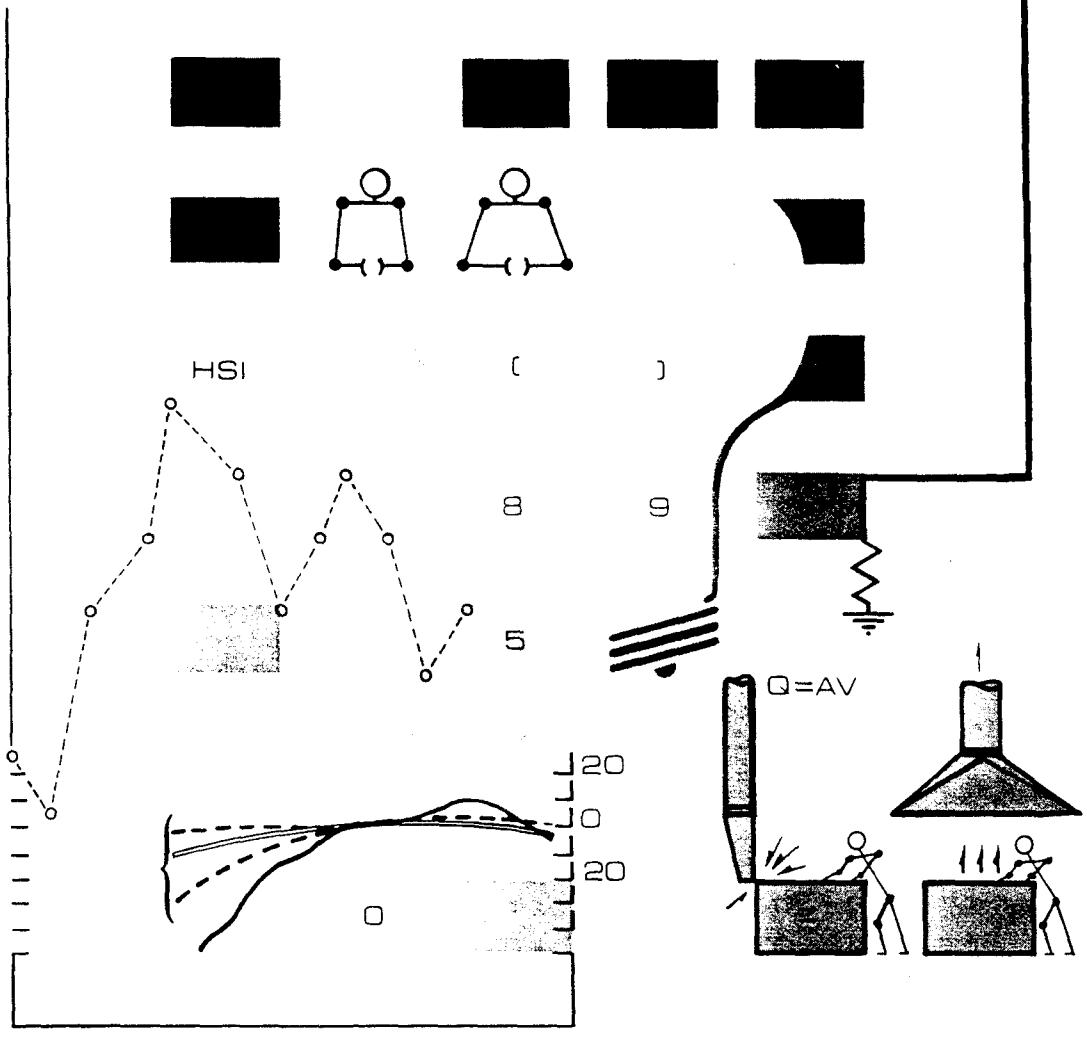
SS2

INDUSTRIAL HYGIENE
ENGINEERING & CONTROL

INTRODUCTION



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 1 — Instructor's Manual

INTRODUCTION TO INDUSTRIAL HYGIENE ENGINEERING AND CONTROL

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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Center for Disease Control

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 1

INTRODUCTION TO INDUSTRIAL HYGIENE ENGINEERING AND CONTROL

INSTRUCTOR'S MANUAL

Unit and Lesson Topic Outline	
Introduction to Industrial Hygiene Engineering and Control	Module 1

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

Unit	Lesson	TOPIC	Time/Hrs.	COMMENTS
1		The Workplace--A Hazardous Environment		
	1	Recognition of Health Hazards	1	Review of the recognition of occupational health hazards, type of hazards present, and how hazards are recognized are discussed.
	2	Methods for Measuring and Evaluating Health Hazards	2	Review of the basic methods for measuring and evaluating different types of health hazards. The review centers around a problem-solving session directed toward identification, measurements, and evaluation of potential hazards.
2		The Effects of Health Hazards on Man		
	1	Human Systems	1	A discussion of the physiological functions of the human body.
	2	Industrial Toxicology	1	The mode of entry, visible effects, and pathogenic effects. How toxic substances are identified.
	3	Physical Hazards	1	A review of the various physical hazards that may be encountered (e.g., noise, thermal, biological, radiation, etc.).
3	1	General Methods of Control Available to the Industrial Hygienist	1	A brief review of the methods of control that are available to the industrial hygienist (e.g., substitution, engineering design, protective equipment, etc.).
				Total Module Time--7 Hours

Terminal Objectives	
Introduction to Industrial Hygiene Engineering and Control	Module 1

The objectives presented represent the competencies which 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 no aids, the student will be able to

   a. recall and list at least 5 industrial hazards.
   b. explain in writing the reason each is a hazard.
   c. recall and list at least one method by which each hazard can be recognized.
   d. classify each hazard by

      (1) type of effect
      (2) type of exposure
      (3) level of effect
      (4) type of hazard

2. Given a typical industrial situation, and any appropriate aids, the student will be able to

   a. design a study to measure and evaluate the potential hazards that are present.
   b. present the study design in such a manner as to convince another industrial hygienist that the design is sound.

