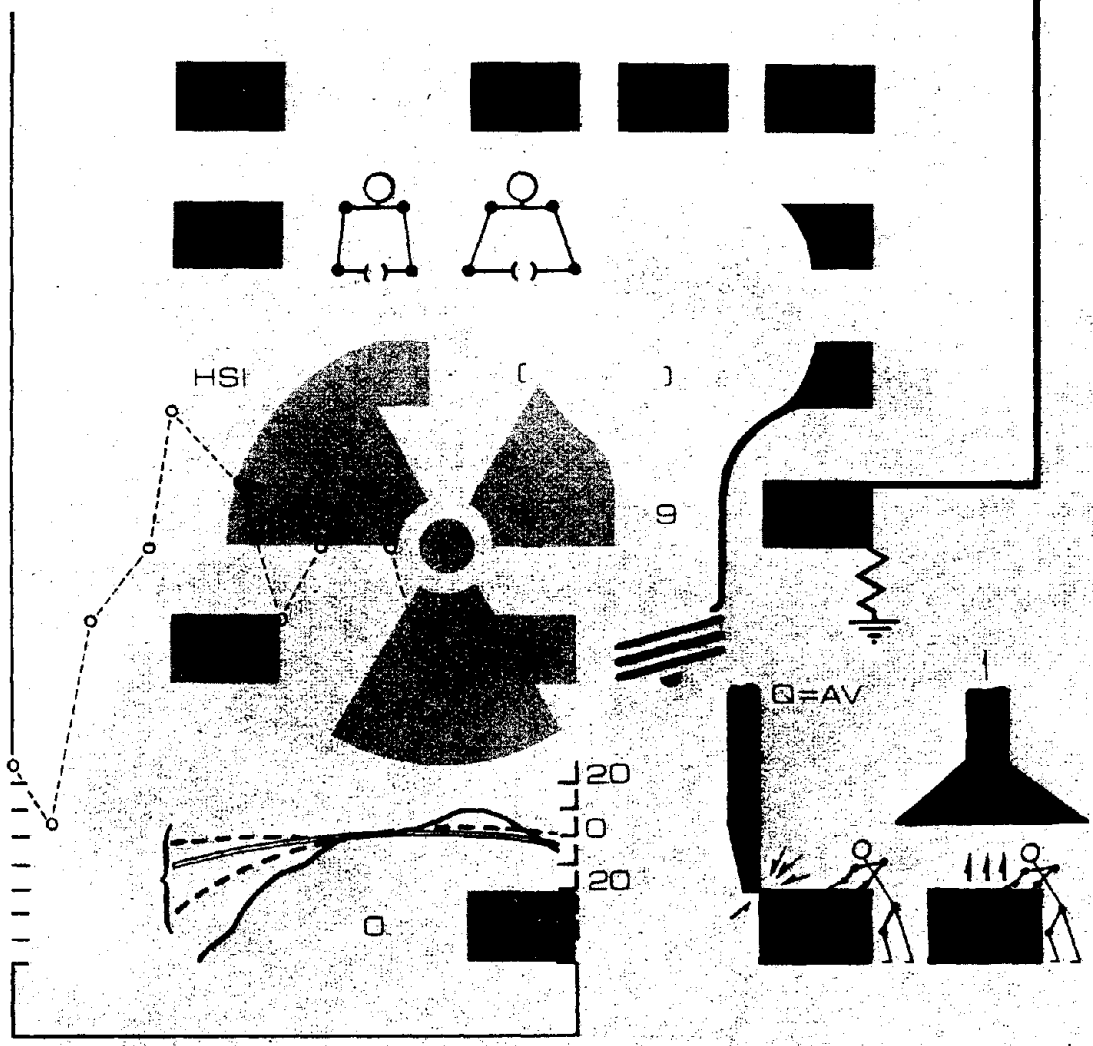
552

INDUSTRIAL HYGIENE
ENGINEERING & CONTROL

OTHER TOPICS



Instructor Manual

U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

Division of Training and Manpower Development

INTRODUCTION TO INDUSTRIAL HYGIENE ENGINEERING AND CONTROL (552)

This is a modularized course designed for use as a one, two, or three week short course or as a one or two semester academic course at either the undergraduate or graduate level. It examines the fundamentals for design of controls to eliminate or satisfactorily deal with occupational health hazards. Lectures, augmented by problem solving sessions, are intended to assist the trainee in selecting, designing, and applying control methods in the work environment. Primary attention is given to industrial ventilation, noise and vibration control, heat stress, and industrial illumination as well as new engineering topics.

The training course manual has been specially prepared for the trainees attending the course and should not be included in reading lists of periodicals as generally available.

Module 8 — Instructor's Manual

OTHER TOPICS

Division of Training and Manpower Development
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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Cincinnati, Ohio

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FOREWORD

The material presented in this document is designed for use in a college or university classroom and is directed to students at an advanced level of study in industrial hygiene. The course may also be utilized in total or in part as the basis for short course offerings.

This material was developed under sponsorship of the National Institute for Occupational Safety and Health, Division of Training and Manpower Development, Cincinnati, Ohio, (Contract CDC—210—75—0076). Serving as Project Officer for the development of this material was Robert B. Weidner, J.D.. Branch Chief, Division of Training and Manpower Development.

The lesson plans and accompanying text entitled *Industrial Hygiene Engineering and Control* were prepared by the staff of Management Resource Associates, Monroeville, Pennsylvania. Serving as authors were Bruce B. Byers. Ronald J. Hritz, and James C. McClintock. Also assisting, as consultants to the development of the materials, were Ralph J. Vernon, Ph.D., and Richard B. Konzen, Ph.D., of Texas A&M University.

Art work for the text was prepared by Carole D. Byers. Manuscript preparation was the responsibility of Elaine S. Holmes.

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INTRODUCTION

Purpose of the Course

The course materials are designed for presentation to students at the baccalaureate or graduate level of study in Industrial Hygiene. The materials presuppose that the student has completed introductory courses in recognition, measurement, and evaluation of occupational health hazards. The materials are designed in such a manner that they are applicable as a two-semester course or a three-week intensive study short course. In addition, the materials may be divided to provide courses of a shorter duration. Since the course is divided into self-contained modules, each module can be used as the basis for the development of a course. (e.g., Module 2, Industrial Ventilation can be utilized as a one-semester offering or a one-week short course.)

The emphasis in each module is the control of occupational hazards. However, this emphasis does not preclude the inclusion of recognition, measurement and evaluation topics within the module. Summary material covering these important areas is included where appropriate within each module. This inclusion is based upon the authors' belief that problem identification and definition are important steps that must be taken before adequate control can be implemented.

Content

The materials are divided into eight (8) self-contained modules. Each module is divided into units and lessons. For the most part, the lessons are based upon a one-hour class session for presentation. The modules that are included, as well as the *minimum* time available to cover the modules are:

Module	*Title*	*Minimum Time*
1	Introduction to Industrial Hygiene Engineering and Control	7 Hours
2	Industrial Ventilation	31 Hours
3	Thermal Stress	4 Hours
4	Sound	7 Hours
5	Industrial Illumination	3 Hours
6	Nonionizing and Ionizing Radiation	8 Hours
7	Ergonomics	5 Hours
8	Other Topics	7 Hours
	Total Time	72 Hours

The time allotted is a minimum time that does not include allowance for testing and review of problems and exercises. Based upon the expereinces gained in a pilot test of the materials, the time allotted above provides for only a brief coverage of the topics included. For thorough coverage of each subject, the allotted time should be increased to at least 120 hours. In any case, the time required is dependent upon the level of detail and completeness of coverage of each topic that is desired.

Course Prerequisites

The students should have taken courses in recognition, measurement and evaluation of occupational health hazards. At a minimum, the students should have completed the following NIOSH sponsored courses or their equivalent:

—Recognition, Evaluation and Control of Occupational Hazards
—Industrial Hygiene Measurements

In addition, the students should have completed education in undergraduate mathematics through the calculus and undergraduate science including general and organic chemistry, physics, and biology. Additional engineering courses such as fluid mechanics and thermodynamics will be helpful to the student.

Components of the Course

The Course Manual is designed to provide the technically competent instructor with the basic educational materials from which to conduct the training sessions. It is not the purpose of the Course Manual to provide a complete skill and knowledge package from which the instructor can obtain the technical competency necessary to conduct training, since such competence is assumed to be an attribute of any instructor chosen to teach in the program. Should the instructor wish to brush up on certain skills and knowledge, the references cited as well as the accompanying text, *Industrial Hygiene Engineering and Control*, will provide a basis for this undertaking.

The course is organized with three (3) basic elements. These elements are:

1. Module—A complete, self-contained package of educational materials that is directed toward the attainment of skills and knowledge in a subject area. These modules can be presented as a stand-alone course or can be combined in various ways to construct courses for use with selected groups of students.

2. Unit—A self-contained package of educational materials that is directed toward attainment of a subset of skills and knowledge in a subject area. The unit does not necessarily lend itself to use as a stand-alone package since certain segments of the skills and knowledge presented depend upon completing previous units within the module.

3. Lesson—Generally, an artificial segmentation of a unit for administrative purposes. Lesson segments are normally one hour in length and, as far as is practical, cover a logical subset of knowledge or skills. Lessons allow for the scheduling of the training in various educational environments.

Instructor's Manual—The Module Plan

The module plan contains the following components:

1. Unit and Lesson Topic Outlines—This outline presents the topics covered within the module and the schedule for presentation of these topics. This information provides a concise and organized summary of the subject material in the module.

2. Terminal Objectives—General competency statements related to the skills and knowledge that should be possessed by the student upon completion of

the module. The skill objectives relate to the manipulative, computational, or decision-making skills that the student should attain upon completion of the module. The knowledge objectives relate to the subject knowledge that the student requires in order to perform the required skills. These objectives serve as a basis upon which an evaluation can be made of the student's mastery of the subject material included in the module.

3. Self-Tests—Postmodule self-tests along with the correct answers to these tests are included with each module.

4. References—A list of reference material can be consulted by the instructor or students.

Instructor's Manual—The Unit Plan

The unit is made up of a number of specific components and contains the lesson content outline. The components of the unit plan are:

1. Performance Objectives—Skill and knowledge objectives related to the subject matter included within the unit. These objectives are written in behavioral terms (i.e., an observable activity or result that can be evaluated quantitatively, as specified, and which is conducted or obtained under specific conditions). The objectives that are presented within the unit plan are of a more specific nature than those terminal objectives or competency statements that are specified by the module plan. The performance objectives presented within the unit might be thought of as enabling objectives; i,e., they represent the skills and knowledge that the student must attain in order to complete the requirements of the terminal objectives for the module.

2. Unit Activities—Activities that the student must perform to complete the unit. Reading assignments, reference materials, and outside activities are presented.

3. Required Facilities, Equipment, and Materials—Materials—The required facilities, equipment and materials that should be available for presentation of the unit. The equipment and materials listed are divided into those which are educational and those which are content oriented (e.g., 16 mm projector vs. pitot tube).

4. Content Outline—Presents an organized outline of the topics to be covered during the presentation of the unit. The content outline is divided into the lesson outlines necessary for completion of the units.

   In addition, the content outline contains instructions to the instructor and reference to slides and overlays that should be used in conjunction with the lecture. These instructions present the sequence of instructor activities, such as when to present a given slide, when a demonstration is required, or when an instructor's experience might be of value.

   Since the course is designed to be taught by technically competent instructors, the material in the lesson content outline is of a topical nature with only that explanation present that should be emphasized to the student. It is expected that the instructor's skill and knowledge will allow for the depth

of presentation and emphasis required. The instructor is encouraged to present material relevant to experience, wherever possible, in order to provide the students with a referent to the subject.

5. Demonstration Outlines—Appropriate outlines for classroom and laboratory demonstrations and sample problems to be presented to the class. The demonstrations are designed to present an outline of the procedural steps that are important in performing the particular measurement, design, or calculation. Steps that are critical or that may lead to common errors are emphasized in the demonstration outlines.

6. Practice Exercises—A series of practice exercises that can be given to the student. These practice exercises can be used as either classroom or laboratory exercises or as homework assignments. Solutions to problems involving calculations are also provided.

Audio Visual Aids

A set of slides, which are referenced in the lesson outlines, have been prepared and are available for use in presenting the course.

MODULE 8

OTHER TOPICS

INSTRUCTOR'S MANUAL

Unit and Lesson Topic Outline	
Other Topics	Module 8

The topics listed below are included within this module. The recommended time to be allotted to each topic is also given. Depending on the particular class, this time may vary slightly; however, the total time for the entire module should not exceed the time allotted.

Unit	Lesson		Time/Hrs.	
1		Control of Industrial Wastes		
	1	Control of Industrial Water Quality	1	A discussion of the uses of water in industry and the procedures to treat water to obtain a desired quality. Cross connection of water sources and controlling thermal pollution are also covered.
	2	Control of Solid Waste	1	The objectives of a solid waste control program are presented. The various sources of solid waste and methods of disposal are also presented.
2		Control of Hazardous Materials		
	1	Purchase, Handling, and Storage of Hazardous Materials	1	Discussion of the areas of the plant where hazardous materials must be controlled. The need for and components of product specification data are discussed. Other data that should be available concerning a hazardous material are also discussed.
	2	Personal Protective Equipment	1	A discussion of personal protective equipment. Emphasis is placed on the various types of respirators. Three major types of respirators are covered along with equipment for protection of other body parts.
3		Industrial Hygiene Economics		
	1	Costs of Industrial Hygiene Control	1	A presentation of the costs of controlling exposures versus the costs of not controlling exposures. Also included is a discussion of the need to consider and compare alternative control methods.

Unit and Lesson Topic Outline				
Other Topics				Module 8
Unit	Lesson		Time/Hrs.	
3				
	2	Basic Economic Analysis	1	A presentation of two methods for making economic decisions between alternatives. The N-year payback and present worth method are discussed
4		Legal Aspects of Industrial Hygiene		
	1	The OSHA Act and Its Implications	1	A discussion of the OSHA act. Presented are the purpose of the act, the agencies established, the citation, recordkeeping, and variance processes.
				Total Module Time--7 Hours

Terminal Objectives	
Other Topics	Module 8

The objectives presented represent the competencies that the student should possess upon completion of this module. All objectives are directed toward the student's obtaining certain category levels of skill and knowledge.

Terminal Objectives

1. Given a series of plans, specifications, and process descriptions for a plant, the student will be able to identify the needs for water in the process and the specific waste water disposal treatment facilities and steps required to return the water back to the source without unduly harming the environment.
2. Given a series of plans, specifications, and process descriptions for a plant, the student will be able to identify the sources and types of solid waste present and develop a solid waste disposal plan to dispose of these solid wastes.
3. Given a typical industrial plant using hazardous and flammable materials, the student will be able to identify the components of a data base that can be constructed to assist in the identification and control of exposures to these materials.
4. Given a description of a job requiring respiratory protection, the student will be able to select the appropriate type respirator for use by the workers to protect against exposure to hazardous material, identify any other protection required by the worker, and develop a plan for initiation of the use of the respirators, including precautions that should be taken to assure that the appropriate protection is obtained.
5. Given a description of at least two alternative methods of control being considered for a specific exposure and the availability of other required data, the student will be able to
   a. estimate the costs involved in the installation of each of the controls.
   b. estimate the costs of not controlling the exposure.
   c. make an economic comparison of the alternatives using the present worth method.
   d. determine the appropriate investment recommendation, given the desired rate of return for the company.
6. Given no aids, the student will be able to identify in general terms the implications of the OSHA act on his employer as related to:
   a. failure to adequately control hazards.
   b. required recordkeeping.
   c. a standard that cannot be met at present
   d. the citation of a hazard that the company feels to be unjust.

UNIT 1

CONTROL OF INDUSTRIAL WASTES

Performance Objectives

Lesson	Control of Industrial Wastes	Module 8 Unit 1

1 1. Given no aids, the student will be able to recall and list in writing at least six (6) uses of water in industry.

1 2. Given no aids, the student will be able to recall and list in writing the eight (8) steps that comprise the treatment of waste water from an industrial plant.

