. Identify various types of boilers.
4. Identify the components of a boiler.
5. Identify the components of steam systems.
6. Identify safety devices associated with steam systems.
7. Identify the types of fuel used for steam generation.

8. Describe water treatment and its importance.

9. Identify the factored/conditions for permissive starts.

10. Identify start-up and shut-down of equipment.

11. Describe operating checks.

AVAILABLE MATERIALS

Boiler Auxiliaries, CORD

Boiler Fundamentals, NUS (OTBFU)

Boiler Operations, NUS (OTBOP)

Boilers, CORD

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATIONS AND PROCESSES (3.0)

UNIT NAME/NO.: REFRIGERATION (3.5)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

This unit provides an introduction to refrigeration and the refrigeration cycle. Major topics of instructions include temperature and pressure and how they relate to heat transfer, mechanical refrigeration systems, and refrigeration system controls and applications.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Describe the functions of the basic components of a typical mechanical refrigeration system.
2. Identify factors that affect the operation of a mechanical refrigeration system.
3. Describe operator checks commonly made on refrigeration systems.
4. Describe major functions typically performed by heating, ventilation, and air condition systems.
5. Describe how to conduct routine system inspections.

AVAILABLE MATERIALS

Refrigeration Systems, 1 & 2, NUS (OTRS1&2)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT OPERATIONS AND PROCESSES (3.0)

UNIT NAME/NO.: DISTILLATION (3.6)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM

INSTRUCTIONAL STRATEGY: LECTURE

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

The purpose of this unit is to present the fundamental principles of distillation. Major topics of instruction include how distillation systems separate liquid mixtures into various components for product recovery and the operating principles of distillation systems.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Explain how the basic principles involved in vaporization and condensation related to the distillation process.
2. State functional definitions for the operating principles of distillation towers.
3. Explain the difference between towers that operate under atmospheric conditions and towers that operate under partial vacuums.
4. Describe tower operating conditions and explain what happens when tower temperatures and pressures change and how adjustments can be made to correct these changes.
5. Describe typical pre-startup checks and the actions taken during the two stages of the startup procedure.
6. Describe shut-down procedures.

AVAILABLE MATERIALS

Distillation, 1 & 2, NUS (RCDI1&2)

Distillation: Principals & Practices, Howell, (API,2101), Video

Introduction to Distillation, NUS (ROIND)

Practical Distillation, 1-8, Howell, (API 1011, 1012, 1013, 1014)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.:	PLANT EQUIPMENT AND MAINTENANCE (4.0)
UNIT NAME/NO.:	PUMPS (4.1)
LEARNING DOMAIN:	VERBAL INFORMATION, INTELLECTUAL SKILLS
LEARNING ENVIRONMENT:	CLASSROOM, FIELD TRIP
INSTRUCTIONAL STRATEGY:	LECTURE, DEMONSTRATION, FIELD TRIP
LENGTH IN HOURS:	6 HOURS

UNIT DESCRIPTION

The purpose of this unit is to present the functions and uses of pumps in systems that provide fluid flow in the plant. The common types of pumps covered in this unit include positive displacement and centrifugal. Equipment operations and safety aspects are major topics of instruction.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify various types of pumps.
2. Identify the components of various types of pumps.
3. Identify various types of pump drivers.
4. Troubleshoot and perform maintenance on pumps.
5. Identify the factors/conditions for permissive starts.
6. Perform start-up and shut-down procedures.
7. Describe how positive displacement and centrifugal pumps generally operate.

8. Identify pumps by different names and list conditions that affect pump operation in a process.

9. Demonstrate how to inspect an operating pump.

AVAILABLE MATERIALS

Centrifugal Pumps, Howell, (API, 1071)

Centrifugal Pumps, Howell, (API, 2401), Video

Positive Displacement Pumps, Howell, (API, 1072)

Pumps, CORD

Pumps, 1, 2 & 3, NUS (OTPU1-3)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT EQUIPMENT AND MAINTENANCE (4.0)

UNIT NAME/NO.: COOLING TOWERS (4.2)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, FIELD TRIP

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, FIELD TRIP

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

The purpose of this unit is to identify various types of cooling towers and explain how each type operates. Major topics of instruction include cooling towers, condensers, and reboilers. Additionally, this unit explains how contaminants affect cooling tower operation and how these effects can be minimized.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify the purpose of cooling towers.
2. Identify various types of cooling towers.
3. Identify the components of cooling towers.
4. Describe the theory of cooling tower operations.
5. Identify normal\abnormal operating conditions.
6. Take samples, analyze, and make adjustments to water quality.
7. Perform routine maintenance and start-up/shut-down procedures.