3. Given a list of the following systems of the body:

   a. skeletal system
   b. muscular system
   c. nervous system
   d. digestive system
   e. circulatory system
   f. respiratory system
   g. defensive systems
   h. endocrine system

   the student will be able to

   a. recall and list at least 1 major function performed by each of the systems.
   b. recall and briefly describe in writing how each system functions.
   c. recall and describe at least 1 way in which each system is either defended by the body or involved in defending the body.

Terminal Objectives	
Introduction to Industrial Hygiene Engineering and Control	Module 1

4. Given no aids, the student will be able to

   a. recall and list at least five (5) toxic materials. For each toxic material, the student will be able to

      (1) recall and list a potential route of exposure that may be taken by the toxic material.
      (2) recall and list a physical form in which the toxic material may be found.
      (3) recall and list a physiological response by the body to the toxic material.

   b. recall and list at least five (5) physical hazards. For each physical hazard, the student will be able to

      (1) recall and describe at least one (1) cause of the physical effect.
      (2) recall and describe at least two (2) effects of the hazard on the human system.
      (3) recall and describe at least one (1) protective mechanism that the body employs to defend against the hazard.

5. Given the hazards identified above, the student will be able to

   a. recall and list at least four (4) general methods of control that might be effective as a protection against exposure to each of the hazards.
   b. explain briefly how each of the above general control methods might be effective in controlling the hazard exposure.

6. Given no aids, the student will be able to recall and describe in writing the procedure that should be used to assure that the appropriate control method(s) is selected, installed, and operating properly.

Title Page	
The Workplace--A Hazardous Environment	Module 1 Unit 1

UNIT 1

THE WORKPLACE--A HAZARDOUS ENVIRONMENT

Performance Objectives		
Lesson	The Workplace--A Hazardous Environment	Module 1 Unit 1
1	1. Given no aids, the student will be able to recall and list at least five industrial hazards, explain in writing the reason each is a hazard, and identify a method by which each hazard can be recognized.	
1	2. Given no aids and a list of typical industrial hazards, the student will be able to recall and list the category in which each hazard would be classified in each of the following classification systems: a. By type of exposure b. By type of hazard c. By level of effect d. By type of effect	
1	3. Given no aids, the student will be able to recall and list at least ten (10) methods that can be used to recognize potential hazards in the industrial setting.	
1	4. Given no aids and a list of descriptions of methods for recognition of hazards, the student will be able to recognize the label associated with each description from the following list: a. accident or injury reports b. physical exams c. employee notification d. required inspection e. literature and discussion with other professionals f. recommended inspections g. continuous monitoring h. review of new or modified operations i. walk-through inspections j. sampling and spot inspections k. preliminary hazard analysis l. review of process flows m. fault tree analysis n. critical incident technique o. failure mode and effect p. job safety analysis	
2	5. Given no aids and a typical industrial situation, the student will be able to identify and list the potential hazards that are present.	
2	6. Given no aids and a list of potential hazards, the student will be able to recall and describe in writing at least one measurement technique that can be used to determine the extent of hazard present for the following: a. toxic gases and vapors b. particulates c. noise d. heat e. ionizing radiation f. nonionizing radiation	

Performance Objectives		
Lesson	The Workplace--A Hazardous Environment	Module 1 Unit 1
2	7. Given a description of a typical industrial situation involving a particular hazard and a list of alternate methods that can be used to measure the extent of the hazard, the student will be able to select the most appropriate method to be used to measure the hazard extent.	
2	8. Given no aids and a measurement method selected by the student as most appropriate for a given hazard, the student will be able to write a justification statement that describes the reasoning behind the choice of method.	
2	9. Given no aids and a list of potential hazards, the student will be able to identify the initial screening measurement and evaluation techniques that can be used for potential hazards involving: a. toxic gases and vapors b. particulates c. noise d. heat e. ionizing radiation f. nonionizing radiation	
2	10. Given no aids and a typical industrial situation, the student will be able to design a study to measure and evaluate the extent of a potential hazard that is present. The hazard will be chosen from one of the following: a. toxic gases and vapors b. particulates c. noise d. heat The study will be designed by a small group of students and will be presented to the class by one of the students.	

Unit Activities--Instructor	
The Workplace--A Hazardous Environment	Module 1 Unit 1

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

Lesson 1--Recognition of Health Hazards

Classroom Presentation

Conduct a discussion related to the recognition of hazards and the classification of these hazards into various categories. The students will participate actively in the discussion.

Time Allotted

1 Hour

Demonstration

No demonstrations are required

Supervised Practice

No supervised practice is required.

Lesson 2--Methods for Measuring and Evaluating Health Hazards

Classroom Presentation

The instructor will divide the class into preassigned groups. Each group will be given a recognition, measurement, and hazard evaluation problem from the included case study and will be required to design a study that will identify and evaluate the presence of hazards in the situation presented. The students will then present the study design to the class for comment and discussion.

Time Allotted

1 hour for study design
1 hour for presentation and discussion

Demonstration

No demonstrations are required

Supervised Practice

The instructor will act as a source of technical information to each of the groups during design of the study and during the ensuing discussion.

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

Lesson 1--Recognition of Health Hazards

Classroom Activity

Attend and participate in a classroom discussion concerning hazard recognition.

Assignment

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

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 1 Chapter 1	Section 1 Chapter 1
the Industrial Environment--its Evaluation and Control		Chapter 10
PROBLEMS		

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

Lesson 2--Methods for Measuring and Evaluating Health Hazards

Classroom Activity

Participate as a member of a small group to design a recognition, measurement, and hazard evaluation study for the case presented in the unit.

Assignment

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

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 1 Chapter 2	Section 1 Chapter 2
the Industrial Environment--its Evaluation and Control		Chapters 13, 15, 16
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 1 Chapter 1

Facilities

1. Lecture and or Discussion--Normal Classroom
2. Practice Exercises--Each assigned group will require a separate area for discussion. Each area should be isolated from the other groups and be equipped with a table large enough to seat all students in the group. Groups will normally have 3 or 4 members.