1 3. Given no aids, the student will be able to recall and describe the process involved in each of the eight (8) steps of waste water treatment. The description should include:

a. the objective of the process step
b. a description of how the process step works
c. a description of alternate methods where appropriate

1 4. Given no aids, the student will be able to recall and define in writing the following terms:

a. destabilization (coagulation)
b. conglomeration (flocculation)
c. sludge
d. anaerobic process
e. aerobic process
f. thermal pollution
g. cross-connection
h. cooling tower operation

1 5. Given no aids, the student will be able to recall and describe the potential hazards that may be encountered during the operation of a cooling tower.

1 6. Given no aids, the student will be able to recall and describe in writing the methods that can be used to control potential hazards resulting from the cross-connection of potable and nonpotable water supplies.

1 7. Given no aids, the student will be able to recall and list in writing at least four (4) potentially hazardous chemicals used in the treatment of waste water, indicating the process in which the chemical is used.

2 8. Given no aids, the student will be able to recall and describe the four (4) objectives toward which a solid waste disposal operation should be directed.

2 9. Given no aids, the student will be able to recall and list in writing the three alternative methods for solid waste disposal.

2 10. Given no aids, the student will be able to describe in writing at least one source of solid waste material for each of the following categories:

a. Raw Material Extraction Industries
b. Process Industries
c. Manufacturing and Assembly Industries
d. Packaging
e. Consumer Use

Unit Activities--Instructor	
Control of Industrial Wastes	Module 8 Unit 1

In order to present the unit material to the student, the instructor will be responsible for the following:

Lesson 1--Control of Industrial Water Quality

Classroom Presentation

Conduct a lecture covering the topic of industrial waste water; its treatment and control. Included in the lesson is a discussion of the various uses of water in industry, the potential pollutants added to the water, and the treatment of waste water to remove the pollutants from the water before entry into the environment. Also discussed are the chemicals that may be used in water treatment and any potential hazards arising from their use.

Time Allotted

1 Hour

Demonstrations

No demonstrations are required.

Supervised Practice

No supervised practice is required.

Lesson 2--Control of Solid Waste

Classroom Presentation

Conduct a lecture covering the topic of solid waste control. Included in the lesson are a discussion of the major objectives to be obtained in a solid waste disposal program, the various major sources of solid waste, and the alternative methods that can be used to control solid waste. The problems inherent in meeting the stated objectives are also discussed.

Time Allotted

1 Hour

Demonstrations

No demonstrations are required.

Supervised Practice

No supervised practice is required.

Unit Activities--Student	
Control of Industrial Wastes	Module 8 Unit 1

In order to complete the unit successfully, the student will be responsible for the following:

Lesson 1--Control of Industrial Water Quality

Classroom Activity

Attend a lecture covering the topic of the control of industrial water quality.

Assignment

The student should review the following materials prior to attending class.

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 8 Chapter 1	Section 8 Chapter 1
the Industrial Environment--its Evaluation and Control		Chapter 44
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 7 Chapter 5
Industrial Hygiene Engineering and Control		Section 7 Self-Test

In order to complete the unit successfully, the student will be responsible for the following:

Lesson 2--Control of Solid Waste

Classroom Activity

Attend a lecture covering the topic of the control of solid waste.

Assignment

The student should review the following materials prior to attending class.

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 8 Chpater 2	Section 8 Chapter 2
the Industrial Environment--its Evaluation and Control		Chapter 45
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 8 Chapter 1

Facilities, Equipment, and Materials	
Control of Industrial Wastes	Module 8 Unit 1

Facilities

Lecture--Normal classroom

Equipment

Educational Materials

Chalkboard
Chalk
Eraser
35 mm Slide Projector with Remote Control
Screen

Health and Safety

None required

Visuals

Slide Series--Industrial Hygiene Engineering and Control
Module 8, Unit 1

References Used in Class

Industrial Hygiene Engineering and Control
the Industrial Environment--its Evaluation and Control

Lesson Outline	
Control of Industrial Water Quality	Module 8 Unit 1 Lesson 1

TOPIC	REMARKS
	The lesson is designed as a one-hour lecture covering the topic of industrial waste water; its treatment and control. Included in the lesson is a discussion of the various uses of water in industry, the potential pollutants added to the water, and the treatment of waste water to remove the pollutants from the water before entry into the environment. Also discussed are the chemicals that may be used in water treatment and any potential hazards arising from their use.
I. Introduction	
A. Water is Important to Industry	Slide 8.1.1.1.--Industry Need for Water
1. Major location criteria is the location of an adequate water supply. 2. Many large industries located on rivers. 3. Aside from use of water as transportation medium, large quantities are used in processes.	
B. Uses of Water in Industry	Slide 8.1.1.2.--Uses of Water in Industry
1. As an additive to the product. 2. As a source of heating and cooling the plant. a. boilers b. evaporative cooling 3. As a source of heat exchange. 4. Sanitary services. 5. Product cleaning. 6. Fire protection. 7. Drinking water. 8. General housekeeping	
C. As water is used, it becomes polluted with waste products	Slide 8.1.1.3.--Water Pollutants
1. Disease-producing organisms.	

Lesson Outline	
Control of Industrial Water Quality	Module 8 Unit 1 Lesson 1

TOPIC	REMARKS
2. Chemicals. a. liquids b. gases 3. Solids of either organic or inorganic composition. 4. Radioactive materials. 5. Heat.	
D. The Water Cycle	Slide 8.1.1.4.--The Water Cycle
1. Source. a. lake b. river or stream c. wells d. municipal water supply	
2. Treatment. a. varys as to ultimate use and source (1) source may be treated (2) may require additives such as with boiler feed water (3) source may be direct from river, lake, etc., and require complete treatment b. potable water is required for drinking and some processes c. some processes, fire protection, etc., may not require potable water (1) some pretreatment may still be necessary (2) remove certain chemicals and solids	
3. Process use. a. during use, water becomes contaminated b. additional water may result at plant because of storm drains and runoff	

TOPIC	REMARKS
c. water becomes so contaminated that it cannot be used any longer	
4. Post treatment.	
a. waste may flow directly back to source	
b. waste may be placed in municipal sanitary system	
c. before waste water exits plant, treatment is required	
(1) eliminate environmental pollution	
(2) provide water in a condition in which it can be further treated by municipal system	
E. Water Conservation	
1. In some areas, source water is at a premium.	
2. Cost of treatment of water can justify conservation.	
3. Recycling of water is a major conservation approach.	
II. The Treatment of Water	
A. The General Process	
1. Treatment depends on use.	
2. Treatment of source water and waste water.	
a. in general, same process	
b. some additional care is given to drinking water	
3. Some specific treatments may vary because of required additives or potential contaminants in waste water.	
4. Process steps.	Slide 8.1.1.5.--The Treatment Process
a. sedimentation to remove large solids	
b. control of pH of water	

Lesson Outline	
Control of Industrial Water Quality	Module 8 Unit 1 Lesson 1

TOPIC	REMARKS
c. coagulation and flocculation (destabilization-conglomeration) d. filtration to further remove solids e. bacterial digestion to remove organic materials f. chemical additives to control disease-causing organisms g. aeration to remove odor and gases as well as control of organisms h. removal of waste sludge	
B. Sedimentation	Slide 8.1.1.6.--Sedimentation Tanks
1. First step is to remove large solids from water. 2. This step accomplished through use of sedimentation. a. large solids settle out over time b. settling ponds, lakes, or tanks can be used c. water is stored for a period of time before use to allow settling d. settled sludge must be removed occasionally	
3. Sludge removal. a. ponds require draining and removal of sludge by bulldozers b. tanks often have sloping bottoms c. tanks may have slowly rotating blades to push sludge to center where small stream of water washes away	Slide 8.1.1.7.--Cleaning Tanks
4. Where large solids include waste material such as paper, etc., an initial screening is done.	Slide 8.1.1.8.--Screening of Large Solids

Lesson Outline	
Control of Industrial Water Quality	Module 8 Unit 1 Lesson 1

TOPIC	REMARKS
B. Control of pH	Slide 8.1.1.9.--pH Control
1. Highly acid water must be neutralized to remove potential damage to piping and other equipment. 2. This is accomplished by adding an alkali to the effluent. 3. Often use caustic soda, quicklime, or trisodium phosphate. 4. In many cases, this control must be accomplished before waste leaves industrial plant to enter a municipal system.	
C. Coagulation and Flocculation (Destabilization-Conglomeration)	
1. Coagulation--addition of a chemical agent to cause small solids to stick together to form large solids.	Slide 8.1.1.10.--Coagulation
a. small solids remain in suspension--do not precipitate b. must be removed c. coagulant causes electric or interionic forces to exist to cause particles to stick together when in contact d. fast chemical process e. rapid agitation to increase contact f. common coagulant is alum or aluminum salts	
2. Flocculation.	Slide 8.1.1.11.--Flocculation
a. physical process in which particles become enmeshed or conglomerate b. slower process c. gentle mixing or agitation	

Lesson Outline	
Control of Industrial Water Quality	Module 8 Unit 1 Lesson 1

TOPIC	REMARKS
3. Generally two tanks used. a. coagulant tank with high agitation b. flocculation tank with gentle mixing	Slide 8.1.1.12.--Coagulation-Flocculation Process
D. Filtration	Slide 8.1.1.13.--Filtration
1. Sand and gravel beds. a. coarse on bottom b. fine on top	
2. As filter loads, flow slows but removes more solids.	
3. Must wash filter. a. backwash b. before filter becomes clogged c. before breakthrough can occur d. proper washing is important to maintain efficiency, flow, and odor control	
E. Bacterial Digestion	Slide 8.1.1.14.--Bacterial Digestion
1. Bacteria can feed on organic solids, yielding carbon dioxide and protein.	
2. Need of oxygen, temperature control, and food (sludge).	
3. Two types of systems.	
a. anaerobic process (1) O_2 is obtained from the materials in the sludge (2) generally process used in settling pond	Slide 8.1.1.15.--Anaerobic Process
b. aerobic (1) uses O_2 supply from air (2) aerate the settling tank	Slide 8.1.1.16.--Aerobic Process

TOPIC	REMARKS
(3) faster process (4) used when organic load is low	
4. Process usually involves either an aerobic system or an anerobic system followed by an aerobic system.	
5. Settling tanks with skimmers to remove floating solids are often used to keep system balance and clarify waste.	Slide 8.1.1.17.--Clarifiers
F. Control of Disease-Causing Organisms	Slide 8.1.1.18.--Control of Organisms
1. Addition of chemicals to kill various disease-causing organisms.	
2. Chlorine used in most cases.	
3. Some other methods of disinfection.	Slide 8.1.1.19.--Alternate Disinfection Methods
a. ultraviolet b. heat c. metal ions (silver) d. iodine e. ozone	
G. Aeration	Slide 8.1.1.20.--Aeration
1. May be done at various stages of treatment.	
2. Adds O_2 and other gases from air.	
3. Can help to remove some gases such as CO_2, H_2S, and CH_4.	
4. Types of aerators.	
a. spray b. waterfall c. multitray d. diffused air	
5. If aeration is done indoors, needs ventilation to remove CO_2, H_2S, and CH_4.	

Lesson Outline	
Control of Industrial Water Quality	Module 8 Unit 1 Lesson 1

TOPIC	REMARKS
H. Removal of Waste Sludge 1. Essentially two methods used. a. incineration b. removal to land fill 2. Need to remove excess water before removal. 3. Some potential for reclamation of energy in large industrial or municipal waste treatment plants	Slide 8.1.1.21.--Removal of Sludge
I. Other Treatments 1. Special additives may be required. a. general industrial (1) wetting agents (2) decalcifiers b. drinking water (1) salt (2) fluoridization 2. Control of level of fecal coliforms in water for drinking.	
III. Thermal Pollution A. Heat is added to water during many processes.	Slide 8.1.1.22.--Thermal Pollution
B. Effects of Thermal Pollution 1. Increases odor of organic material. 2. Can cause failure of subsequent waste water, particularly bacterial digestion. 3. Increases growth of algae. 4. Kills marine life.	Slide 8.1.1.23.--Effects of Thermal Pollution
C. Controls 1. Cooling towers. 2. Spray ponds.	

TOPIC	REMARKS
D. Cooling Tower Most Common 1. Water pumped to top. 2. Allowed to fall in spray or sheet form. 3. Tower contains baffles or decks. 4. Source of upward motion of air through tower. a. natural draft b. fan at top 5. Heat in water is exchanged to air through evaporative cooling.	Slide 8.1.1.24.--Cooling Tower
E. Problems 1. Evaporative cooling produces a fog from tower. 2. Fog can contain pollutants that are hazardous. 3. Drift--the effect of wind on movement of fog. 4. If possible, pollutants that are hazardous should be removed before cooling.	
IV. Cross-Connection of Water Sources	Slide 8.1.1.25.--Cross-Connection
A. Various Sources of Water May Be Used 1. Potable. 2. Cooling. 3. Fire protection. 4. Process (potable or nonpotable). 5. Recycled. 6. Waste.	
B. Inadvertent Cross-Connection of Sources Can Occur 1. Results in misuse of potentially hazardous water. 2. Coding and labeling of supplies can help prevent this occurrence.	

Lesson Outline	
Control of Industrial Water Quality	Module 8 Unit 1 Lesson 1

TOPIC	REMARKS
3. Piping layouts that are properly labeled should be prepared and consulted.	
C. In some cases, it is desirable to have cross-connection sources	
1. Makeup on recycled water. 2. Connection of public water supply to plant supply. 3. Connection of public water supply for makeup.	
D. Cross-connection can result in contamination of the source of clean water	
1. Back pressure developed that causes contaminated water to flow back into pipe. 2. Causes of back pressure.	
a. reduced pressure in one supply line b. interrupted supply c. excessive demand d. breaks in lines e. freezing f. improper sizing of piping	
E. Control of Cross-Connections	
1. Review all piping for cross-connections. 2. Eliminate cross-connections where possible. 3. Use of vertical fall into storage tank or reservoir.	Slide 8.1.1.26.--Head Tank
a. no direct connection b. requires overflow so water level does not reach input supply of cleaner water	
4. Use of movable connection when supplied must not be directly connected at all times.	

TOPIC	REMARKS
V. Control of Hazardous Materials in Water Treatment	
A. Chemicals Used in Coagulation	Slide 8.1.1.27.--Chemicals Used in Coagulation
1. Review slide.	
a. name b. formula c. form d. handling materials e. TLV f. flammability	
2. Comments.	
a. tests have indicated that aluminum sulfate has an undetermined toxicity for animals b. bentonite exhibits a LD_{50}:35 mg/kg for intravenous injection of rats c. ferric chloride exhibits little or no toxicity orally; however, acute toxicity for intravenous--LD_{50}:7.2 mg/kg d. ferric sulfate is much less toxic for intravenous--LD_{50}:99 mm/Kg	
B. Chemicals Used in Disinfection	Slide 8.1.1.28.--Chemicals Used in Disinfection
1. Review slide.	
a. name b. formula c. form d. handling materials e. TLV f. flammability	
2. Comments.	
a. these chemicals extremely toxic. b. care in handling and control is required	

Lesson Outline	
Control of Industrial Water Quality	Module 8 Unit 1 Lesson 1

TOPIC	REMARKS
C. Chemicals Used in pH Control 1. Review slide. a. name b. formula c. form d. handling materials e. TLV f. flammability 2. Comments. a. some potential for hazards b. materials are irritants	Slide 8.1.1.29.--Chemicals Used in pH Control

Practice Exercises	
Control of Industrial Water Quality	Module 8 Unit 1 Lesson 1

1. Review the case study on AMF Corporation presented in Module 1. List the requirements for water that this plant would have. What waste treatment facilities are necessary, given the fact that no municipal system is present to handle the waste?

2. For the above situation, design a waste treatment process that will meet the requirements of removing pollutants before the materials are dumped into a nearby river. Use estimates of water usage to determine the size requirements of the waste treatment facility.