AVAILABLE MATERIALS

Cooling Towers, Howell, (API, 1150)

Cooling Towers, Howell, (API, 2301), Video

Distillation Tower Operations, NUS (RODTO)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT EQUIPMENT AND MAINTENANCE (4.0)

UNIT NAME/NO.: TURBINES (4.3)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, FIELD TRIP

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, FIELD TRIP

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

This unit is designed to introduce the operations principles of a typical steam turbine. This unit identifies the major components and explains how these components work together to convert thermal energy into mechanical energy.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Describe the basic construction of steam turbines.
2. Explain the principles of steam turbines.
3. Describe governors and their functions.
4. Describe operational problems of steam turbines.
5. Explain the theory of operations of combustion gas turbines.
6. Describe the construction of a combustion gas turbine.
7. Identify the auxiliaries of the combustion gas turbines.
8. Explain the control of operations of the combustion gas turbine.

AVAILABLE MATERIALS

Generating Steam in the Power Plant, TPC

How Power Plants Work, TPC

Steam Turbines, Howell, (API, 1082)

Steam Turbines, NUS (OTSTU)

Turbines, CORD

Turbine Lube-Oil System, CORD

Turbine Control, CORD

Turbine Protective System, CORD

Turbine Turning Gear Operation, CORD

Using Steam in the Power Plant, TPC

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT EQUIPMENT AND MAINTENANCE (4.0)

UNIT NAME/NO.: DRIVE TRAIN EQUIPMENT (4.4)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, FIELD TRIP

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, FIELD TRIP

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

The purpose of this unit is to present various types of drive components used in industrial facilities. Additionally, this unit explains how to employ the proper operating procedures and safety measures necessary for efficient drive component performance.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Explain the purpose and general concepts of equipment drive components.
2. Identify various types of commonly used drive components.
3. Describe typical applications, safety procedures, and operator checks for each type of drive component.

AVAILABLE MATERIALS

Couplings, Gear Trains and V-Belt Drives, Howell, (API, 1085)

Equipment Drive Components, NUS (OTEDC)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT EQUIPMENT AND MAINTENANCE (4.0)

UNIT NAME/NO.: MATERIAL HANDLING (4.5)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, FIELD TRIP

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, FIELD TRIP

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

This unit will presents a general introduction to material handling concepts, various types of major equipment available, and use of associated equipment and measurement systems. Other topics of instruction include safety precautions, physical characteristics of material to be handled, and proper selection of equipment. Emphasis is placed on safely handling hazardous materials and following the safety requirements established by various regulatory agencies.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify regulations governing materials handling.
2. Identify equipment used for handling/transferring materials.
3. Identify various types of storage vessels/containers.
4. Identify various types of hoses and couplings used in materials handling.
5. Identify methods used for solids material handling.
6. Identify gauging tasks.

7. Perform sampling tasks.

8. Perform pre/post loading inspections.

AVAILABLE MATERIALS

Material Handling Equipment for Bulk Solids, NUS (OTMHE)

Material Handling of Bulk Liquids, NUS (OTMHL)

Material Handling of Bulk Solids, NUS (OTMHS)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT EQUIPMENT AND MAINTENANCE (4.0)

UNIT NAME/NO.: VALVES (4.6)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, FIELD TRIP

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, FIELD TRIP

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

This unit presents the identification and operation of the most common valves along with troubleshooting and repair difficulties that may develop due to fouling, leakage, or wear.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify various types and uses of valves.
2. Identify valve components.
3. Identify factors affecting valve opening and closing.
4. Identify various valve malfunctions and repair/replace faulty valve.

AVAILABLE MATERIALS

Valves, CORD

Valves, Howell, (API, 1140)

Valves, 1 & 2, NUS (OTVA1&2)

Valves: Operations & Design, Howell, (API), Video

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT EQUIPMENT AND MAINTENANCE (4.0)

UNIT NAME/NO.: HEAT EXCHANGERS (4.7)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, FIELD TRIP

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, FIELD TRIP

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

This unit explains the operation of industrial heat exchangers. This unit identifies and explains heat exchangers by different names and lists conditions affecting heat exchanger operation in a process.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify types of heat transfer.
2. Identify types and components of heat exchanger.
3. Describe the operation and function of a heat exchanger.
4. Commission a heat exchanger and perform maintenance.
5. Define heat, temperature, thermal energy, and heat transfer.
6. Explain heat transfer, specific heat, sensible heat, and latent heat.

AVAILABLE MATERIALS

Heat Exchangers, 1 & 2, NUS (OTHE1&2)

Heat Exchangers, Howell, (API, 1160)

Heat Exchangers, Howell, (API, 2302), Video

Heat Transfer and Fluid Flow, CORD

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT EQUIPMENT AND MAINTENANCE (4.0)

UNIT NAME/NO.: COMPRESSORS (4.8)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, FIELD TRIP

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, FIELD TRIP

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

This unit presents the basic laws of gas behavior, the units of gas measurement, and general descriptions of the purpose and use of compressors in industry. Various types of compressors are identified. Operator responsibilities and other safety aspects of compressors and compressed gas systems are reviewed.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify various types of air compressors.
2. Identify the components and uses o compressed air systems.
3. Determine proper instrument air dryer operation.
4. Perform routine inspection and maintenance.
5. Describe basic principles of operation of reciprocating compressors.
6. Describe the principles of operation of centrifugal compressors.
7. Identify the major components and auxiliary systems associated with compressors and describe their general operation.