Equipment and Materials

Educational

Chalkboard
Chalk
Erasers
Overhead Slide Projector
Visual Pen
Screen

Health and Safety

None required

Visuals

Visual 1.1.1--Slide Series--Industrial Hygiene Engineering and Control

References Used in Class

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

Lesson Outline	
Recognition of Health Hazards	Module 1 Unit 1 Lesson 1

TOPIC	REMARKS
	This lesson is designed as a one (1) hour discussion of the recognition of health hazards in the environment. The major emphasis is upon the development of a structured and systematic approach to accomplish the required recognition. To assist the student in developing such a systematic approach, classification systems and tools for recognizing potential hazards are presented. The lesson is to be taught inductively with the students encouraged to draw upon their experience.
I. Introduction	
A. Some common hazards encountered B. Some methods by which hazards can be identified	Ask the students to list three different hazards which have been encountered in their work experience and how the hazard was identified. Allow approximately 5 minutes for the students to complete the list. If work experience is lacking, use general experience related to household or consumer products.
II. Discussion	
A. Hazard recognition 1. What is the hazard? 2. Why is it a hazard? 3. How was it recognized? 4. How was it controlled?	Ask a number of students to identify one hazard from their list and to indicate how it was recognized. List each hazard and method of recognition presented by the students on a transparency or the chalkboard for later reference. (Visual 1.1.1 provides a convenient format for the transparency). The experience of the instructor can serve as a valuable reference in adding additional hazards not covered by the class. Briefly discuss how each hazard was controlled.

Lesson Outline	
Recognition of Health Hazards	Module 1 Unit 1 Lesson 1

TOPIC	REMARKS
B. Classification of the hazard 1. By type of exposure. a. air quality b. physical hazards c. hazardous materials d. flammable materials e. materials handling f. mechanical and electrical g. facilities	Ask the class how each of the identified hazards might be classified. There may be a number of classifications for each of the hazards; no one way is better than another. In addition the level of specificity of classification can vary. The specific classifications given by the class should be discussed. The importance of classifying rests in the formation of a structure for solving industrial hygiene problems and not in the classification itself.
2. By type of hazard. a. health hazard b. safety hazard	The classifications given in the outline can be presented to the class to indicate other ways to classify the hazards, or the major classifications (by type of exposure, etc.) may be used to cue the class prior to their supplying the classification.
3. By level of effect to humans. a. low-annoyance and possible harmful effect b. medium-dangerous to health of humans c. high-cause death or severe injury to health	Classification of hazards can provide a framework which can assist the industrial hygienist in recognizing hazards. It can also provide a basis for evaluation of the extent and seriousness of the hazard present.
4. Other classifications a. by type of effect--acute, chronic, unknown, etc. b. by system of the body affected c. by method of control--this method can be dangerous since it classifies by solution prior to the statement of the problem	

Lesson Outline	
Recognition of Health Hazards	Module 1 Unit 1 Lesson 1

TOPIC	REMARKS
III. Summary A. The workplace has many hazards. B. The hazards are not all equal in terms of: 1. Effect on humans 2. Seriousness of hazard 3. Type of exposure presented 4. Difficulty in controlling C. There are many ways to recognize hazards 1. Accident or injury reports 2. Physical exams 3. Employee notification 4. Required inspections 5. Literature and discussions with other professionals 6. Recommended inspections 7. Continuous monitoring 8. Review of new or modified operations 9. Walk-thru inspections 10. Sampling and spot inspections 11. Prelimary hazard analysis 12. Review of process flows 13. Fault tree analysis 14. Critical incident technique 15. Failure mode and effect 16. Job safety analysis	The summary should pull together the results of the discussion in a manner to provide the students with specific information concerning the type of hazards present and the methods by which they may be recognized. The instructor should take the lead in this summary. Slide 1.1.1.--Classification of Hazards Slide 1.1.2.--Accident or Injury Reports Slide 1.1.3.--Physical Exams Slide 1.1.4.--Employee Notification Slide 1.1.5.--Required Inspections Slide 1.1.6.--Literature Slide 1.1.7.--Recommended Inspections Slide 1.1.8.--Continuous Monitoring Slide 1.1.9.--Review of Operations Slide 1.1.10.-Walk Thru Slide 1.1.11.-Sampling and Spot Inspection Slide 1.1.12.-Preliminary Hazard Analysis Slide 1.1.13.-Process Flow Review Slide 1.1.14.-Fault Tree Analysis Slide 1.1.15.-Critical Incident Technique Slide 1.1.16.-Failure Mode and Effect Slide 1.1.17-Job Safety Analysis

Lesson Outline	
Recognition of Health Hazards	Module 1 Unit 1 Lesson 1

TOPIC	REMARKS
	It may be necessary to define briefly some of the methods presented as not all members of the class will be familiar with each of the methods. This will particularly be the case for special methods such as fault tree analysis and preliminary hazard analysis. Only a brief definition can be given since time is limited. The student should be encouraged to investigate the unfamiliar methods further.

VISUAL 1.1.1

HAZARD	HOW RECOGNIZED	CLASSIFICATION	CONTROL METHOD

Lesson Outline	
Methods for Measuring and Evaluating Health Hazards	Module 1 Unit 1 Lesson 2

TOPIC	REMARKS
	This lesson is designed as a two (2) hour group discussion and presentation of the included case study. The case study serves to review many of the potential hazards that might be encountered in a typical industrial setting. It offers the student an opportunity to review some of the potential hazards that must be controlled and, as such, serves as a referent for the rest of the course.
I. Introduction	
A. Problem 1. Identify the hazards present. 2. Develop a scheme for measuring and evaluating the extent of the hazards present.	Introduce the task to the class. Assign members of the class to individual groups; the membership of which has been previously established. Point out that a series of questions follow the exercise that will assist in the solution of the problem.
B. Assign the problem to each group.	Problems are found in the Practical Exercises section of this lesson.
C. Assign groups to an area where they can work on the problem.	The work area in which each group will work should be separate to provide for uninterrupted discussion of the problem. Preferably, each area should have a table large enough to seat all group members around it comfortably.
II. Groups Work on Problem	The instructor should monitor the groups' progress on problem solution and assist those groups that do not seem to be progressing. Try to spend a short time with each group and return to each group at least once during this time period.