Lesson Outline	
Control of Solid Waste	Module 8 Unit 1 Lesson 2

TOPIC	REMARKS
	This lesson is designed as a one-hour lecture covering the topic of solid waste control. Included in the lesson are a discussion of the major objectives to be obtained in a solid waste disposal program, the various major sources of solid waste, and the alternative methods that can be used to control solid waste. The problems inherent in meeting the stated objectives are also discussed.
I. Introduction	
A. Disposal of Solid Waste Is a Problem	Slide 8.1.2.1.--The Solid Waste Problem
1. Manufacturing process creates a significant amount of solid waste. 2. This waste must be removed from the process area and disposed of. 3. Method of disposal can be a problem.	
a. potential health hazard b. economics c. environmental pollution	
B. The Objectives of a Solid Waste Disposal Program	
1. To dispose of solid waste in such a manner that it does not cause potential health hazard.	Slide 8.1.2.2.--Objective 1
a. to the workers exposed during movement b. to the public as a result of ultimate disposition	
2. To dispose of solid waste in such a manner that the effect on the environment is minimized.	Slide 8.1.2.3.--Objective 2

TOPIC	REMARKS
a. disposal is likely to have some effect on the environment b. attempt should be to minimize this effect	
3. To dispose of solid waste in such a manner that the maximum utility and conservation of waste is obtained before disposal.	Slide 8.1.2.4.--Objective 3
a. by extracting that material that has value b. in many cases, economics result in dispqsal of valuable materials	
4. To dispose of solid waste in such a manner that the economic cost is minimized.	Slide 8.1.2.5.--Objective 4
a. handling and disposal costs must be considered b. reclamation costs are important	
II. Sources of Industrial Waste	
A. Raw Material Extraction	Slide 8.1.2.6.--Raw Material Extraction
1. Raw material extraction involves such industries as:	
a. mining b. lumber c. agriculture d. fishing	Slide 8.1.2.7.--Typical Extraction Industries
2. Basic raw materials are obtained from the environment.	
3. Effect of the extraction is massive amounts of waste products.	
a. only a small amount of material extracted is usable b. waste or unwanted materials must be disposed of	

TOPIC	REMARKS
c. in mining, large amounts of rock and soil must moved from face of mine to surface in significant quantities	Slide 8.1.2.8.--Extracted Wastes
d. in lumber industry, much larger portion of raw material is reclaimed but still waste occurs	
e. agriculture results in plant and animal wastes that, though organic, must be disposed of	
B. Process Industries	Slide 8.2.1.9.--Process Industries
1. Basic raw materials are converted into usable products that may or may not require further processing.	
a. chemical b. basic iron and steel c. plastics d. oil refining e. paper f. power production	Slide 8.2.1.10.--Typical Process Industries
2. Process industries generate wastes during the processing of the materials into usable form.	
3. Examples of waste.	Slide 8.2.1.11.--Process Wastes
a. slag from iron and steel production b. particles removed from air during air-cleaning operation c. spent fuel rods from nuclear power plant may present most difficult disposal problem	

TOPIC	REMARKS
C. Manufacturing and Assembly	Slide 8.1.2.12.--Manufacturing and Assembly
1. Manufacturing and assembly involves the conversion of processed materials into usable products.	
a. metal fabrication b. assembly c. soft goods d. construction	Slide 8.1.2.13.--Typical Manufacturing and Assembly Industries
2. Waste products are a result of trimming and machining loss of materials and parts used in the assembly and manufacture of the usable end product.	
a. airborne particulates from milling and machining b. trimmings and waste in textiles c. excess materials from construction	Slide 8.1.2.14.--Manufacture and Assembly Wastes
D. Packaging	Slide 8.1.2.15.--Packaging
1. Packaging can occur at any transfer point between the various stages of production or industries as well as to the consumer. 2. Packaging waste is a major problem. 3. Package serves no usable function other than protection of the product. 4. When protection is no longer needed, packaging is discarded.	
E. Consumer Use	Slide 8.1.2.16.--Consumer Use
1. Once the product has served its useful life, it is discarded.	

Lesson Outline	
Control of Solid Waste	Module 8 Unit 1 Lesson 2

TOPIC	REMARKS
2. Cost of waste is significant. a. removal b. environmental pollution 3. Problems of throw-away society.	
III. Control of Solid Waste	Slide 8.1.2.17.--Control of Solid Waste
A. Three Alternatives are Available 1. Sanitary landfill. 2. Incineration. 3. Recycling.	Slide 8.1.2.18.--Three Alternatives
B. Use of Sanitary Landfill	Slide 8.1.2.19.--Sanitary Landfill
1. Cost of transport to fill is high. 2. Land is a scarce resource. 3. Location is important. 4. Drainage away from fill must be controlled so as not to contaminate water sources. 5. Fill is built in layers. 6. For toxic and radioactive materials. a. encase in container to protect surrounding environment b. selection of area must consider geologic structure and potential for earthquake c. often buried deep in abandoned mines or caves	Slide 8.1.2.20.--Landfill Design
C. Incineration	Slide 8.1.2.21.--Incineration
1. Objective is to reduce volume of materials to be disposed of. 2. Incineration can also destroy some of the potentially dangerous materials.	Slide 8.1.2.22.--Objective of Incineration

Lesson Outline	
Control of Solid Waste	Module 8 Unit 1 Lesson 2

TOPIC	REMARKS
3. Incineration results in potential for contamination of air. a. need to control emissions from incinerator b. use of various types of air cleaners is necessary (1) particulate (2) gases	Slide 8.1.2.23.--Potential Contimination from Incineration
4. Residual ash from incineration must be transported to landfill.	
D. Recycling	Slide 8.1.2.24.--Recycling
1. Waste products often contain valuable materials. a. if materials can be extracted, then these materials can be recycled b. extraction can be costly and difficult	
2. By-products of incineration may yield valuable materials. a. combustion gases b. heat c. potential energy source	
3. Consideration of waste recycling in the initial production design.	
4. Example of design for recycling. a. hazardous material b. presents potential exposure c. design package to be used along with product in the process d. removes potential hazard e. removes cost of disposal of waste materials	Slide 8.1.2.25.--Design for Recycling

Lesson Outline	
Control of Solid Waste	Module 8 Unit 1 Lesson 2

TOPIC	REMARKS
E. Compaction and Grinding	Slide 8.1.2.26.--Compaction and Grinding
1. When the landfill approach is used, a potential method for reduction of volume is to compact and/or grind waste.	
2. Compaction reduces volume but does not change form.	
3. Grinding reduces volume and changes form to a slurry.	Slide 8.1.2.27.--Schematic of Flow
a. water added for form slurry	
b. this allows for transport of waste into sluice or pipes; thus lowering cost of removal from source	
c. water can be extracted at destination	
d. sludge can be incinerated or carried to landfill	
e. nongrindable materials are ejected to be removed in normal fashion	
f. applicable for certain types of waste	
F. Composting--To dispose of organic waste in manner such that usable product is obtained (fertilizer)	
IV. Meeting the Objectives	
A. Objectives	Slide 8.1.2.28.--Objectives of Solid Waste Disposal
1. Removal of potential health hazard.	
2. Minimize harmful effect on environment.	
3. Obtain maximum utility and conservation of waste.	
4. Minimize economic cost of waste removal.	
B. Competing Objectives	Slide 8.1.2.29.--Competing Objectives
1. No easy answer.	
2. To meet one objective completely, may have a negative effect on other objectives.	

Lesson Outline		
Control of Solid Waste		Module 8 Unit 1 Lesson 2
TOPIC		REMARKS
C. Removal of Potential Health Hazard 1. Method of disposal may introduce a potential exposure. a. workers may be exposed as waste is transported b. potential air pollution from incineration c. landfill may expose public to hazards as a result of drain off 2. Potential development of disease organisms or rodent population as a result of disposal of nontoxic organic substances. 3. Public health agencies are charged with control of waste disposal to promote this objective. a. difficult task b. cannot cover all potential problem areas 4. What is the responsibility of industry to protect public health without governmental interventions? a. kepone b. PCB c. mine acid drainage 5. Cost to industry is great but cost to general public and economy may be even greater. 6. This objective is not going to be met easily.		Slide 8.1.2.30.--Removal of Potential Health Hazard Note: If time allows this subject could be the source of a lively discussion. Where does industry's responsibility end? What alternatives are available? The pollutants listed have had a significant impact on the public and the general economy.
D. Minimize Harmful Effect on the Environment 1. The same dilemma exists in terms of responsibility for the environment.		Slide 8.1.2.31.--Protection of Environment

TOPIC	REMARKS
2. Environmental Protection Agency is responsible for enforcement of standards. 3. Long-term effect on environment should be considered. 4. Consumer products are discarded after useful life.	
E. Utility and Conservation of Waste 1. Natural resources are limited. 2. In order to conserve resources, valuable materials in waste should be recovered. a. cost of recovery b. value of resource recovered c. as resource becomes more difficult to obtain, cost increases and recovery becomes more feasible	Slide 8.1.2.32.--Utility and Conservation of Waste
F. Economic Cost of Waste Disposal 1. Waste disposal introduces a cost that must be borne by the industry. 2. Lowest cost method to industry may be to dump into sanitary landfill. 3. This approach may result in the highest cost to public. 4. Industry management is responsible to stockholders first. a. maximize profit b. cost of waste removal lowers profits or increases product cost 5. Industry also has responsibility to community in which it lives. a. poor practices may increase long-term costs b. public relations 6. Indication of need for regulatory agency such as EPA.	Slide 8.1.2.33.--Economics of Removal

Practice Exercises	
Control of Solid Waste	Module 8 Unit 1 Lesson 2

1. Review the case study on AMF Corporation presented in Module 1 to determine the sources of solid waste that are present. Develop a written program outline to remove and dispose of the solid wastes generated in the plant.

2. Assume you are an industrial hygienist and that your company is being accused of causing a health hazard as a result of the drainage of toxic materials from a landfill into a stream that serves as the water source for a nearby community. How would you handle this accusation? Develop a written plan of action.

UNIT 2

CONTROL OF HAZARDOUS MATERIALS

Performance Objectives		
Lesson	Control of Hazardous Materials	Module 8 Unit 2
1	1. Given no aids, the student will be able to recall and describe in writing the definition of a hazardous material.	
1	2. Given no aids, the student will be able to recall and list the major areas where control of hazardous materials is required in the plant.	
1	3. Given no aids, the student will be able to recall and list at least six (6) pieces of data or information that should be obtained from the supplier of a given material.	
1	4. Given no aids, the student will be able to recall and list the five (5) general questions that should be answered concerning the use of hazardous materials in the plant.	
1	5. Given no aids, the student will be able to recall and describe in writing how the technique of Failure Mode and Effect can be used to identify the potential exposure of workers to hazardous materials.	
1	6. Given no aids, the student will be able to recall and list at least six (6) basic rules for handling hazardous materials.	
1	7. Given no aids, the student will be able to recall and list at least ten (10) types of data that would be contained in an information system for hazardous materials and employee exposure.	
1	8. Given no aids, the student will be able to describe in writing at least five (5) uses that might be made of an information system containing data concerning hazardous materials and employee medical and work history.	
2	9. Given no aids, the student will be able to recall and list in writing six (6) basic categories of protection that might be required by the worker.	
2	10. Given no aids, the student will be able to recall and list in writing the three basic types of respirators that can be employed in the workplace.	
2	11. Given no aids, the student will be able to recall and describe in writing the major operational characteristics of the following types of respirators: a. canister type b. cartridge type c. mechanical filter type d. hose mask type e. air-line type f. abrasive blasting type g. recirculation type h. open circuit type The student will be able to describe how the unit works and when it should be used.	

Performance Objectives		
Lesson	Control of Hazardous Materials	Module 8 Unit 2
2	12. Given no aids, the student will be able to recall and list in writing the seven (7) major factors that should be considered when choosing a respirator.	
2	13. Given no aids, the student will be able to recall and list in writing at least eight (8) precautions that should be taken when using a respirator.	
2	14. Given no aids, the student will be able to recall and list in writing at least one type of protective equipment for hazards involving the following: a. face b. eyes c. hands d. skin e. feet f. head g. nose h. exposure of body	

Unit Activities--Instructor	
Control of Hazardous Materials	Module 8 Unit 2

In order to present the unit material to the student, the instructor will be responsible for the following:

Lesson 1--Purchase, Handling, and Storage of Hazardous Materials

Classroom Presentation

Conduct a lecture covering the topic of the purchase, handling, and storage of hazardous materials. Included in the lesson is a discussion of the need for material specification data to be available to enable the industrial hygienist to identify and apply the appropriate controls in the handling, storage, and use of hazardous materials. Problems related to the handling and storage of hazardous materials are also discussed.

Time Allotted

1 Hour

Demonstrations

No demonstrations are required.

Supervised Practice

No supervised practice is required.

Lesson 2--Personal Protective Equipment

Classroom Presentation

Conduct a lesson on the topic of personal protective equipment. The emphasis of the lesson is on protective equipment that is used when potential exposure to hazardous materials exists. Of particular importance is the discussion of the various types of respirators. Three major types of respirators are covered: the air purifying respirator, the air supplied respirator, and the self-contained breathing unit. Other protective equipment is briefly discussed, such as protection for the skin, face, and eyes.

Time Allotted

1 Hour

Demonstrations

It is suggested that each type of equipment discussed be displayed for the class. The display can be referred to during the discussion of each particular piece of equipment. If time allows, each type should be tried out by the students so that they might experience the feeling of the worker. (See Practice Exercise 3).

Supervised Practice

No supervised practice is required.

Unit Activities--Student	
Control of Hazardous Materials	Module 8 Unit 2

In order to complete the unit successfully, the student will be responsible for the following:

Lesson 1--Purchase, Handling, and Storage of Hazardous Materials

Classroom Activity

Attend a lecture covering the topic of the purchase, handling, and storage of hazardous materials.

Assignment

The student should review the following materials prior to attending class.

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control		Section 8 Chapter 3
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 8 Chapter 2

Unit Activities--Student	
Control of Hazardous Materials	Module 8 Unit 2

In order to complete the unit successfully, the student will be responsible for the following:

Lesson 2--Personal Protective Equipment

Classroom Activity

Attend a lecture covering the topic of personal protective equipment.

Assignment

The student should review the following materials prior to attending class.

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 8 Chapter 4	Section 8 Chapter 4
the Industrial Environment--its Evaluation and Control		Chapter 36
Optional Basic Elements of Respiratory Protection		Complete Booklet
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 8 Chapter 3

Facilities, Equipment, and Materials	
Control of Hazardous Materials	Module 8 Unit 2

Facilities

Lecture--Normal Classroom

Equipment

Educational Materials

Chalkboard
Chalk
Eraser
35 mm Slide Projector with Remote Control
Screen

Health and Safety

Respirators of the following types:

Canister
Cartridge
Mechanical Filter
Air-Line
Hose Mask
Abrasive Blasting
Recirculating Self-Contained Breathing
Open Circuit Self-Contained Breathing

Other Equipment

Safety Glasses
Goggles
Face Shield
Helmet
Gloves
Apron
Cut-Away Safety Shoes

Visuals

Slide Series--Industrial Hygiene Engineering and Control
Module 8, Unit 2

References Used in Class

Industrial Hygiene Engineering and Control
the Industrial Environment--its Evaluation and Control
Basic Elements of Respiratory Protection

Lesson Outline	
Purchase, Handling, and Storage of Hazardous Materials	Module 8 Unit 2 Lesson 1

TOPIC	REMARKS
	This lesson is designed as a one-hour lecture covering the topic of the purchase, handling, and storage of hazardous materials. Included in the lesson is a discussion of the need for material specification data to be available to enable the industrial hygienist to identify and apply the appropriate control in the handling, storage, and use of hazardous materials. Problems related to the handling and storage of hazardous materials are also discussed.
I. Introduction	
A. What are Hazardous Materials?	Slide 8.2.1.1.--Hazardous Materials
1. Any material that can have an injurious effect on the health of the worker. 2. The effect may be acute or chronic. 3. The effect may be relatively minor, or it may be fatal. 4. In addition, any material that can result in the potential of fire or explosion.	
B. Hazardous Materials May Take the Form of	Slide 8.2.1.2.--Form of Hazardous Materials
1. Liquid 2. Solids of various forms 3. Gases	
C. Form of material will, to some extent, dictate the handling and storage methods	
D. Level of toxicity or flammability will dictate the care that must be exercised in handling and storing particular materials.	
E. One major problem is to identify potentially hazardous materials.	
1. Not simply done.	