8. Describe operator responsibilities and safety aspects of compressor system operation.

9. Describe start-up and shut-down procedures.

AVAILABLE MATERIALS

Centrifugal Compressors, Howell, (API, 1053)

Centrifugal Compressors, Howell, (API, 2402), Video

Compressors, 1 & 2, NUS (OTCO1&2)

Introduction to Compression, Howell, (API, 1051)

Positive Displacement Compressors, Howell, (API, 1052)

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT EQUIPMENT AND MAINTENANCE (4.0)

UNIT NAME/NO.: PIPING SYSTEMS (4.9)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, FIELD TRIP

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, FIELD TRIP

LENGTH IN HOURS: 6 HOURS

UNIT DESCRIPTION

The purpose of this unit is to present to some of the components commonly found in piping systems. Major topics of instruction include the purpose of piping and piping auxiliaries, the function of pipe supports, expansion devices, insulation, hear tracing, protective devices, steam traps, and the various uses for tubing and how to make up a small tubing run.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Define a fitting.
2. Understand the functions of fittings.
3. Identify the different types of fittings.
4. Define tubing.
5. Describe tubing applications.
6. Identify advantages of tubing.

AVAILABLE MATERIALS

Pipe Fitting Basics. Howell, (API, 2602). Video

Piping and Auxiliaries, NUS (OTPA1)

Piping Systems. TPC Training Systems

Tubing. Howell, (API, 2603), Video

INSTRUCTIONAL PLAN

CLUSTER NAME/NO.: PLANT EQUIPMENT AND MAINTENANCE (4.0)

UNIT NAME/NO.: HAND TOOLS (4.10)

LEARNING DOMAIN: VERBAL INFORMATION, INTELLECTUAL SKILLS

LEARNING ENVIRONMENT: CLASSROOM, FIELD TRIP

INSTRUCTIONAL STRATEGY: LECTURE, DEMONSTRATION, FIELD TRIP

LENGTH IN HOURS: 3 HOURS

UNIT DESCRIPTION

This unit explains how to identify, select, use, and care for various hand tools, process equipment tools, simple electrical test equipment, and hoisting/pulling equipment. Other topics of instruction include stopping leaks, cleaning strainers, and replacing filters.

UNIT OBJECTIVES

Upon successful completion of this unit the learner will:

1. Identify and use various types of hand tools.
2. Identify various types of power tools.
3. Identify various types of non-sparking tools.
4. Perform various linear measurements.

AVAILABLE MATERIALS

Hand Tool Basics, Howell, (API, 2601), Video

Hand Tools - Operations Maintenance, NUS (OTHTO)

Using Hand Tools, TPC

Using Portable Power Tools, TPC

APPENDICES

LEARNING DOMAINS

Attitude - learners make choices or decisions; learners have a choice to make and instruction influences the decision that is to be made; attitudinal goals are usually not achieved at the end of instruction.

Cognitive Strategies - learners use learning strategies including rehearsing strategies, organizing strategies, elaboration strategies, and comprehension monitoring.

Intellectual Skills - requires learners to do some unique cognitive activity; learners must solve a problem or perform an activity with new information or examples; includes discriminations, concepts, rules, and problem solving.

Psychomotor Skills - learners must execute muscular actions, with or without equipment, to achieve specified results; there may be mental or cognitive activity that must accompany the motor activity.

Verbal Information - requires only one answer for each question and one way to answer each question; no problem solving or rule application; requires learners to provide specific responses to relatively specific stimuli; the learner must state, list, or describe something.

LEARNING ENVIRONMENTS

Classroom - appropriate for small or large group discussions and lectures.

Field Trip - demonstrates skills performance through observation of real experiences and activities.

Independent Study - appropriate for self-instructional material and individualized instruction.

On-the-Job Training - enables learners to learn tasks more effectively through actual or real experiences and activities.

Skills Lab - appropriate for hands-on experience with equipment or for face-to-face contacts with other learners or the instructor; learners receive instruction from an instructor's demonstration and are provided the opportunity to practice.

INSTRUCTIONAL STRATEGIES

- Brainstorming
- Computer-Assisted Instruction
- Demonstration
- Discussion
- Field Trips
- Individualized Instruction
- Lecture
- Problem Solving
- Simulations/Games
- Skills Practice
- Small Group/Cooperative Learning
- Tutoring /Coaching

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Safety on the Job, Oklahoma Department of Vocational-Technical Education, Center for Instructional Materials and Curriculum, 1500 West Seventh, Stillwater, Oklahoma 74074-4364, Phone (800) 522-5810