Lesson Outline	
Methods for Measuring and Evaluating Health Hazards	Module 1 Unit 1 Lesson 2

TOPIC	REMARKS
III. Group Presentation A. Each group presents to the class the study design which has been developed. B. Discussion and comment on the design.	Allow each group no more than 10 minutes for the presentation and discussion. The instructor should lead the comments and questions if the other class members are not quick to comment on the presentation. Special emphasis of the discussion should be directed toward the following: a. Have all of the potential hazards been identified? b. Has a preliminary hazard assessment been undertaken? c. Have alternative measurement schemes been considered? d. Is there justification for the measurement chosen? e. Will the measurement and evaluation scheme provide definitive results from which to determine the existence of a hazard? f. Is there sufficient justification for taking action to remove the hazard?
IV. Summary A. Consider all hazards 1. Structured approach can help. a. checklists b. methods such as fault tree analysis 2. Think in terms of the classification of hazards B. Design the measurement and evaluation study before starting 1. Eliminates errors necessitating redoing study. 2. Can plan for problems ahead of time. 3. Less likely to be led astray during the actual measurement and evaluation.	The instructor should wrap up the class by presenting a brief summary of key points for the recognition, measurement, and evaluation of hazards. The outline can be used as a lecture or directed discussion for this summary.

Lesson Outline	
Methods for Measuring and Evaluating Health Hazards	Module 1 Unit 1 Lesson 2

TOPIC	REMARKS
C. Can preliminary estimate of the potential hazard be obtained? D. Has anyone else had a similar problem? 1. Literature 2. Discussion with other professionals. E. Consider alternative schemes for measurement where possible. F. Design the study carefully 1. Location of sampling points. 2. Time when samples taken. 3. Specificity of sampling method. 4. Choice of equipment. G. Be sure the scheme chosen is best 1. Ultimate validity of results. 2. Reliability of study. 3. Economics of study. 4. Time required to complete the study. H. Can you justify to management that action be taken to remove the hazard based upon the results of your study? I. Have you considered the economics of the hazard? 1. Dollar savings may make the hazard removal more acceptable to management. 2. Economics is a major consideration in the design of control systems.	

Case Study	
Acme Metal Fabricating, Inc. (AMF)	Module 1 Unit 1 Lesson 2

Introduction

The following pages describe a case concerning an industrial firm, Acme Metal Fabricating, Inc. (AMF). This case will be used for study throughout the course. The case attempts to describe a realistic industrial plant that faces many occupational health and safety problems. Some of the practice exercises and assignments in the rest of the course will return to this case study in an attempt to make your learning experience more realistic. The first practice exercise can be found immediately following the case description.

Case Study	
Acme Metal Fabricating, Inc.	Module 1 Unit 1 Lesson 2

General Description

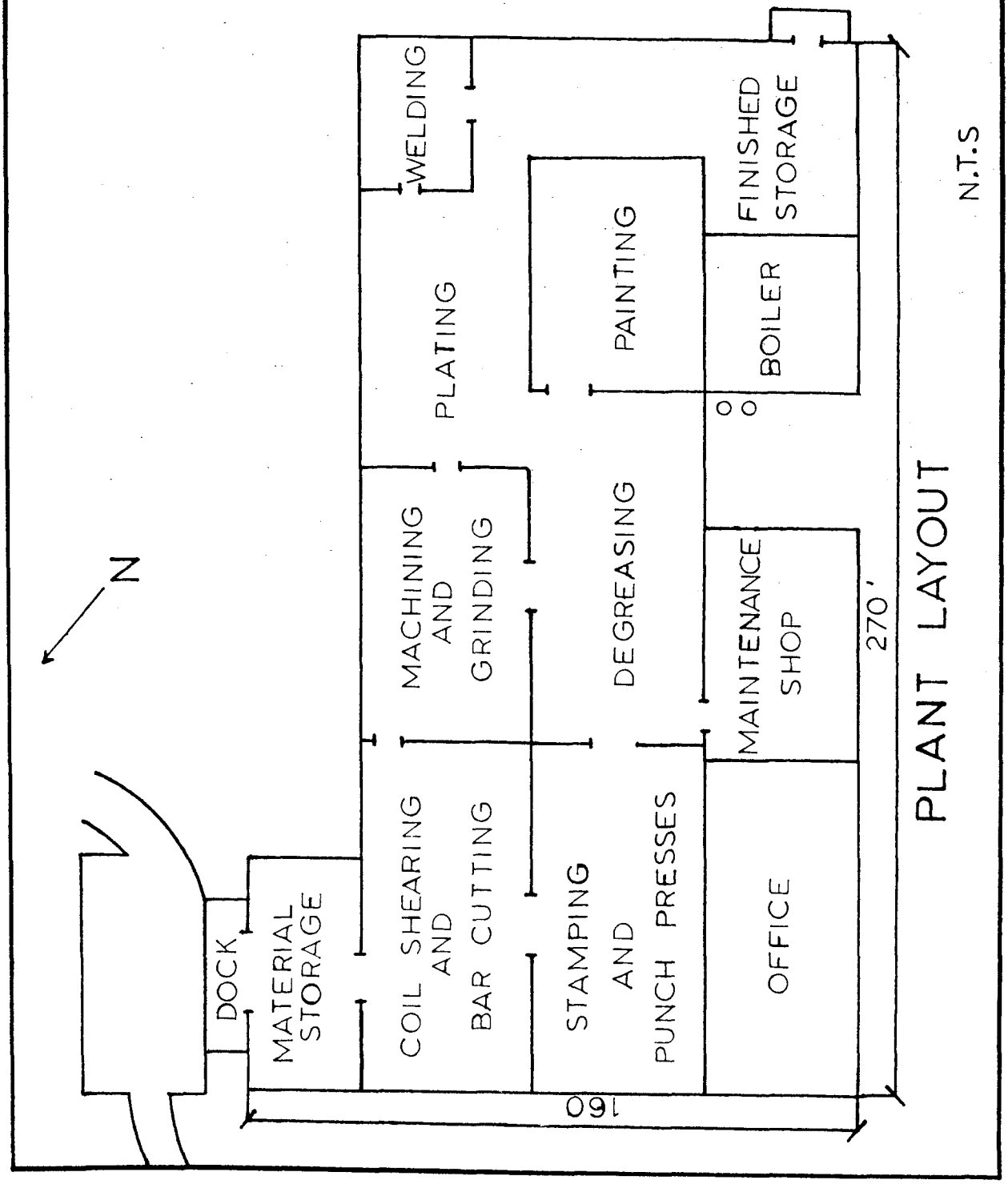
Acme Metal Fabricating, Inc. (AMF) is a small metal fabricating firm operating on the west side of Centertown, Ohio (population 16,500). AMF employs 94 people including office and design engineering staff. The plant is a large, single story building with dimensions of 270 ft. by 120 ft. and open ceiling heights of 16 ft. in the production and storage areas. Office ceiling heights are 10 ft. AMF is engaged in the fabrication of large and small metal parts used by other manufacturers in the local area.