TOPIC	REMARKS
2. Many compounds contain toxic or flammable materials that are not identified. 3. Materials are often coded to protect identity. 4. Multitude of chemicals and chemical compounds in use in industry. 5. Multitude of brand names.	
II. Areas of Control of Hazardous Materials	
A. Major Areas Where Control of Hazardous Materials Is Required 1. Entry to plant. 2. Handling and movement. 3. Storage in the plant. 4. Use in process. 5. Waste products generated from process. 6. Shipment of product to ultimate user.	Slide 8.2.1.3.--Areas of Control of Hazardous Materials
B. Entry to Plant 1. The first place to identify and control hazardous materials is at entry to plant. 2. If not identified at entry, control is difficult.	Slide 8.2.1.4.--Control at Entry
C. Handling and Movement in Plant 1. Most difficult to control as large number of workers can be exposed. 2. Transfer points are especially crucial.	Slide 8.2.1.5.--Control of Handling
D. Storage of Materials 1. On surface, seems to be relatively safe. 2. However, even in storage, materials can present a potential hazard. 3. Danger is likely to go unnoticed unless action to identify problems is taken.	Slide 8.2.1.6.--Control of Storage

Lesson Outline		
Purchase, Handling, and Storage of Hazardous Materials		Module 8 Unit 2 Lesson 1
TOPIC		REMARKS
E. Processes Using Hazardous Materials 1. Major control is through ventilation. 2. Chemical changes in the process can result in in-process materials that may not be known.		Slide 8.2.1.7.--Control in Process
F. Control of Waste Products 1. Process may convert harmless materials into hazardous waste. 2. Waste products cannot be dumped into environment. 3. Control is necessary to protect workers from exposure to hazardous waste when handling. 4. Control is necessary to protect environment and general public.		Slide 8.2.1.8.--Control in Waste
G. Shipment to Ultimate User 1. Product safety. 2. Need to provide user information.		
III. Purchase of Hazardous Materials		Slide 8.2.1.9.--Purchase Control
A. Initial Step in Control 1. Identify hazardous material before entry into plant. 2. Identify at purchase time. 3. In this way can plan for protection of plant personnel from first entry of materials into plant. 4. Cannot provide protection if do not know problem exists.		

Lesson Outline	
Purchase, Handling, and Storage of Hazardous Materials	Module 8 Unit 2 Lesson 1

TOPIC	REMARKS
B. Need to work closely with purchasing agent to develop procedures to handle purchase of hazardous materials.	
1. Purchasing agent may require education concerning the problem and need for control.	
2. Procedures should be developed to identify responsibilities.	
a. purchasing agent b. industrial hygienist	
3. Objective is to identify hazardous materials prior to purchase.	Slide 8.2.1.10.--Objective of Purchase Control
a. allows for potential of substitution of less hazardous material b. allows for development of procedures that can be used to control materials before they enter plant c. without prior identification, probability of exposure of workers is greatly increased.	
C. Manufacturer or supplier is major source of information concerning potentially hazardous materials	
1. Arrange to discuss potential problem with purchasing agent and supplier.	
2. Develop a data sheet on chemicals to be supplied along with bid from supplier.	
3. Do not purchase without complete information.	
4. Responsibility will be with buyer concerning exposure of workers to hazardous materials.	

Lesson Outline		
Purchase, Handling, and Storage of Hazardous Materials		Module 8 Unit 2 Lesson 1
TOPIC		REMARKS
D. Information to Obtain from Supplier		
1. Certain basic information should be obtained.		
2. Product specification data requirements should be developed (Material Safety Data Sheet).		
3. Components of specification data requirements.		Slide 8.2.1.11.--Components of Specifications
a. chemical compound name		Slide 8.2.1.12.--Compound Name
b. chemicals that are present in compound		Slide 8.2.1.13.--Chemical Composition
c. toxicity		Slide 8.2.1.14.--Toxicity
(1) level of toxicity (2) type of hazard (3) TLV if applicable		
d. flammability		Slide 8.2.1.15.--Flammability
(1) UEL (2) LEL (3) flash point		
e. any incompatible materials		Slide 8.2.1.16.--Incompatabilities
(1) avoids potential reaction between chemicals (2) provides information concerning location and type of storage		
f. form of material		Slide 8.2.1.17.--Material Form
(1) liquid (2) gas (3) solid		
g. packaging of material as delivered		Slide 8.2.1.18.--Packaging
(1) type of packaging used (2) quantity/package		

TOPIC	REMARKS
h. any recommendations concerning handling, storage and use of materials	Slide 8.2.1.19.--Handling Recommendations
i. an example of label used on product	Slide 8.2.1.20.--Labeling
(1) label may not be adequate (2) specific labeling may be requested	
j. other information	Slide 8.2.1.21.--Other Information
(1) molecular weight (2) specific gravity (3) specific heat (4) solubility (5) vapor pressure	
E. Present Materials in Use	
1. Many chemicals may be in use for which information does not exist.	
2. The same information should be obtained for these materials.	
3. Review of presently used materials should be conducted.	
a. potential hazards b. possible substitutions c. precautions advised d. methods of control currently used and the adequacy of these methods	
F. Development of a Data Base of Hazardous Materials	Slide 8.2.1.22.--Hazardous Material Data Base
1. Where many compounds and materials are in use, the data available are voluminous.	
2. A system should be developed to organize the materials into a logical format that can be used on a day-to-day basis.	

TOPIC	REMARKS
3. Also, the data included will need to be expanded to include other information. 4. The data base can be a tool of significant use in the recognition, evaluation, and control of hazardous materials.	
IV. Suggested Data Base for Hazardous Materials	Slide 8.2.1.23.--Components of a Data Base
A. Include data as provided from the product specifications by supplier	Slide 8.2.1.24.--Supplier Information
1. Chemical names and composition. 2. Toxicity. 3. Flammability. 4. Form of material. 5. Incompatabilities 6. Packaging. 7. Handling and use recommendations. 8. Labeling. 9. Other information.	
B. Other Data to be Included	
1. Where is the material used?	Slide 8.2.1.25.--Where Used
a. locations in the plant where material is used b. what processes are involved? c. where is the material stored? d. where is the material handled or moved?	
2. When is the material used?	Slide 8.2.1.26.--When Used
a. material may not be used at all times b. may be used on different shift c. may be used for different process schedules	

Lesson Outline	
Purchase, Handling, and Storage of Hazardous Materials	Module 8 Unit 2 Lesson 1

TOPIC	REMARKS
3. Why is the material used?	Slide 8.2.1.27.--Why Used
a. what is the purpose of use?	
(1) solvent (2) cleaner (3) product component (4) other	
b. this information may assist in determining substitutes	
4. How is the material used?	Slide 8.2.1.28.--How Used
a. what procedure is followed in use of product?	
(1) loading, unloading (2) handling (3) use in process	
b. what equipment is used to process the material?	
c. describe the process and how it works	
(1) open or closed process (2) interim chemical reactions and materials (3) steps in process	
d. identify potential exposures	
(1) during normal operations (2) when system failures occur (3) not easy to do, will require significant research	
e. identify the controls currently in use	

TOPIC	REMARKS
5. Who is potentially exposed? a. records should be kept on employee work history b. does individual work in area where potential exposure to material exists? c. what does employee do to bring in contact with material? d. what is employee's health history? e. this type of information is usable in other areas such as noise, thermal stress, and ergonomic exposures.	Slide 8.2.1.29.--Who Uses
6. What materials should be included in such a base of information? a. ideally, all materials b. practically (1) materials with TLV (2) materials that are suspected carcinogens (3) materials that are flammable or explosive (4) materials that have incompatible reactions with other materials used	Slide 8.2.1.30.--What Materials to Include
7. Other information that might be included. a. accepted methods for sampling to determine if below TLV b. history of sampling results (1) when (2) where (3) how (4) results	Slide 8.2.1.31.--Other Information

TOPIC	REMARKS
c. history of problems that have occurred d. type of problems that result from exposure (1) dermatitis (2) physiological reaction (3) carcinogenic (4) other	
C. Computerization of Records	
1. Potential for developing a computer-based information system exists. a. hazardous materials b. employee health and work history	
2. Not all information needs to be computerized. a. key information kept on computer b. back-up information kept in files	
3. Uses of such a system. a. identify possible causative agents when illness occurs b. identify potential problem areas where control may be necessary c. spot potential areas where emergencies could occur d. indicate need for monitoring e. provide basis for scheduling of monitoring f. indicate areas where substitution of material may be made	Slide 8.2.1.32.--Uses of Computerized System

Lesson Outline	
Purchase, Handling, and Storage of Hazardous Materials	Module 8 Unit 2 Lesson 1

TOPIC	REMARKS
V. Handling of Hazardous Materials	Slide 8.2.1.33.--Handling of Hazardous Materials
A. During handling. potential for exposure is high	
1. Worker comes in close contact with material.	
2. Danger of accident or failure of equipment increases potential for exposure.	
3. As material is transferred through plant, many workers are potentially subjected to exposure.	
B. One method of control is to eliminate the contact with workers	Slide 8.2.1.34.--Eliminate Contact
1. Automatic process for handling.	
2. This removes worker from area.	
C. Use of Failure Mode and Effect Analysis	Slide 8.2.1.35.--Failure Mode and Effect
1. Where and how can failures in system occur?	
2. What effect will such failures have?	
3. What potential controls can be instituted?	Note: At this point, it may be worthwhile to discuss a system using FMEA. Take a typical system for handling and storing a hazardous material and determine
a. reduce possibility of failure b. protect workers in case of failure	--what can go wrong --what might be cause --what will result --what controls can be implemented
4. Develop procedures to be instituted in case of emergency.	A possible system might be the delivery, handling, storage, processing, and waste removal of nuclear fuel rods.

Lesson Outline	
Purchase, Handling, and Storage of Hazardous Materials	Module 8 Unit 2 Lesson 1

TOPIC	REMARKS
D. Some Basic Rules for Handling Hazardous Materials 1. Provide workers with emergency protective equipment. 2. Provide workers with training as to danger and action to take when exposure is likely. 3. As much as possible, remove man from job. 4. Provide adequate ventilation when handling is done in open. 5. Provide maintenance and cleanup crews with training as to danger, emergency procedures. 6. Assure that outside factors do not affect materials. a. sparking in flammable area b. introduction of incompatible materials 7. Assure proper maintenance and inspection of handling equipment. 8. Assure integrity of packaging and transfer equipment. 9. Minimize potential exposure by moving through plant in off hours or in relatively vacant areas.	Slide 8.2.1.36.--Basic Handling Rules
VI. Storage of Hazardous Materials A. Storage Area 1. Location. a. as much as possible, away from work areas b. outside or underground 2. Do not store incompatible materials in same area.	Slide 8.2.1.37.--Storage of Hazardous Materials

TOPIC	REMARKS
3. Be aware of environmental conditions. a. heat b. humidity B. Provide proper storage containers and stacking. C. Be sure containers are well maintained and inspected periodically. D. Proper cleaning is essential if materials stored in tanks are to be changed. E. Provide adequate sprinkling system where flammable materials are stored. F. Inspect storage facilities on a regular basis to indentify potential problems. G. Use bonded and grounded tanks for storage of flammable materials.	

Practice Exercises	
Purchase, Handling, and Storage of Hazardous Materials	Module 8 Unit 2 Lesson 1

1. Using the case study presented in Module 1 (AMF, Inc.) identify hazardous materials that might be used and develop an information base to describe the materials and their use. Assume a computer is present and available for use in a computerized data base to identify and provide information concerning potential exposures to hazardous materials. Develop and describe a system for use by AMF. Include a description of the data that might be placed on the computer and that which would remain in back-up files. Describe how you would use such a system as an industrial hygienist for AMF. Note: Assume that a large number of such materials are used to justify the use of a computer.

2. Using the same case study, follow one potentially hazardous material through the process. Where can failures occur that will expose workers to the material? What controls can be instituted to minimize the danger of such failures?

3. As a recently hired industrial hygienist for a large chemical processing plant, you are concerned about exposures to hazardous materials. Develop a written plan of action that you can follow to determine the extent of the problem and institute appropriate controls for problem areas. Assume you are the first such individual to work in the plant and that previously the health of the employee was the responsibility of an individual with very little knowledge of the occupational health and safety field.

Lesson Outline	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

TOPIC	REMARKS
	This lesson is designed as a one-hour lesson on the topic of personal protective equipment. The emphasis of the lesson is on protective equipment that is used when potential exposure to hazardous materials exists. Of particular importance is the discussion of the various types of respirators. Three major types of respirators are covered: the air purifying respirator, the air supplied respirator, and the self-contained respirator. Other protective equipment is briefly discussed, such as protection for the skin, face, and eyes.
I. Introduction	
A. Hazards in Workplace Take Many Forms	Slide 8.2.2.1.--Form of Hazards
1. Gases	Slide 8.2.2.2.--Gases
a. toxic gases may be inhaled and attack respiratory system b. gases can enter the bloodstream such as in case of CO. c. gases can also act on the skin and eyes	
2. Vapor, mists, and fog.	8.2.2.3.--Vapor, Mists, and Fog
a. act in essentially the same manner as gas in respiratory system b. exposure of skin to vapor can be harmful c. types of gases and vapors (1) irritants resulting in inflammation (2) asphyxiants interfere with body use of O_2 (simple and chemical) (3) systemic absorbed into system	

Lesson Outline	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

TOPIC	REMARKS
3. Particulate matter. a. small particles may be inhaled b. can enter eyes c. very small particles can enter bloodstream d. types of particulates (1) nuisance causing discomfort (2) fibrosis producing (3) irritants cause inflammation (4) sensitizers result in sensitive reaction of body (5) systemic are absorbed into system	Slide 8.2.2.4.--Particulate Matter
4. Liquids. a. can be absorbed through skin--systemic action b. can enter and harm eyes c. can be ingested (1) accidentally (2) failure to clean thoroughly before smoking or eating	Slide 8.2.2.5.--Liquids
5. Fumes and smoke. a. may be inhaled and enter respiratory tract. b. may act on skin c. may enter eyes	Slide 8.2.2.6.--Fumes and Smoke
6. Other hazards. a. noise b. electromagnetic radiation c. traumatic	Slide 8.2.2.7.--Other Hazards
B. Personal Protective Equipment as a Control 1. Other controls should be implemented first. a. ventilation b. substitution	Slide 8.2.2.8.--Personal Protective Equipment

Lesson Outline	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

TOPIC	REMARKS
c. engineering changes d. removing worker from contact with source (isolation of worker or source)	
2. Personal protective equipment is a last resort.	Slide 8.2.2.9.--Last Resort
a. in the case of an emergency b. when other controls fail c. when no other control exists and job is required	
C. Basic Categories of Protective Equipment	Slide 8.2.2.10.--Categories of Protective Equipment
1. Protection from inhalation of hazardous materials. 2. Protection from skin contact with hazardous materials. 3. Protection of eyes. 4. Protection of ears. 5. Protection from traumatic injury to body part. 6. Protection from thermal stress.	
II. Protection from Respirable Hazards	Slide 8.2.2.11.--Respirators
A. Three Basic Types of Personal Protectors Available	
1. Air purifying respirators.	Slide 8.2.2.12.--Air Purifying Respirators
a. canister type b. cartridge type c. mechanical filter	
2. Air supplied respirators	Slide 8.2.2.13.--Air Supplied Respirators
a. hose mask type b. air-line respirator c. abrasive blasting type respirator	
3. Self-contained breathing.	Slide 8.2.2.14.--Self-Contained Breathing Type
a. recirculation b. open circuit	

Lesson Outline	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

TOPIC	REMARKS
B. Selection of Proper Respirator 1. Proper respirator must be used or else may provide false security and potential harm to worker. 2. Respirator should be selected for the specific application. 3. Major factors to consider. a. what is the hazardous material? b. what are its characteristics? (1) chemical properties (2) physiologic reaction (3) concentration c. under what conditions is the worker exposed? (1) normal work conditions (2) emergency conditions d. how long will the worker require protection? (1) quick escape (2) time to perform work duties e. the type of activity to be performed while using respirator f. any additional protection that may be required (1) eyes (2) skin (3) may act as a systemic agent through exposed skin g. use approved respirators (1) NIOSH approves (2) MESA approves	Slide 8.2.2.15.--Major Selection Factors

Lesson Outline	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

TOPIC	REMARKS
h. rating of respirators	
(1) protective factors; ratio of contaminant in atmosphere to that being breathed using a respirator	
(2) as protective factor increases, the respirator is more efficient	
C. Air Purifying Respirators	Slide 8.2.2.16.--Air Purifying Respirators
1. Purpose is to remove contaminants from the air that is respired.	
2. Sufficient oxygen must be present to support life.	
3. Canister type.	Slide 8.2.2.17.--Canister Type
a. full face piece b. hose connecting mask to canister. c. canister is filled with material that chemically reacts with a particular known contaminant to render harmless	It is suggested that a display including each type of respirator be present in classroom. Instructor can refer to display during the discussion of each type of respirator.
(1) materials vary (2) generally limited to certain concentration stated by manufacturer	
(3) canisters include chemical sorbent for materials such as	Slide 8.2.2.18.--Canisters for Various Materials
-acid gases -organic vapors -carbon monoxide -vinyl chloride -ammonia -hydrogen sulfide -chlorine	

Lesson Outline	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

TOPIC	REMARKS
(4) color coding of canisters is used -white--acid gas -black--organic vapors -green--ammonia -blue--carbon monoxide -various color stripes	Slide 8.2.2.19.--Color Coding Point out various canisters and color coding in display.
d. life of canister varies (1) breathing rate (2) temperature of atmosphere (3) humidity (4) concentration of contaminant (5) standards for life specified by Bureau of Mines (6) generally around 30 min but can get larger size canisters	8.2.2.20.--Canister Life
e. canister may have window to indicate usage (1) window has reference-half circle of a color (2) as canister is used, other half changes color (3) when two colors match, canister is losing effectiveness	Slide 8.2.2.21.--Window Type
f. canisters that are used for CO generate heat (1) if hot air when inhaled, concentration too high for canister (2) heat may be dangerous in flammable atmosphere	

Lesson Outline	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

TOPIC	REMARKS
g. canister type is for emergency (1) not for regular work (2) should be warning as to when to use (3) best if gas has odor or taste at or near TLV	
h. canister should be discarded and replaced after use	
4. Cartridge type respirator.	Slide 8.2.2.22.--Cartridge Type
a. cartridge is small canister attached directly to face piece (1) half mask with one or two cartridges (may have full mask) (2) cartridge similar to canister only smaller (3) may also include filters for particulates	
b. cartridges are approved for use only in non-emergency situations (1) where material is hazardous, only after prolonged exposure (2) certain organic vapors (3) some dust, fumes, and mist	
5. Mechanical filter type.	Slide 8.2.2.23.--Mechanical Filter
a. half face or full mask with filter for removal of particulates b. filters are connected to mask c. filters are composed of fibrous material d. as filter fills up, efficiency is improved	

TOPIC	REMARKS
e. breathing resistance is the limiting factor to use of filter f. filter medium varies depending on the size of particulate	
D. Air Supplied Respirator	Slide 8.2.2.24.--Air Supplied Respirators
1. Hose mask.	Slide 8.2.2.25.--Hose Mask
a. full face piece with one inch noncollapsible hose attached b. hose connected to a motor driven or hand operated pump c. may be connected to positive air pressure source d. blower intake is located in an uncontaminated area e. system should be fail-safe to allow breathing in the event of failure of blower f. very little resistance to breathing and worker can use longer without fatigue as compared to canister type g. hose cannot be too long (maximum approximately 300 feet)	
2. Air-line respirator.	Slide 8.2.2.26.--Air-Line Respirator
a. essentially same as hose mask except connect to air pressure line (2-20 cfm) b. connecting line is smaller diameter c. filtering of compressed air is necessary to assure clean when delivered to worker	

TOPIC	REMARKS
d. demand type valve is often used to regulate flow of air to worker (1) opens on inhalation (2) closes during exhalation (3) exhaled air is discharged through a separate valve	Slide 8.2.2.27.--Demand Schematic
e. may require pressure regulator and relief valve to attach to plant air supply f. offers low breathing resistance and is suitable for long wear	
3. Abrasive blasting type. a. for use where potential exists for abrasive materials to strike face and upper body b. may be either pump (hose) supplied or air-line supplied c. helmet with hood, inner collar, and viewing lens d. air enters hood from hose and is exhausted at neck collar or through exhalation valve	Slide 8.2.2.28.--Abrasive Blasting Hood
4. Air supplied suits where complete body protection is required.	
E. Self-Contained Breathing Units 1. Units are used where deficiency of oxygen is present and where distance or movement prohibits use of hose mask or air-line respirator. 2. Worker carries a supply of air that is attached to mask.	Slide 8.2.2.29.--Self-Contained Breathing Units

TOPIC	REMARKS
a. oxygen generating chemicals activated by moisture in user's breath b. liquid oxygen in cylinder c. compressed air in cylinder	Slide 8.2.2.30.--Parts of Unit
3. May be constant flow or demand operated.	
4. Recirculating type.	Slide 8.2.2.31.--Recirculating Type
a. reservoir bag in which exhaled air is captured b. oxygen is added by passing exhaled air through canister in which CO_2 is retained and O_2 is evolved c. may be added from compressed or liquid cylinder d. requires venting since excess O_2 is produced.	
5. Open circuit type.	Slide 8.2.2.32.--Open Circuit Type
a. oxygen or air supplied from cylinder b. exhaled air is vented	
F. Precautions for Use of Respirators	Slide 8.2.2.33.--Precautions for Use of Respirators
1. Be sure approved mask is used. 2. Maintenance and cleaning of equipment should be performed regularly. 3. A second man should be outside contaminated area.	
a. lifeline b. respirator equipment	
4. Employees should be properly trained in use of respirator. 5. Users should be in good health and physical condition. 6. Canisters that have been used should be discarded.	

TOPIC	REMARKS
7. Warning of exhaustion of supply or canister should be provided on equipment. 8. Equipment should be inspected completely prior to use. 9. Canisters should be stored in dry place. (1) weigh at purchase and before use (2) provides data on moisture absorbed (3) if seal is broken, do not keep over one year 10. If potential exposure can occur in a given work area, workers should be supplied with and trained to use respirators. 11. Test drills on emergency use of respirators should be conducted periodically. 12. Be sure to fit worker.	
III. Other Personal Protective Equipment	Slide 8.2.2.34.--Other Protective Equipment
A. Face and Eyes	
1. Safety glasses.	Slide 8.2.2.35.--Face and Eyes Slide 8.2.2.36.--Glasses
a. used where moderate impact particles and small particles may be generated b. hazard is when enter eye c. side shield is desirable d. plastic and metal frames e. impact and shock resistant glass	
2. Goggles.	Slide 8.2.2.37.--Goggles
a. protect larger area b. can be work over glasses c. tighter fit and offer more protection	

Lesson Outline	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

TOPIC	REMARKS
3. Face shields. a. where high incidence of particles impacting face or where potential for minor explosion exists b. offer protection to entire face c. should cover side of head as well as entire face and chin d. safety glasses should be worn underneath shield	Slide 8.2.2.38.--Face Shields
4. Hoods for extreme cases.	Slide 8.2.2.39.--Hoods
B. Head Protection 1. Helmet to protect from impact to head. 2. Protect from shock. 3. Type of helmet varies and should be chosen for hazards of the job.	Slide 8.2.2.40.--Head Protection
C. Skin Protection 1. Protect exposed area from systemic action of toxic materials. 2. Protect from dermatitis. 3. Protect from radiant heat. 4. Includes: a. gloves b. aprons c. full suits	Slide 8.2.2.41.--Skin Protection
5. Type of material and design important. a. does not react to contaminants b. impervious to contaminants c. flame retardant d. antistatic type e. must allow worker to function with minimum retardation	Slide 8.2.2.42.--Material and Design

Lesson Outline	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

TOPIC	REMARKS
D. Other Equipment	
1. Noise.	Slide 8.2.2.43.--Noise
a. ear plugs b. ear muffs	
2. Feet.	Slide 8.2.2.44.--Feet
a. hard toe shoe b. steel sole c. instep guards d. conductive soles	
3. Safety showers.	Slide 8.2.2.45.--Showers
a. eye bath b. complete deluge shower c. locate in close proximity to work area	
4. Protective creams--not as satisfactory as gloves.	

Practice Exercises	
Personal Protective Equipment	Module 8 Unit 2 Lesson 2

1. Obtain a catalog of a manufacturer of personal protective equipment and review the contents. Look for the various types of equipment available. Is approval of equipment listed? What limitations are noted by the manufacturer? Are all potential areas of protection covered, or is the equipment limited to only a few types of protection?

2. Your boss told you that in a particular operation in which the workers handle hazardous materials the workers should be supplied with respirators. He said to buy a hose mask type from a local safety supply firm since this type seemed to be the cheapest. What would you do? Develop an outline of the steps you would take to handle the problem.

3. Obtain a canister type, hose mask, air-line, or self-contained respirator and try it out. Notice the difficulties that are experienced when breathing. What problems do you have when moving about? How does the mask affect your vision? What is the effect when performing other physical tasks?

Title Page	
Industrial Hygiene Economics	Module 8 Unit 3

UNIT 3

INDUSTRIAL HYGIENE ECONOMICS

Performance Objectives		
Lesson	Industrial Hygiene Economics	Module 8 Unit 3
1	1. Given no aids, the student will be able to recall and describe in writing the process by which a company's Worker's Compensation premium cost is calculated using the experience modification factor.	
1	2. Given an annual payroll amount, an experience modification factor, and a base premium rate, the student will be able to calculate the annual premium rate for Worker's Compensation Insurance.	
1	3. Given no aids, the student will be able to recall and list in writing at least five (5) costs that are incurred by not providing controls to protect the workers' health and safety.	
1	4. Given a series of descriptions of potential losses in dollars, an estimated risk factor, and the total plant employment, the student will be able to develop a priority list of the order in which controls should be considered.	
1	5. Given no aids, the student will be able to recall and list in writing at least five (5) costs that might be incurred when providing controls to protect the workers' health and safety.	
1	6. Given no aids, the student will be able to recall and list in writing the seven (7) general methods of control that may be implemented to reduce exposure to hazardous conditions.	
1	7. Given no aids, the student will be able to recall and list in writing the five (5) steps that should be taken in selecting a control method to use.	
2	8. Given no aids, the student will be able to recall and describe in writing why it is important to identify the objectives of a control program prior to selecting the alternatives to be compared.	
2	9. Given a problem description including the investment, annual savings, and the costs as a result of the investment, the student will be able to calculate the following: a. the payback period b. the advisability of making the investment, given a desired rate of return using the present worth approach c. the advisability of making the investment, given desired after-tax rate of return, tax and investment credit rates, and a depreciation schedule using the present worth approach.	

Unit Activities--Instructor	
Industrial Hygiene Economics	Module 8 Unit 3

In order to present the unit material to the student, the instructor will be responsible for the following:

Lesson 1--Costs of Industrial Hygiene Control

Classroom Presentation

Conduct a lesson covering the topic of industrial hygiene control costs. Included in the presentation are the costs as a result of not controlling exposures as well as the costs of controlling exposures. The need to consider alternative control methods and to prioritize the problems based upon the expected economic losses are also discussed. The general control selection process is discussed.

Time Allotted

1 Hour

Demonstration

No demonstrations are required.

Supervised Practice

No supervised practice is required.

Lesson 2--Basic Economic Analysis

Classroom Presentation

Conduct a lesson on the topic of basic economic analysis techniques that can be used to compare capital investments. Two techniques are presented; the first being the N-year payback method and the second being the present worth approach. The basis for use of the present worth approach is discussed, and a sample problem presented in class. The effect of taxes on the economic analysis is also presented.

Time Allotted

1 Hour

Demonstrations

The demonstration problems are presented in class. These problems are:

1. N-Year Payback
2. Present Worth Approach
3. After-Tax Present Worth

Supervised Practice

No supervised practice is required.

Unit Activities--Student	
Industrial Hygiene Economics	Module 8 Unit 3

In order to complete the unit successfully, the student will be responsible for the following:

Lesson 1--Costs of Industrial Hygiene Control

Classroom Activity

Attend a lecture covering the topic of the costs of industrial hygiene control.

Assignment

The student should review the following materials prior to attending class.

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 8 Chapter 5	Section 8 Chapter 5
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 8 Chapter 4

Unit Activities--Student	
Industrial Hygiene Economics	Module 8 Unit 3

In order to complete the unit successfully, the student will be responsible for the following:

Lesson 2--Basic Economic Analysis

Classroom Activity

Attend a lecture on the topic of basic economic analysis.

Assignment

The student should review the following materials prior to attending class.

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 8 Chapter 6	Section 8 Chapter 6
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 8 Chapter 5

Facilities, Equipment, and Materials	
Industrial Hygiene Econonics	Module 8 Unit 3

Facilities

Lecture--Normal classroom

Equipment

Educational

Chalkboard
Chalk
Eraser
35 mm Slide Projector with Remote Control
Screen

Health and Safety

None required.

Visuals

Slide Series--Industrial Hygiene Engineering and Control
Module 8, Unit 3

References Used in Class

Industrial Hygiene Engineering and Control

Lesson Outline	
Costs of Industrial Hygiene Control	Module 8 Unit 3 Lesson 1

TOPIC	REMARKS
	The lesson is designed as a one-hour lesson on the topic of the costs of industrial hygiene control. Emphasis is placed on the costs of controlling exposures versus the costs of not controlling exposures. The specific costs incurred in each case are discussed. Also presented is the need to consider alternative control methods in order that the best alternative is selected. The general control selection process is discussed.
I. Introduction	
A. Selling Industrial Hygiene Control	Slide 8.3.1.1.--Need May Be Evident
1. Need for industrial hygiene control may be evident to the industrial hygienist.	
a. need to protect workers' health b. may appear that this is sufficient reason for control	
2. Management may require convincing.	Slide 8.3.1.2.--Management View
a. objective is to maximize profit b. industrial hygiene controls cost money c. not always that industrial hygiene controls contribute to objective d. what are risks of not controlling	
3. One job of industrial hygienist is to convince management of need for control.	Slide 8.3.1.3.--Selling Controls
a. to do this, must use a logical decision process	

TOPIC	REMARKS
b. must approach in the same manner as management approaches other decisions c. since economics of decisions are important to management, must also be important to industrial hygienist	
B. How To Sell Industrial Hygiene Control	
1. Approach on same basis as other decisions. 2. Why is it required? 3. What are the benefits? 4. What are the costs? 5. May not be able to sell as helping to maximize profit. 6. Can minimize cost of controls required.	
C. Factors That Are Important in Selling an Industrial Hygiene Control Program	
1. Economics.	Slide 8.3.1.4.--Factors to Sell--Economics
a. what are the costs of controls? b. what are the costs of not controlling? c. relative comparison of methods of control.	
2. Other factors.	Slide 8.3.1.5.--Factors to Sell--Other
a. legal requirements b. moral responsibility to worker c. what is the risk factor of exposure d. given an exposure, what is the level of danger to the worker	
(1) extreme--death, disability, or physical impairment	

TOPIC	REMARKS
(2) moderate--illness with lost time (3) low--discomfort to worker but no resulting lost time	
II. Economic Cost of Not Providing Controls	
A. Worker's Compensation	Slide 8.3.1.6.--Worker's Compensation
1. Reasons for.	
a. remove risk of loss of employment as result of injury or illness from employee b. remove risk of common law suit to employer for loss to employee c. provide worker with compensation for loss incurred as a result of work-related injury or illness	
2. In general, required to have coverage of employees in most industries.	
a. state laws govern and there is some variance between states as to size and type of industry requiring coverage b. type of coverage and payment schedule varies between states c. in most states, law covers occupational illness as well as injury	
3. Premium costs.	
a. based upon	
(1) risks of industry (2) experience of company (3) gross payroll	

TOPIC	REMARKS
b. basic rate is established for a particular industry group based on experience	
c. experience of a particular company is evaluated as compared to industry; rating determined.	
(1) called "experience modification factor" (EMF)	Slide 8.3.1.7.--Experience Modification Factor
(2) EMF < 1 if experienced loss less than average for industry	
(3) EMF = 1 if experienced loss same as average for industry	
(4) EMF > 1 if experienced loss greater than industry	
d. premium cost is determined based upon annual payroll	
e. example	Slide 8.3.1.8.--Example of Worker's Compensation Premium
	Base industry rate = $1.65/$100 payroll
	Annual Payroll = $360,000 after deductions for wages in excess of maximum annual rate
	EMF = 1.8
	Premium = $\frac{\$1.65}{\$100}$ x $360,000 x 1.8 = $10,692
	Cost above industry average = $4,752
f. premium as a result of high EMF is cost of not providing control.	
g. costs of processing claims is also a cost of not providing controls.	