The Plant Manager, Jim Brown, has recently become aware of the possible existence of conditions which are hazardous to the health and safety of the workers. Having no one who is responsible for the health and safety of the workers, he has contacted your firm, Health and Safety, Inc., for the purposes of determining if hazards are present and, if so, recommending controls to alleviate the hazard. You and some other members of the firm's staff have been chosen to act as consultants to AMF. Mr. Brown has provided the following descriptive information concerning the operation of AMF to your group.

Case Study

Plant Layout

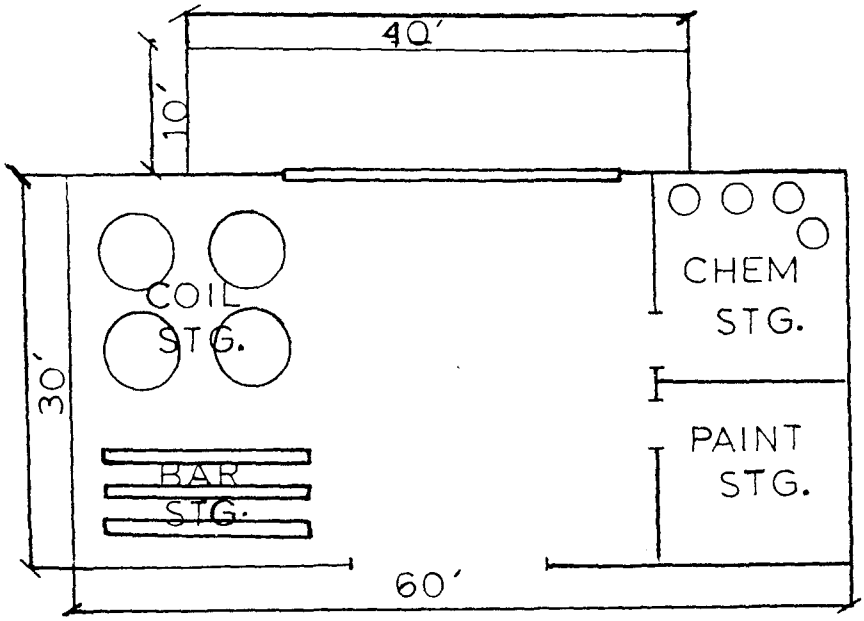
Module 1
Unit 1
Lesson 2



Case Study

Material Storage

Module 1
Unit 1
Lesson 2



PERSONNEL
2 FORKLIFT DRVRS.
1 WAREHOUSE WKR.
1 RECEIVING CLRK.

N.T.S.

Process Description

Steel Coils

1. Steel coil is delivered by truck.
2. Forklift truck (LPG) moves coils from truck to storage. Coils weight from 8,000# to 15,000# each depending on steel gauge.
3. Coils are stored on end.

Bar Stock

1. Bar stock is delivered by truck.
2. Forklift (LPG) moves bar stock to storage racks. Bars may vary in size from 1" x 2" x 6' to 6" x 8" x 6'.

Chemicals and Welding Materials

1. Chemicals delivered by truck in 55-gal drums. Acetylene, carbon dioxide, LPG, and oxygen are delivered in cylinders.
2. Forklift truck moves chemicals and cylinders to storage room door.
3. Drums and cylinders are moved manually using a hand cart which is pushed to storage area and tilted to slide drum or cylinder off into storage.
4. Drums are stored on end. Cylinders are stored horizontally on the floor.
5. Forklift trucks are charged with LPG in the area outside the chemical storage room.