Lesson Outline	
Costs of Industrial Hygiene Control	Module 8 Unit 3 Lesson 1

TOPIC	REMARKS
B. Disability Insurance 1. Many industries pay for disability insurance in addition to premium for worker's compensation. 2. Cost of higher premiums may be a cost of not providing industrial hygiene controls. 3. Along with this, any incurred sick leave pay not insured that results from occupational illness or injury is also a cost of not providing controls.	Slide 8.3.1.9.--Disability Insurance
C. Legal Costs 1. Law may specify the requirement for controls. 2. Lack of proper control may result in potential losses from law suits.	Slide 8.3.1.10.--Legal Costs
D. Cost of Replacing the Lost Employee 1. Recruiting costs. 2. Loss of production from new employee. 3. Training costs. 4. Short-term absence cost--need for overstaffing.	Slide 8.3.1.11.--Replacing Employees
E. Medical Insurance 1. Medical coverage is provided by employer. 2. Medical insurance premiums may be less as a result of group experience. 3. Increased medical costs as a result of occupational injury or illness may result in higher premiums.	Slide 8.3.1.12.--Medical Insurance

Lesson Outline	
Cost of Industrial Hygiene Control	Module 8 Unit 3 Lesson 1

TOPIC	REMARKS
F. Availability of Labor Pool 1. Jobs involving risks are likely to pay higher. 2. Law of supply and demand. 3. High risk may limit potential applicants and thus the cost of recruiting.	Slide 8.3.1.13.--Availability of Labor Pool
G. Production Losses 1. As a result of employee absence. 2. As a result of turnover. 3. As a result of legal action. 4. As a result of employee moral and general attitude.	Slide 8.3.1.14.--Production Losses
H. Public Relations 1. May give organization a bad name. 2. Can cause loss of sales.	Slide 8.3.1.15.--Public Relations
I. Social Costs 1. Value of wage earner to family. 2. Cost to government to keep families whose source of earning power is lost. 3. Not as direct as other costs; indirectly raises taxes.	Slide 8.3.1.16.--Social Costs
J. Risk of Illness or Injury 1. Must assess risk and extent of illness or injury. 2. Cannot control all possible exposures. 3. Control of highest risk exposures and those with greatest loss potential will minimize the costs incurred as a result of not controlling exposures.	Slide 8.3.1.17.--Risks of Illness or Injury

TOPIC	REMARKS
4. Example to develop priorities for control.	Slide 8.3.1.18.--An Example Assume 3500 employees work at a facility and that the following exposures exist: Exposure A Loss/occurrence estimated at $1000 Probability of exposure is 1 in 100 for a year. Exposure B Loss/occurrence estimated at $10,500 with a probability of 1 in 500 for a year. Exposure C Loss/occurrence estimated at $250,000 with a probability of 1 in 2500 for a year. Slide 8.3.1.19.--The Solution Expected Loss (A) = $1000 x .01 x 3500 = $35,000 Expected Loss (B) = $10,500 x .002 x 3500 = $73,500 Expected Loss (C) = $250,000 x x .0004 x 3500 = $350,000
III. Economic Costs of Providing Industrial Hygiene Controls	
A. Equipment Costs	Slide 8.3.1.20.--Cost of Controls Equipment
1. Controls may require equipment that has a cost. 2. Space for equipment has a cost since it is not directly productive. 3. Delivery and installation costs. 4. Purchasing and engineering costs. 5. Modifications to plant and production equipment to accommodate control equipment.	

Lesson Outline	
Costs of Industrial Hygiene Control	Module 8 Unit 3 Lesson 1

TOPIC	REMARKS
B. Effects on Production 1. Lost production for installation of controls. 2. Any downtime necessary for maintenance of controls. 3. Any losses in productive capability as a result of controls.	Slide 8.3.1.21.--Effects on Production
C. Costs of Operation of Controls 1. Maintenance of controls. 2. Power costs to operate controls. 3. Costs of personal protective equipment for maintenance and production employees. (Both equipment and maintenance of equipment.)	Slide 8.3.1.22.--Operation Costs
D. Costs of Training Employees 1. Training in precautions of use. 2. Training in operation. 3. Training of maintenance crews.	Slide 8.3.1.23.--Training Costs
E. Life of Control Equipment 1. At some point, equipment must be replaced. 2. Replacement of equipment has a cost.	Slide 8.3.1.24.--Replacement of Equipment
F. Other Related Costs 1. Special packaging may be required. 2. Special procedures may be required that slow production. 3. Warning or monitoring equipment may be necessary. 4. Waste removal.	Slide 8.3.1.25.--Other Related Costs

Lesson Outline	
Costs of Industrial Hygiene Control	Module 8 Unit 3 Lesson 1

TOPIC	REMARKS
G. Costs for Various Controls Will Differ	
1. Not all costs will be incurred for all methods of control.	
2. Operating costs may be high while the cost of obtaining and installing equipment is low.	
3. Opposite may be the case for another control.	
IV. Selecting a Control Method	
A. General Methods of Control Available	Slide 8.3.1.26.--General Control Methods
1. Engineering change.	
2. Substitution.	
3. Process or procedure change.	
4. Isolation.	
5. Ventilation.	
6. Administrative.	
7. Personal protective equipment.	
B. Identify the Exposure	Slide 8.3.1.27.--Identify Exposure
1. What is the exposure?	
2. Who is exposed, when, where, how?	
3. What is the extent of hazard involved?	
a. is loss severe, moderate, or low?	
b. estimated cost of loss	
4. What is the risk involved?	
a. likelihood of exposure	
b. personnel subjected to exposure when it occurs	
5. What specifically is the object of the control method?	

Lesson Outline	
Costs of Industrial Hygiene Control	Module 8 Unit 3 Lesson 1

TOPIC	REMARKS
C. What Methods of Control Should Be Considered 1. First choice should not be selected without comparison to others. 2. Often first choice is not the best method for control. 3. Alternatives should be considered. 4. Each general method of control identifies an alternative. 5. Within a method of control, various alternatives can be identified. D. Developing Alternatives 1. Start with six (6) general methods of control. 2. Identify alternatives for each general method. 3. To develop additional alternatives, consider modifications to selected alternatives. 4. Modifications can be obtained by considering: a. if any part of alternative can be eliminated b. can two or more alternatives be combined c. can the procedure for use be changed d. can changes be made in some parts of the alternative to make it more attractive 5. Use of group process. a. two heads are better than one b. synergistic effect of a group	

TOPIC	REMARKS
c. use of brainstorming (1) quantity of ideas (2) do not evaluate until initial ideas are exhausted	
E. Predicting Result of Alternative Control Implementation	Slide 8.3.1.29.--Predict Results
1. Not all alternative controls will be equal. a. effect b. costs of implementation	
2. Need to be able to predict the results of selecting and implementing a particular alternative.	
3. Prediction can be based on experiences, or if no experience, experience of others or experimental results.	
4. Objective is to determine as much as possible the result that will be obtained if the control is implemented.	
5. What level of protection will be obtained by instituting the particular alternative control; i.e., how much will the risk factor be lowered?	
6. What will be the cost of implementing the alternative?	
F. Evaluate Alternatives to Determine the "Best" or Most Acceptable Alternative	Slide 8.3.1.30.--Evaluate Alternatives
1. What alternative(s) result in reaching the objective?	
2. What alternative that attains the objective is the best economically?	
3. Next lesson discusses various methods for evaluating alternatives to determine the best economic situation.	

Practice Exercises	
Costs of Industrial Hygiene Control	Module 8 Unit 3 Lesson 1

1. You have just applied for a job with responsibility for the entire health and safety program of a manufacturing plant. The plant has no program for controlling worker exposure to hazards. The experience modification factor for the plant is 5.6 based on an annual payroll of $750,000 and a base rate of insurance of $2.25/$100 payroll. Records of all accidents, injuries, and illnesses are on file indicating location, person involved, costs, and probable cause. The plan manager hired you only after severe pressure from the home office. He is quoted as saying, "There's no money to be made in safety and health."

   Develop a written plan that you can present to the manager to identify the costs and approach you will use to perform your job.

The written plan should have as a minimum the following:

1. Clearly stated objectives.
2. Estimate of worker's compensation cost savings.
3. Provision for assessing priority of action based upon risks as identified from records.
4. Estimates of other costs including lost time, lost production, training, etc.
5. The step-by-step procedure that will be used.

Lesson Outline	
Basic Economic Analysis	Module 8 Unit 3 Lesson 2

TOPIC	REMARKS
I. Introduction A. Need a method for comparing alternatives in a standard manner 1. Alternatives may have different costs of implementation. 2. Given the same result in meeting the objectives stated for control, need to choose best alternative. 3. In simple case, this is done by selecting the lowest cost alternative. B. Lowest cost alternative is not always easy to determine at first glance 1. Initial investment may differ. 2. Operation costs may vary. 3. Life of equipment may vary. 4. Labor costs to operate and maintain may vary. 5. Space requirements may vary. C. Important to compare alternatives that meet objectives 1. If meet objective, comparing comparable alternatives. 2. If alternative does not meet objective, then not comparable.	This lesson is designed as a one-hour lesson on the topic of basic economic analysis techniques that can be used to compare capital investments. Two techniques are presented; the first being the N-year payback method and the second being the present worth approach. The basis for use of the present worth approach is discussed and a sample problem presented in class. Also discussed briefly is the effect of taxes on the economic analysis.

TOPIC	REMARKS
3. Emphasizes the need to state objectives clearly. a. what is the desired result? b. can it be measured? c. what conditions of performance are required? d. how will the results be measured? e. what tolerances are required?	
4. Alternatives must be compared to objective. a. if meet, then can be considered further b. if do not meet objective, can be eliminated	
D. Factors that can be considered to compare alternatives using economic analysis 1. Initial investment cost. 2. Yearly operating costs. 3. Savings generated over existing method.	
II. Economic Analysis--N-Year Payback	
A. Simplest Method	
1. Useful to compare new method to an existing method. 2. Savings that result from the new method are compared to the required investment to obtain payback.	
3. Payback = $\frac{I}{S}$	
4. Choice of cutoff payback period. a. varies to some degree on type of investment. b. generally 3-5 years used for equipment	

TOPIC	REMARKS
c. plant investments may use 10-year or greater payback period	
B. Demonstration Problem #1--N-Year Payback	Note: See Demonstration #1 at end of Lesson Outline
III. Economic Analysis--Present Worth	
A. Simple method of N-Year Payback does not always provide the best approach	
1. Costs and savings flow may vary from year to year.	
2. Unequal life cycles may be present.	
B. Present Worth Approach	
1. A bird in the hand is worth two in the bush.	
2. A dollar earned today can be invested to earn more money.	
3. A dollar earned next year cannot be invested until next year and is worth less.	
4. This is basis of present worth approach.	
C. Objective of Present Worth Approach	
1. Put all costs and savings in terms of current dollars.	
2. This is done by using a compound interest rate to discount the money back to its equivalent worth in dollars today.	
3. Inflation is not considered since it is assumed that it will equally affect costs and profits.	
4. Rate used is determined by:	
a. cost to borrow capital, or	
b. an accepted rate of return on investment, generally the profit return rate.	

Lesson Outline	
Basic Economic Analysis	Module 8 Unit 3 Lesson 2

TOPIC	REMARKS
D. How Present Worth Works	
1. Consider 10 dollars today.	
2. How much more is the $10 worth than $10 1 year, or, $10 in 2 years, considering a return of 5%?	
3. $10 in 1 year at 5%.	Value = $10 + 10(.05) = 10.50
	Generalizing
	Value = $(1 + i)$
4. $10 in 2 years at 5%.	Value = $10(1 + .05) + 10(1 + .05)(.05)$
	Generalizing
	Value = $I(1 + i) + I(1 + i)(i)$ $= I\left[1 + i + i + i^2\right]$ $= I\left[1 + 2i + i^2\right]$ $= I(1 + i)^2$
5. Results can be generalized for n years.	$I(1 + i)^n$
6. How much money would have to be earned in future to be worth the same as money today?	Future earnings = $I(i + i)^n$
7. Future earnings are worth what value today?	$I = \frac{\text{Future Earnings}}{(I + i)^n}$
8. What is the present worth of a series of savings as follows, using a rate of return of 8%.	Present Worth --Solution

At End of Year	Savings
1	$400
2	200
3	500
4	300

Yr.	Savings	+	Factor		Present Worth
1	400	x	$\frac{1}{(1 + .08)}$	=	$ 370.37
2	200	x	$\frac{1}{(1 + .08)^2}$	=	171.47
3	500	x	$\frac{1}{(1 + .08)^3}$	=	396.92
4	300	x	$\frac{1}{(1 + .08)^4}$	=	220.51
			Present Worth	=	$1159.27

TOPIC	REMARKS
9. To determine rate of return on investment: PW (Investment) - PW (Savings) = 0 10. In above case, to earn the 8% rate of return, the investment today must equal $1159.72 to earn the savings stated.	
E. Demonstration Problem #2	Note: See Demonstration Problem #2 at end of Lesson Outline.
IV. Effect of Taxes on Economic Analysis	
A. Taxes play an important part in economic decisions	
1. Taxes affect profits. 2. Taxes are paid on profits after expenses and depreciation are deducted. 3. Depreciation is a method for charging the costs of equipment purchased over the life of the equipment. 4. Expenses are charged as incurred since they have no life beyond present year.	
B. Depreciation	
1. Amount that can be depreciated is calculated from Capital Investment - Salvage Value.	
2. The depreciation can then be obtained in a number of ways. Two ways:	
a. straight line depreciation b. declining balance method	$\frac{\text{(Capital Investment - Salvage)}}{\text{n years of life}}$ $D = \frac{2}{n} I(1 - \frac{2}{n})^{j-1}$ where D = depreciation for year j $\frac{2}{n}$ = maximum allowable % depreciation n is number years of life I = investment j = year of depreciation

TOPIC	REMARKS
c. others such as sum of years' digits method 3. The declining balance results in charging more of cost in early years of investment. a. taxes will be reduced in early years b. since dollars are returned sooner, can be invested and earn a return. c. total actual dollars depreciated are same regardless of method d. present worth of dollars for declining balance method is higher, resulting in lower taxes C. Investment Credit 1. In order to stimulate economy government has given investment credit on capital expenditures. 2. Investment credit can be charged against current year's taxes. D. Taxes can affect the decision to make an investment 1. Depends on flow of capital vs. expense dollars. 2. Investment credit can have effect on the decision. 3. Tax laws constantly changing. 4. Need expert advice from tax accountant to interpret the current law and its effect on an investment. E. Demonstration Problem #3	Note: See Demonstration Problem #3 at end of Lesson Outline.

1. N-Year Payback

A plant operates with an intermittently cleaned type bag house to remove particulates from exhaust air. The bag house requires cleaning daily, involving production shutdown for 1 hour and an operator at $12/hour including fringe benefits. The bag house was purchased one (1) year ago at an installed cost of $50,000. A newly-designed bag house can be obtained for $160,000 installed. The new design will not require shutdown for cleaning since it is cleaned continuously. The new design will operate at the same efficiency in removing particulates but will cost $50/day more to operate. One hour's production has an estimated value of $300 profit to the firm. Assuming a three (3) year payback is required for investments of this type, answer the following questions:

a. If the plant is now operating to capacity, 365 days a year and if additional capacity can be sold, should the investment be made?

b. If the plant is operating 2 shifts/day on 365 day basis, should the investment be made?

c. Is any other alternative available and if so, is this alternative a better investment than the new equipment?

SOLUTION

N-Year Payback

a. Investment = $160,000

Do not consider the $50,000 spent on the old equipment since this represents a sunk cost (i.e., costs or investments in the past are "water over the dam").

Savings

Labor Cost = $12/hour x 365 days = $4380

Production Revenue = $300/hr x 365 days = $109,500

Costs of Operating New Equipment

$50/day x 365 days = $18,250

Net Savings = Savings - Costs

= ($4380 + $109,500) - $18,250 = $95,630

$$\text{Payback} = \frac{160{,}000}{95{,}630} = 1.67 \text{ years}$$

SOLUTION (Continued)

b. Investment = $160,000

Savings

Labor Cost = $12/hour x 365 days = $4380

Cost of Operating new equipment

$50/day x 365 days = $18,250

Net savings = 4380 - 18,250

= -$13,870

Point out that additional capacity is not worth anything unless it can be sold. In this case, until plant is operating at capacity, the investment is not justified.

c. An alternative is to install a second intermittent type bag house in parallel with the first one and clean one while the other is operating. This will require no shutdown. To compare this alternative to the existing situation:

Investment = $50,000 (assuming quoted price is same)

Savings

Labor Cost = same as present (alternate day cleaning)

Production Revenue = $300/hour x 365 days = $109,500

Payback

$$\text{Payback} = \frac{\$50,000}{\$109,000} = .46 \text{ years}$$

This is clearly the best economic alternative.

2. Present Worth Approach

A manufacturer has been using a dilution ventilation system for control of nuisance dusts in the work area. However, with the cost of fuel rising, a local exhaust system is being considered as a replacement for the existing system. It is estimated that the cost of tempering make-up air will be reduced one-fourth (1/4) of the present cost of $50,000 annually. In addition, power costs consumption will be lowered $8,000 annually using the local exhaust system. Also, it is expected that the dilution ventilation system will require a major overhaul in 5 years at a cost of $50,000. The investment cost for the new system is $300,000.

If the desired rate of return for the firm is 6%, should the investment be recommended? Assume a 10-year life for the project.

SOLUTION

Present Worth Approach

In each year, the savings obtained by making the investment will be:

Heating + Power = Total Savings

$(50{,}000)3/4 + 8000 = \$45{,}500$

In year 5, the additional overhaul cost of $50,000 will also be saved. The resulting savings and present worth at 6% are as follows:

Year	Savings	x	Present Worth $(1+i)^n$	=	PW(Savings)
1	$45,500	x	.94339	=	$ 42,925
2	45,500	x	.88999	=	40,495
3	45,500	x	.83961	=	38,203
4	45,500	x	.79209	=	36,040
5	45,500	x	.74725	=	34,000
6	95,500	x	.70496	=	67,324
7	45,500	x	.66505	=	30,260
8	45,500	x	.62741	=	28,547
9	45,500	x	.59189	=	26,931
10	45,500	x	.55839	=	25,407
			Total Present Worth	=	$ 370,132

Since

$PW_{.06}(\text{Savings}) > PW_{.06}(\text{Investment})$

then the rate of return criteria is exceeded and the investment should be recommended.

NOTE: Point out if the actual return rate is desired, a trial and error approach is used by making calculation at different rates until

$PW_i(\text{Savings}) = PW_i(\text{Investment})$

3. Effect of Taxes

What will be the effect of taxes on the problem presented in #2 if the after-tax rate of return is 6% and the $50,000 overhaul cannot be expensed? Use a straight line depreciation for the 10-year life of the local exhaust system, a 7 1/2% investment credit, and a tax rate of 50%. Assume no salvage value for the local exhaust system after its life and a 5-year life of the $50,000 overhaul.

SOLUTION

Effect of Taxes

Savings will be taxed at 50%.

Year	(After Tax Savings + Depreciation)	x	$PW_{.06}$	=	$PW_{.06}(S)$
1	(22,750 + 15,000)	x	.94339	=	$ 35,613
2	(22,750 + 15,000)	x	.88999	=	33,597
3	(22,750 + 15,000)	x	.83961	=	31,695
4	(22,750 + 15,000)	x	.79209	=	30,170
5	(22,750 + 15,000)	x	.74725	=	28,209
*6	(22,750 + 6,250)	x	.70496	=	20,444
7	(22,750 + 10,000)	x	.66505	=	21,780
8	(22,750 + 10,000)	x	.62741	=	20,548
9	(22,750 + 10,000)	x	.59189	=	19,384
10	(22,750 + 10,000)	x	.55839	=	18,287
	Total Present Worth			=	$ 259,727

Since

$$PW_{.06}(\text{Savings}) < PW_{.06}(\text{Investment} - .075\ \text{Investment})$$

(*Includes 7 1/2% investment credit on overhaul)

The investment is not recommended.

Practice Exercises	
Basic Economic Analysis	Module 8 Unit 3 Lesson 2

1. Currently your employer is dumping solid waste products into a sanitary landfill. It has been pointed out that extraction process equipment can be purchased and installed for $275,000 that will remove a valuable material ($3/lb) from the waste with an operating cost of $60,000 annually. The waste is estimated to consist of approximately 20% of this material. Currently, the firm is hauling 200 tons of solid waste containing the material annually at a cost of $15/ton. What payback can be expected from such an investment? Would you recommend the investment?

2. Your employer currently spends $80,000 annually to maintain and supply respirators to be used by employees in the paint shop. An estimate has been obtained for providing a local exhaust system in the area. It is expected that the local exhaust system will eliminate the need for spending the $80,000 on respirators. The installed cost of the system is $350,000, and its operating cost is estimated at $10,000 annually. What is the payback that can be expected? Would you recommend the investment?

3. The cost of tempering make-up air for a local exhaust system is rising at a rate of 10% annually. Currently, the annual cost for tempering make-up air is $45,000. A recycling of exhaust air for conserving tempered air has been proposed at an installed cost of $360,000. This proposed recycling would reduce the cost to temper air to $10,000 annually based on the current rates for heating. If a 4% rate of return for a 10-year life is used as a cutoff for investment, should the investment be recommended? Assume that recycling will provide equal quality air to the workplace and that other costs are the same.

1. Estimated annual savings

Material Value

200 tons x 2000 lbs/ton x .20 x $3/lb = $240,000

Waste Hauling

200 tons x .20 x $15/ton	= 600
Gross Savings	= $240,600
Operating Costs	-60,000
Net Savings	$180,000

$$\text{Payback} = \frac{I}{S} = \frac{\$275,000}{180,600} = 1.52 \text{ years}$$

The investment should be recommended.

2. Estimated Annual Savings

$80,000 - $10,000 = $70,000 savings

$$\text{Payback} = \frac{\$350,000}{70,000} = 5 \text{ years}$$

It is likely that the investment should be recommended even though the payback is high. The two methods are not similar and cannot be compared on a pure economic basis. Personal protective equipment is a last resort and should be replaced if a better method exists regardless of the costs involved.

3.

At current rate, projected annual savings are

Current Cost - Projected Costs = $45,000 - $10,000 = $35,000

These savings are increased by 10% annually or in year n by the amount of

$$(1 + 10)^{n-1} \times \text{Savings}_{n-1}$$

The savings stream is as follows:

Year	Savings	$(1 + 10)^{n-1}$	Projected Savings	$PW_{.04}$	$PW_{.04}$Savings
1	$35,000	1.000	$ 35,000	.9615	$ 33,652
2	35,000	1.100	38,500	.9242	35,582
3	35,000	1.210	42,350	.8890	37,649
4	35,000	1.331	46,585	.8548	39,821
5	35,000	1.464	51,240	.8219	42,114
6	35,000	1.611	56,385	.7903	44,561
7	35,000	1.772	62,020	.7599	47,129
8	35,000	1.949	68,215	.7307	49,845
9	35,000	2.144	75,040	.7026	52,723
10	35,000	2.358	83,530	.6756	56,311
				$PW_{.04}$Savings	= $ 439,387

Since $PW_{.04}$ (S) > PW(I)

Recommend installation of recycling facility.

Title Page	
Legal Aspects of Occupational Safety and Health	Module 8 Unit 4

UNIT 4

LEGAL ASPECTS OF OCCUPATIONAL SAFETY AND HEALTH

Performance Objectives		
Lesson	Legal Aspects of Occupational Safety and Health	Module 8 Unit 4
1	1. Given no aids, the student will be able to recall and describe in writing the responsibilities of the Department of Labor and the Department of Health, Education and Welfare as provided by the OSHA act.	
1	2. Given no aids, the student will be able to recall and describe in writing the two different types of standards provided by the OSHA act.	
1	3. Given no aids, the student will be able to recall and describe in writing the employer record keeping requirements as provided by the act.	
1	4. Given no aids, the student will be able to recall and describe in writing the procedural steps and time requirements for contest of a citation.	
1	5. Given no aids, the student will be able to recall and describe in writing the two types of variances that can be obtained concerning compliance with a given standard.	

Unit Activities--Instructor	
Legal Aspects of Occupational Safety and Health	Module 8

In order to present the unit material to the student, the instuctor will be responsible for the following:

Lesson 1--Legal Aspects of Occupational Safety and Health

Classroom Presentation

Conduct a lesson covering the major provisions of the Occupational Safety and Health Act. The purposes of the act, responsibilities of OSHA and NIOSH, provisions for inspections, citations, and penalties are discussed. The record keeping requirements are also discussed as well as the contest of penalties and citations.

Time Allotted

1 Hour

Demonstrations

No demonstrations are required.

Supervised Practice

No supervised practice is required.

In order to complete the unit successfully, the student will be responsible for the following:

Lesson 1--Legal Aspects of Occupational Safety and Health

Classroom Activity

Attend a lecture covering the legal aspects of occupational safety and health.

Assignment

The student should review the following materials prior to attending class.

READING	SHORT COURSE	EXTENDED 1-HOUR
The OSHA Act	X	X
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 8 Chapter 6

Facilities, Equipment, and Materials	
Legal Aspects of Occupational Safety and Health	Module 8 Unit 4

Facilities

Lecture--Normal Classroom

Equipment

Educational

Chalkboard
Chalk
Eraser
35 mm Slide Projector with Remote Control
Screen

Health and Safety

None required

Visuals

Slide Series--Industrial Hygiene Engineering and Control
Module 8, Unit 4

References Used in Class

The OSHA Act

Lesson Outline	
Legal Aspects of Occupational Safety and Health	Module 8 Unit 4 Lesson 1

TOPIC	REMARKS
	This lesson is designed as a one-hour lecture covering the major provisions of the OSHA act. The purposes of the act, responsibilities of OSHA and NIOSH, provisions for inspections, citations, and penalties are discussed. The record keeping requirements are also discussed as well as the contest of penalties.
I. Introduction	
A. Occupational Safety and Health Act signed into law December 29, 1970.	
B. Purposes	Slide 8.4.1.1.--Purpose of Act
1. To assure safe and healthful working conditions for the nation's working men and women.	
2. To preserve human resources.	
C. Major responsibilities and authorities delegated to the Department of Labor	Slide 8.4.1.2.--Responsibilities and Duties of OSHA
1. To promulgate, modify, and improve mandatory occupational safety and health standards.	
2. Authorized to enter factories.	
3. To prescribe regulations for maintaining accurate records.	
4. To develop and maintain statistics on occupational safety and health.	
5. To establish and supervise programs for the education and training of employee and employer personnel.	
6. To make grants to states.	

Robert B. Weidner, JD, PE, Division of Training, NIOSH, June, 1973.

TOPIC	REMARKS
D. Major responsibilities and authorities delegated to the Department of Health, Education and Welfare	Slide 8.4.1.3.--Responsibilities and Duties of HEW
1. To conduct, directly or by grants or contracts, research, experiments or demonstrations relevant to occupational safety and health.	
2. To develop criteria for dealing with toxic materials and harmful physical agents.	
3. To make toxicity determinations on request by employer or employee groups.	
4. To publish an annual listing of all known toxic substances.	
5. To conduct directly, or by grants and contracts, educational programs aimed at providing an adequate supply of qualified personnel.	
6. To establish a National Institute for Occupational Safety and Health.	
E. Establishd a 12-member National Advisory Committee on Occupational Safety and Health	Slide 8.4.1.4.--Other Provisions
F. Established an Occupational Safety and Health Review Commission that will adjudicate disputes.	
G. Established a National Commission of State Workmen's Compensation Laws to make a study and evaluation of such laws.	
H. Scope of Act	
1. Pertains to every employer EXCEPT United States and State or political subdivisions of the State.	

TOPIC	REMARKS
2. Covers every workplace EXCEPT for working conditions with respect to which other Federal agencies and specified (e.g., AEC contract) state agencies, exercise statutory authority to prescribe or enforce standards or regulations affecting occupational safety and health.	Note: Point out possibility of state plan and note those states that have such plans.
II. Duties	
A. The General Duty Clause	
1. " . . . to furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or likely to cause death or serious physical harm to his employee."	
Two types:	Slide 8.4.1.5.--Two Types of Standards
a. "General Standards" which are applicable to all employees are contained in Title 29, Code of Federal Regulations, Part 1910.	Note: Explain difference between these two standards and discuss an example.
b. "Particular Standards" which are applicable to specific industries such as the Safety and Health Regulations for Construction which are contained in Title 29, Code of Federal Regulations, Part 1518.	

TOPIC	REMARKS
III. Inspections A. The Act contains a general prohibition against giving advance notice of inspection, except in limited circumstances. 1. In cases of apparent imminent danger to enable the employer to abate the danger as quickly as possible. 2. In circumstances where the inspection can most effectively be conducted after regular business hours or where special preparations are necessary for an inspection. 3. Where necessary to assure the presence of representatives of the employer and employees or the appropriate personnel needed to aid in the inspection. 4. In other circumstances where the Area Director determines that giving of advance notice would enhance the probability of an effective and thorough inspection. B. Extent of Inspections 1. The Act authorizes inspectors to enter without delay at reasonable times where work is performed by employees of an employer and to conduct investigations during regular working hours at other reasonable times within reasonable limits and in a reasonable manner.	

TOPIC	REMARKS
2. The Act also authorizes the inspection of all pertinent conditions, including structures, machines, apparatuses, devices, equipment and materials therein, and to question privately any employer, owner, operator, agent or employee.	
IV. Citation	
A. Types	Slide 8.4.1.6.--Types of Citations
1. "Citation for Serious Violation"--OSHA Form 2A: issued by Area Director when investigation reveals a serious violation.	
2. "Citation"--OSHA Form-2B: issued by Area Director when investigation reveals a de minimis violation.	
B. Accompanying Forms	
1. "Notification of Proposed Penalty"--OSHA Form-3: issued by Area Director with each citation, except a de minimis citation.	
2. "Notification of Failure to Correct Violation and of Proposed Additional Penalty"--OSHA Form-3A: issued by Area Director if the violation found is after the second investigation and is for failure to correct a previous violation.	