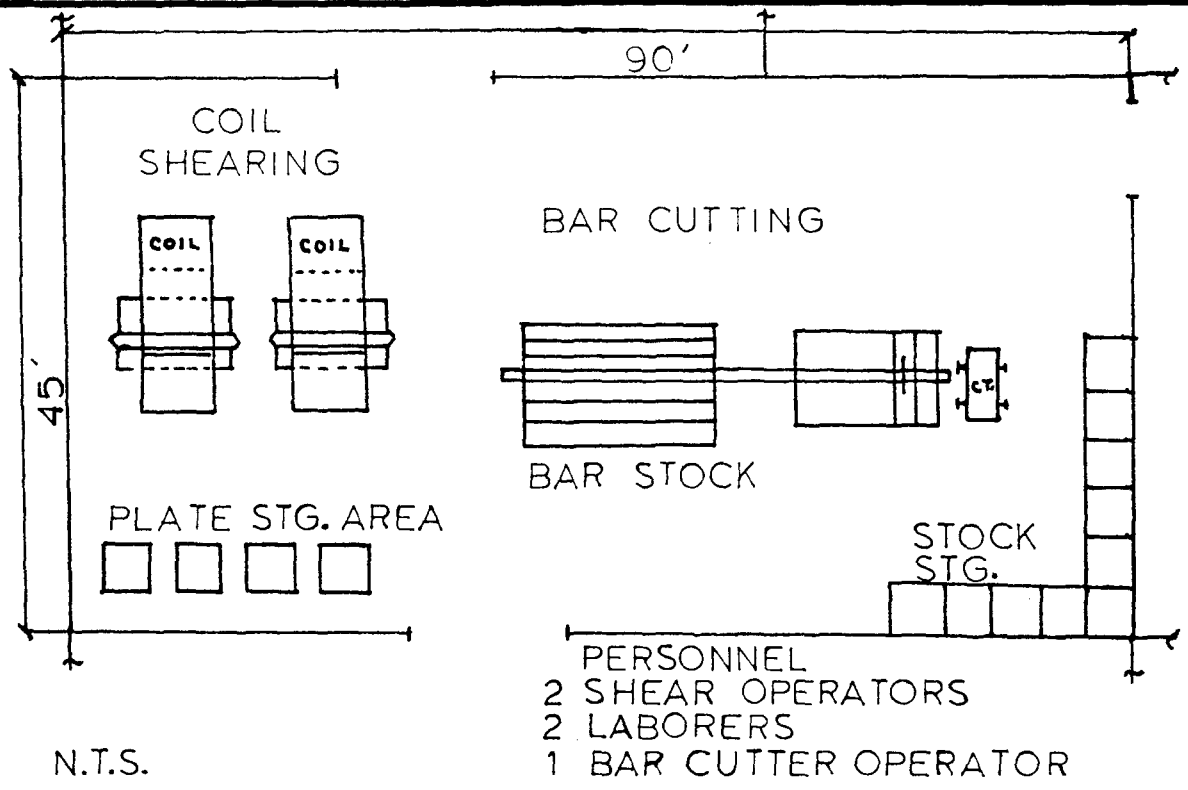
Paint

1. Paint is delivered by truck on a pallet in 5-gal cans.
2. Forklift truck moves the pallet to storage room door.
3. Cans are manually carried to a 3-level rack and placed in labeled positions.

Case Study

Coil Shearing and Bar Cutting Shop

Module 1
Unit 1
Lesson 2



Process Description

Coil Shearing

1. Coil is moved from storage to the shears by forktruck (LPG).
2. Forktruck loads shear with coil.
3. If coil size needs changing, forktruck assists in move. Unused coil is returned to storage.
4. Steel coil is sheared to required size and automatically stacked on pallet.
5. Forktruck moves pallets from shear end to in-process plate storage.

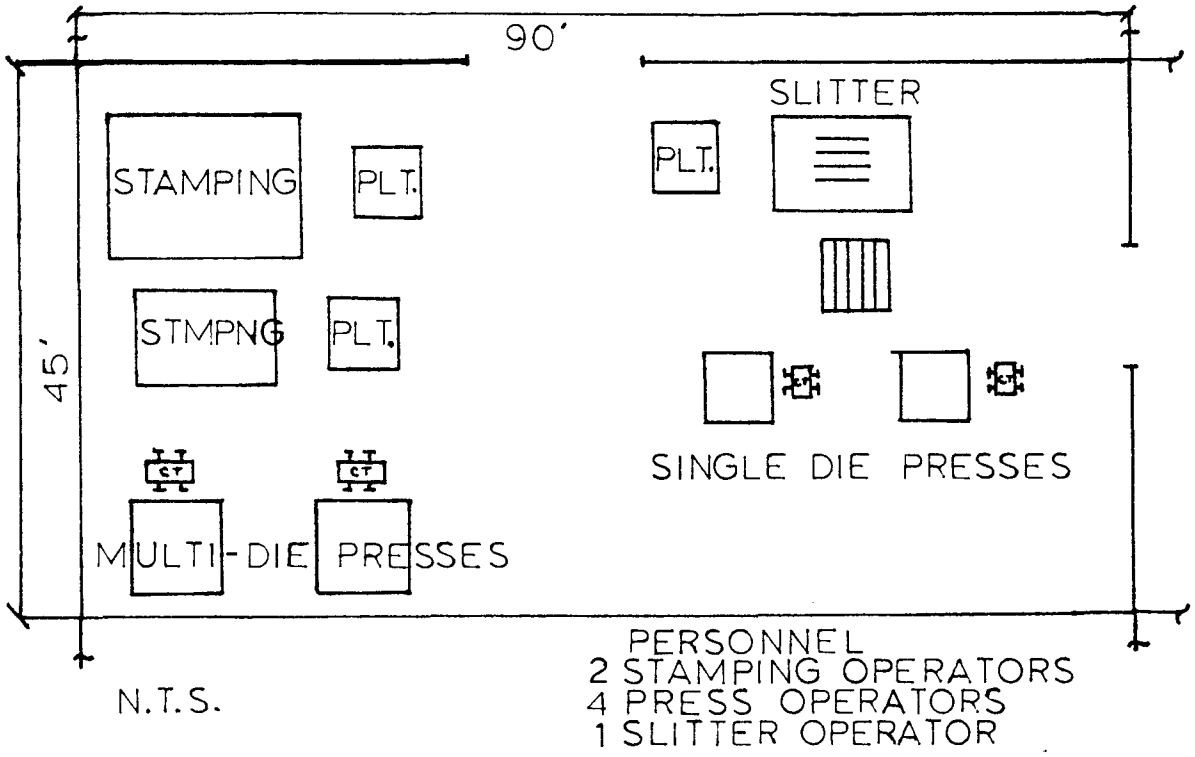
Bar Cutting

1. Bar stock is moved from storage by forktruck to in-process bar storage.
2. Overhead manual crane is used to position bar for cutting shear.
3. Bar stock is cut to specification for the individual pieces to be machined.
4. Finished stock is manually moved by cart to finished stock storage rack.

Case Study

Stamping and Punch Press Shop

Module 1
Unit 1
Lesson 2



Process Description

Stamping

1. Plate is delivered by forktruck to stamping machine.
2. Single plate is automatically fed by vacuum to stamping area.
3. Operator activates stamping mechanism approximately once every 1-2 minutes.
4. Stamped part is placed in truck wagon by operator who manually removes the part from the stamping machine.
5. Operator changes dies and press punch to meet specifications.

Slitting

1. Plate is moved from storage to slitting operation by forktruck.
2. Plate is slit to specified size by manually moving plate through slitters.
3. Finished slit plate is manually stacked for punching.

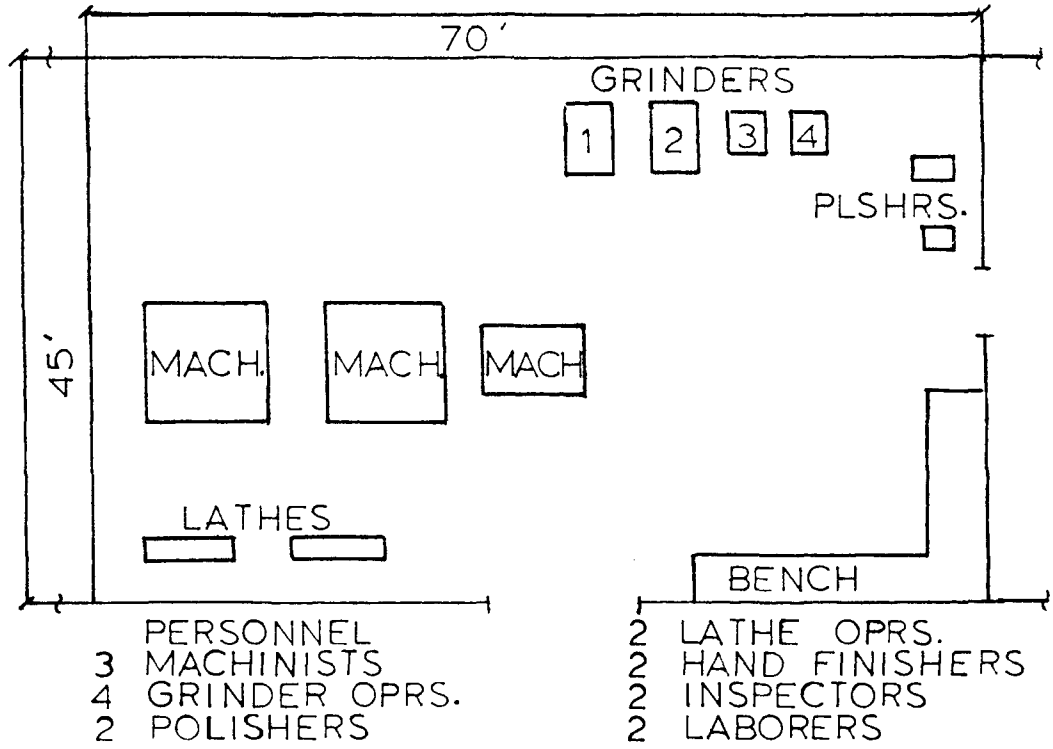
Punch Presses

1. Two single die punch presses are used for punching slit plate. Two multi-die presses are used for plate punching.
2. Plate is moved to multi-die presses by forktruck. Slit plate is manually loaded in single die presses.
3. All presses operate automatically with operator feeding stock and removing finished product from stacker.
4. Finished products are stored in tote boxes in small cart that can be pulled manually or by forklift.
5. Operator changes punches and dies to meet specifications.

Case Study

Machining and Grinding Shop

Module 1
Unit 1
Lesson 2



N.T.S.

Process Description

Machining

1. Cut bar stock is moved to milling machines by cart pulled manually or by forklift.
2. Cut bar stock is machined to specifications using metal milling machines. Cutting oils are used to assist in the milling process.
3. Bar stock is turned on metal lathe to specification using cutting oils to assist in the process.
4. Finished parts are moved to grinders, polishers, or to degreasing by cart pulled manually or by forklift.