TOPIC	REMARKS
V. Recordkeeping, Posting of Periodic Reports Recordable occupational injuries and illnesses are defined as occupational illnesses and injuries which result in fatalities, or nonfatal cases which result in loss of work days, transfer to another job, termination of employment, and illnesses and injuries which require medical treatment (other than first aid) or involve the loss of consciousness or restriction in motion.	
A. Log of Occupational Injuries and Illnesses, OSHA Form-100	Slide 8.4.1.7.--Log
1. Must be entered as soon as practical, but no later than 6 days after receiving information that a recordable injury or illness has occurred. 2. An equivalent may be used if it contains all details provided in OSHA Form-100.	
B. Supplemental Record of Occupational Illnesses and Injuries, OSHA Form-101	Slide 8.1.4.8.--Supplemental Record
C. The Annual Summary, OSHA Form-102	Slide 8.1.4.9.--Annual Summary
1. Must be completed no later than January 31 of each year. 2. Must be certified by employer to be true and correct. 3. Must be posted at each establishment no later than Feb. 1 of each year and shall remain posted for 30 consecutive days.	

TOPIC	REMARKS
VI. Penalties The Act is penal in nature because it provides criminal sentences, criminal fines, and civil penalties to be assessed against an employer for violation of either the General Duty Clause or specific standards promulgated under the Act. A. Types 1. Willful Violations Causing Death of an Employee. 2. Willful or Repeated Violations. 3. Serious Violations. 4. Nonserious or Other Violations. 5. De Minimis Violations. 6. Daily Penalties for Failure to Abate. 7. Failure to Post Notice of Employee Rights Under Act. 8. Failure to Post Citations. 9. Failure to Report Employment Deaths. 10. Failure to Maintain Records. 11. Penalty for Giving False Information. 12. Penalties for Killing, Assaulting, or Hampering the Work of Enforcement Personnel.	Note: Discuss meaning as interpreted by current law and court rulings.
VII. Contest of Citations and Penalties A. Notice of Contest 1. An employer who receives a citation and proposed penalties has the right to contest either the citation or the proposed penalties, or both, to the Occupational Safety and Health Review Commission.	

TOPIC	REMARKS
2. Must be filed within within 15 working days from receipt of citation and proposed penalty.	
B. Procedure	Slide 8.4.1.10.-- Procedure for Contest
1. Within 7 days of receipt of the notice of contest, the Area Director must file with the Commission the notice of contest or modification of abatement and all citations, notifications of failure to correct violations.	
2. Within 20 days of the receipt of the notice of contest, the Secretary of Labor files with the Commission a complaint against the employer. The employer will receive a copy of the complaint, as will the representative of the employees who have elected party status.	
3. The employer must file an answer within 15 days after receipt of the complaint.	
4. After the Commission has received the employer's notice of contest from the Area Director, the Commission appoints a judge to conduct the hearing who has control over all proceedings, discovery, depositions, and production of documents in the case.	
C. Review of the Final Order of the Commission	
1. The employer or other party that has received an adverse order from the Commission has the right to have the Commission's order reviewed by the Court of Appeals.	

Lesson Outline	
Legal Aspects of Occupational Safety and Health	Module 8

TOPIC	REMARKS
2. The review by the Court of Appeals is limited to only those questions of law or objections raised before the Commission.	
VIII. Variances The Act provides that any affected employer may be granted a temporary variance from a standard, a permanent variance from a standard, or a variance, tolerance, or exemption for any or all provisions of the Act.	
A. Temporary Variance	Slide 8.4.1.12.--Variances
1. The employer must establish that: a. he is unable to comply with a standard by its effective date because of the unavailability of professional or technical personnel or of materials and equipment needed to come into compliance with the standard or because necessary construction or alteration of facilities cannot be completed by the effective date. b. he is talking all available steps to safeguard his employees against the hazards covered by the standard. c. he has an effective program for coming into compliance with the standard as quickly as possible.	
2. The contents of the application for a temporary variance are set forth in detail in 29 C.F.R. Section 1905.10 (b) (1972).	

TOPIC	REMARKS
B. Permanent Variance 1. The employer must establish by a preponderance of evidence that the conditions, practices, means, methods, operations and processes used or proposed to be used by him will provide employment and a place of employment for his employees which are as safe and healthful and those which would prevail of he complied with the standard. 2. The contents of the application for a variance are set forth in detail in 29 C.F.R. Section 1905.11(b)(1972). C. Variances, Tolerances, and Exemptions from the Act 1. Any employer must request a variance, tolerance or exemption from the Act if it is to avoid serious impairment of the national defense. 2. The contents of the application are set forth in detail in 20 C.F.R. Section 1905.12 (b)(1972). D. Procedure for Variances 1. When an employer files an application with the Assistant Secretary for a temporary variance, permanent variance, or a variance, tolerance or exemption from the Act, the request will be referred to a hearing examiner who shall preside over the hearing and conduct and control all proceedings.	

TOPIC	REMARKS
2. Based upon the evidence presented, the hearing examiner will make his decision, which shall become final 20 days after service thereof, unless exceptions are filed. 3. If exceptions are filed, the record and transcript are transmitted to the Assistant Secretary, who shall rule on the exceptions and the rule or order of the hearing examiner. 4. ONLY the decision of the Assistant Secretary may be appealed and reviewed by the Court of Appeals. IX. Discussion A. Was the OSHA Act necessary? If so, why? B. Do you feel the OSHA Act has been effective in reaching its objectives or purpose? C. Is the OSHA Act an effective control for occupational hazards?	

Self-Test	
Other Topics	Module 8

1. List six uses of water in industry.

2. List the eight steps that are used for the treatment of water.

3. Explain the difference between an aerobic and anaerobic bacteria digestion process.

4. Explain the operation of a cooling tower.

5. Draw a schematic of the method used for connecting a plant water supply system to a municipal source in order to prevent backflow of plant water into the municipal system.

6. What are the four (4) objectives toward which a solid waste disposal program should be directed?

7. List three methods which can be used in the disposal of solid waste.

8. List the five major areas of the plant where control of hazardous materials is necessary.

9. List the data which should be obtained from a supplier of hazardous material.

10. List at least six (6) rules for the handling of hazardous materials.

Self-Test	
Other Topics	Module 8

11. What are the six (6) basic types of protection from hazards which workers require?

12. List and describe the major characteristics of the three (3) basic types of respirators.

13. What factors should be considered when selecting a respirator?

14. A company with an adjusted annual payroll of $6,350,000 and an experience modification factor of 3.3 is deciding whether to enter into an effort to control hazards. If the base rate for the industry group is $2.35/$100, what potential savings might the company realize by such an action?

15. In the above example, what other costs might be reduced as a result of a decision to control hazards?

16. If the decision is made to enter into the aggressive control program, what steps should be taken to implement the program?

_____

_____

_____

_____

_____

17. A firm is deciding whether to implement a new handling procedure for a hazardous material which involves the use of a package which can be dumped into the process directly or to buy a bag dumping unit at a cost of $52,000. Costs are estimated as follows:

Packaging Method

Additional Package Cost	= $24,000/yr
Labor Cost	= 9,000/yr

Bag Dumping Method

Labor	= $15,000/yr
Waste Product Loss	= 5,000/yr
Maintenance	= 1,000/yr

Using the present worth approach and assuming an investment life of 5 years and a required return rate of 6%, which alternative should be chosen based upon the economics?

18. Does an employer have any recourse when a citation has been given by the Occupational Safety and Health Administration? If so, what procedure exists for this recourse?

19. If for some reason you as an employer cannot comply with a standard, what recourse do you have?

20. What records must the employer keep to comply with the OSHA Act?

Self-Test	
Other Topics	Module 8

1. List six uses of water in industry.

   1. *Product additive*
   2. *Source of heat*
   3. *Source of cooling*
   4. *Sanitary services*
   5. *Product cleaning*
   6. *Fire protection*
   7. *Drinking water*
   8. *Housekeeping*

2. List the eight steps which are used for the treatment of water.

   1. *Sedimentation*
   2. *pH control*
   3. *Coagulation--flocculation*
   4. *Filtration*
   5. *Bacterial digestion*
   6. *Chemical additives*
   7. *Aeration*
   8. *Sludge removal*

3. Explain the difference between an aerobic and an anaerobic digestion digestion process.

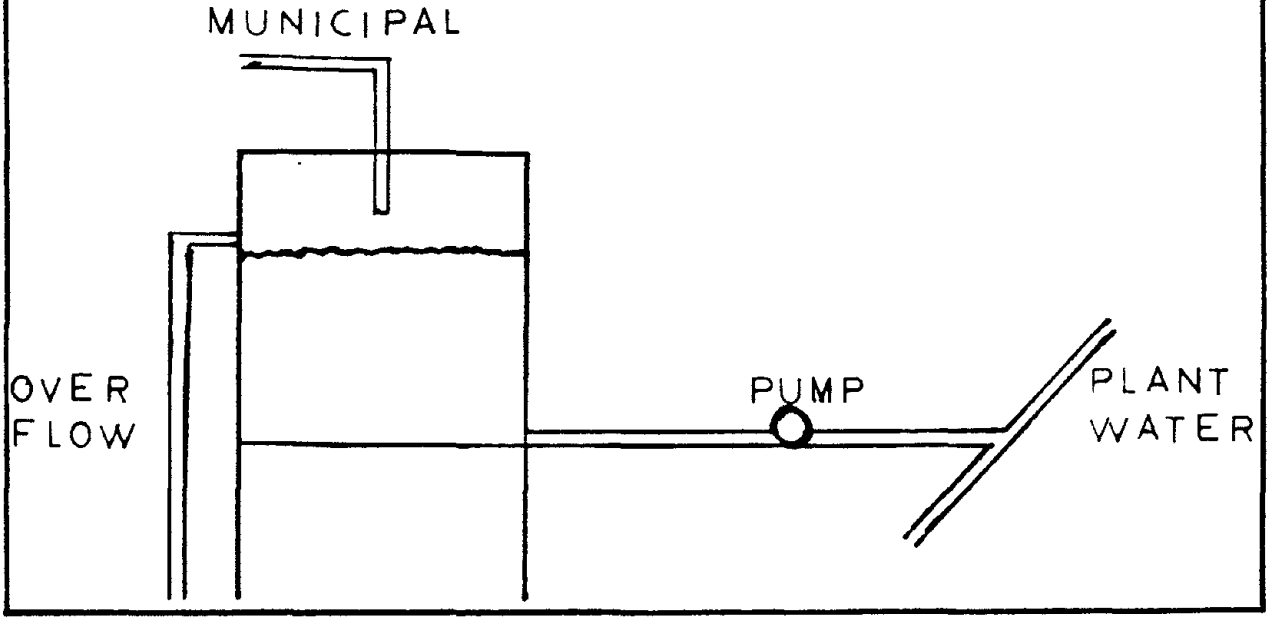
   1. Aerobic uses O_2 from air or other source for bacterial digestion.

   2. Anaerobic uses O_2 from waste products for bacterial digestion.

4. Explain the operation of a cooling tower.

   H_2O is pumped to top of tower and falls to catch basin at bottom through series of baffles. Cooling is result of evaporation in which heat is absorbed to change state from water to vapor.

5. Draw a schematic of the method used for connecting a plant water supply system to a municipal source in order to prevent backflow of plant water into the municipal system.



6. What are the four (4) objectives toward which a solid waste disposal program should be directed?

1. To assure it does not cause a health hazard.

2. To assure minimum effect on environment.

3. To obtain maximum utility and conservation of waste.

4. To minimize economic cost of disposal.

7. List three methods which can be used in the disposal of solid waste.

1. Sanitary landfill 2. Incineration 3. Recycling

8. List the five major areas of the plant where control of hazardous materials is necessary.

1. At entry to plant.

2. In plant handling

3. In storage.

4. In process use.

5. In waste products

9. List the data which should be obtained from a supplier of hazardous material.

1. Chemical compound name

2. Chemical formulation

3. Toxicity

4. Flammability

5. Incompatible materials

6. Material form

7. Packaging

8. Label

9. Molecular weight

10. Specific gravity

11. Specific heat

12. Solubility

13. Vapor pressure

10. List at least six (6) rules for the handling of hazardous materials.

1. Provide emergency protective equipment.

2. Provide workers with training concerning exposure.

3. Remove man from the job.

4. Provide adequate ventilation.

5. Provide maintenance and cleanup crews with training.

6. Eliminate effects of outside influences.

7. Maintain and inspect handling equipment.

8. Integrity of packaging.

9. Move in off hours

11. What are the six (6) basic types of protection from hazards which workers require?

1. Inhalation
2. Skin contact
3. Eyes
4. Ears
5. Traumatic injury
6. Thermal stress

12. List and describe the major characteristics of the three (3) basic types of respirators.

1. Air purifying--Canister, cartridge, or filter removes pollutant.
2. Air supplied--Air is supplied through hose or air line to worker in hazardous area.
3. Self-contained--Worker carries O_2 source into hazardous area.

13. What factors should be considered when selecting a respirator?

1. What is hazardous material?
2. What are its characteristics?
3. Under what conditions will respirator be used?
4. How long will it be used
5. What activity will worker be performing while using respirator?
6. Any other protection required.

14. A company with an adjusted annual payroll of $6,350,000 and an experience modification factor of 3.3 is deciding whether to enter into an effort to control hazards. If the base rate for the industry group is $2.35/$100, what potential savings might be company realize by such an action?

$6,350,000 x $2.35/$100 x 3.3 = $492,442.50
$6,350,000 x $2.35/$100 x 1 = 149,225.00
Potential Savings = $343,217.50

15. In the above example, what other costs might be reduced as a result of a decision to control hazards?

1. Lost time in production.
2. Sick pay.
3. Recruitment and hiring costs.
4. Legal costs.
5. Medical insurance.
6. Disability insurance.
7. Public relations.

16. If the decision is made to enter into the aggressive control program, what steps should be taken to implement the program?

1. Identify the hazards and related risks.

2. Set objectives and priorities for control.

3. Determine alternative methods for control.

4. Evaluate controls.

5. Select and implement the control alternative.

17. A firm is deciding whether to implement a new handling procedure for a hazardous material which involves the use of a package which can be dumped into the process directly or to buy a bag dumping unit at a cost of $52,000. Costs are extimated as follows:

Packaging Method

Additional Package Cost	= $24,000/yr
Labor Cost	= 9,000/yr

Bag Dumping Method

Labor	= $15,000/yr
Waste Product Loss	= 5,000/yr
Maintenance	= 1,000/yr

Using the present worth approach and assuming an investment life of 5 years and a required return rate of 6%, which alternative should be chosen based upon the economics?

Compare Investment to Packaging *Cost (Packaging) - Cost (Dumping) = Savings*

Year	*Savings*	*PW,06*	*PW(S)*
1	*$12,000*	*.9434*	*$11,321*
2	*12,000*	*.8900*	*10,680*
3	*12,000*	*.8396*	*10,075*
4	*12,000*	*.7921*	*9,505*
5	*12,000*	*.7473*	*8,968*
		PW(Savings)	*$50,549*

Select the packaging method.

18. Does an employer have any recourse when a citation has been given by the Occupational Safety and Health Administration? If so, what procedure exists for this recourse?

Yes. An appeal can be formally filed within 15 working days. Complaint will be filed against company within 20 days of receiving appeal. Employer must file answer within 15 days after receipt of complaint. Hearing is held with OSHA Review Commission.

19. If for some reason you as an employer cannot comply with a standard, what recourse do you have?

An appeal for variance can be filed. Hearing is held where employer must justify need for temporary or permanent variance, indicating problem, steps being taken, and a program for coming into compliance.

20. What records must the employer keep to comply with the OSHA Act?

1. Log of injuries and illnesses.

2. Supplemented record of illness and injury.

3. Annual summary.

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Abstract: This instructor's manual presents the eighth module in a series of eight which form a course designed for students at an advanced level of training in the field of industrial health. This module discussed several additional topics not included in the first seven modules. The discussion on controlling industrial wastes included the quality of water and centered on a discussion of the uses of water industry and the procedures needed to treat water to obtain a desired quality. Control of solid waste considered the various sources of solid wastes and methods of disposal, along with the objective of a solid waste control program. Under the control of hazardous materials the manual focused on purchasing, handling, and storing hazardous materials and using personal protective equipment such as respirators. The economics behind industrial hygiene were considered, including the costs of controlling exposures versus the costs of not controlling exposures and the need to consider and compare alternative control methods. Two methods are presented for making a decision between alternatives for economic considerations. Lastly the legal aspects of industrial hygiene are considered with a discussion of the OSHA Act.