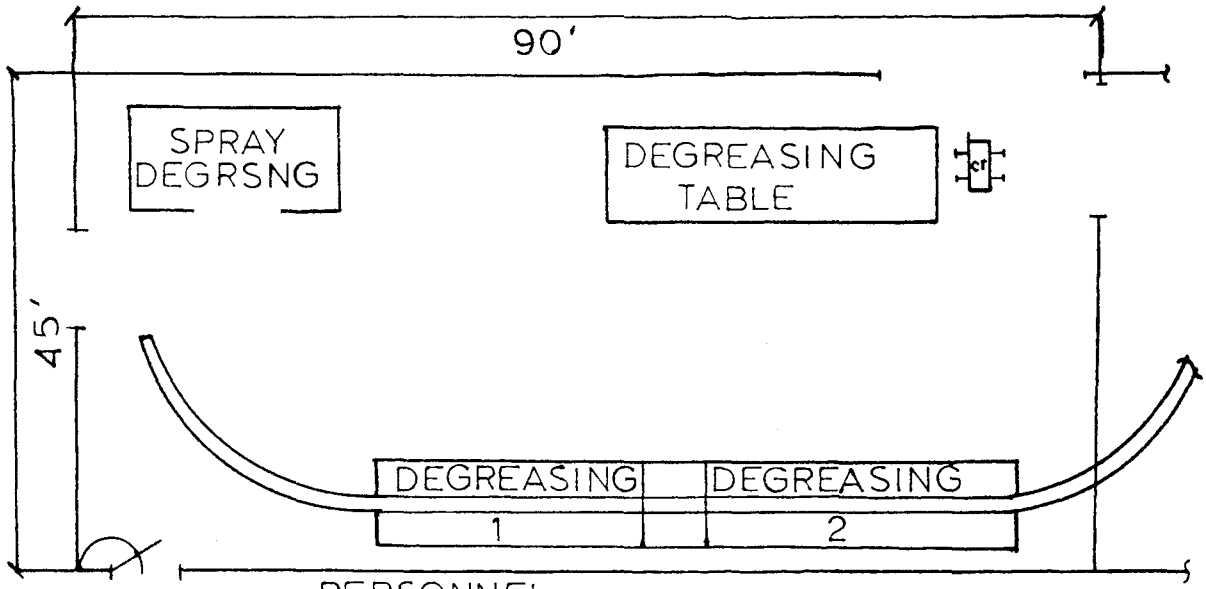
Grinding and Polishing

1. 2-3" grinders 18" in diameter operating at 150 RPM. 2-2" grinders 12" in diameter operating at 180 RPM. 1-4" polisher 18" in diameter operating at 250 RPM. 1-3" polisher 12" in diameter operating at 350 RPM.
2. Parts are ground and polished to meet specifications.
3. Completed parts are moved by hand cart to work bench for inspection and hand finishing.
4. Hand finishing is done using small 1" grinding and polishing wheels of 4" diameter operating at 500 RPM.

Case Study

Degreasing Shop

Module 1
Unit 1
Lesson 2



PERSONNEL
1 DEGREASER OPR. 2 LABORERS
3 MANUAL DEGREASERS
1 SPRAY DEGREASER

N.T.S.

Process Description

Large Parts

1. Large parts moved by forktruck pulling cart to vapor degreaser.
2. Degreaser workers remove parts from wagon and attach to overhead conveyor.
3. Degreaser operator operates controls to move part into degreaser. Operator is responsible for timing part in degreaser.
4. Degreaser consists of 2-tank process. Part immersed in first tank; vapor bathed in second tank.
5. Tanks are steam heated to 190°. Solvent used is trichloroethylene with stabilizers added. Thermostat controls vapor line.
6. Tanks are cleaned and charged every 48 hours of operation.
7. Each tank is 23' long, 5' wide, and 10' high. Solvent is 4' deep.

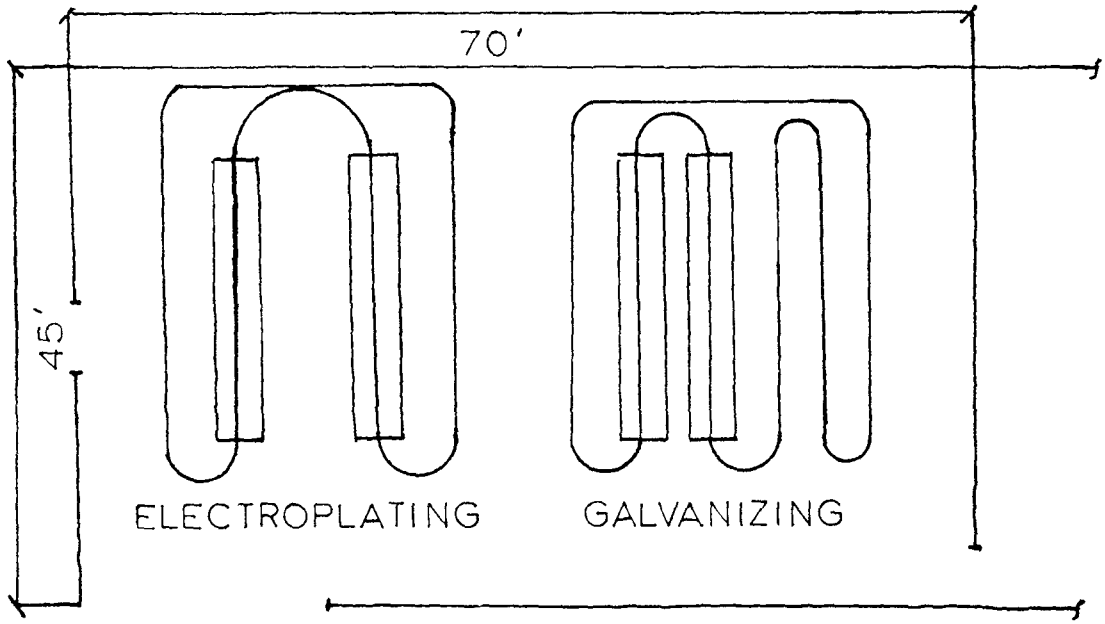
Small Parts

1. Small parts are delivered from either machining/grinding or the punch press operation by cart to degreasing tables and booth.
2. At degreasing table small parts are attached to hand operated conveyor chain and dipped into small tank of trichloroethylene at room temperature, removed, brushed with paint brush to loosen oil and grease, and allowed to dry while hanging on chain conveyor.
3. Other small parts are attached to chain in small spray booth. Operator sprays parts to remove oil and grease and moves to drying position to air dry. Small hand spray is used to apply solvent.
4. Dried parts put in cart for painting, electroplating, or welding as required.

Case Study

Electroplating Shop

Module 1
Unit 1
Lesson 2



PERSONNEL

2 GALVANIZING WKRS.
2 CHROME PLTRS.
2 INSPECTORS
2 LABORERS

N.T.S.

Process Description

Chrome Plating

1. Parts are delivered by hand cart to the overhead conveyor.
2. Parts are attached to overhead conveyor, which is a manually operated motor-driven systen, to move parts through the plating process.
3. A pre-plating acid cleaning process is accomplished by dipping the parts into a solution of sulfuric acid.
4. The chrome plating dip tank is filled with chromic acid with additives to reduce misting.
5. Chrome plated parts are inspected while on the conveyor.
6. Parts are removed from the conveyor to hand carts.

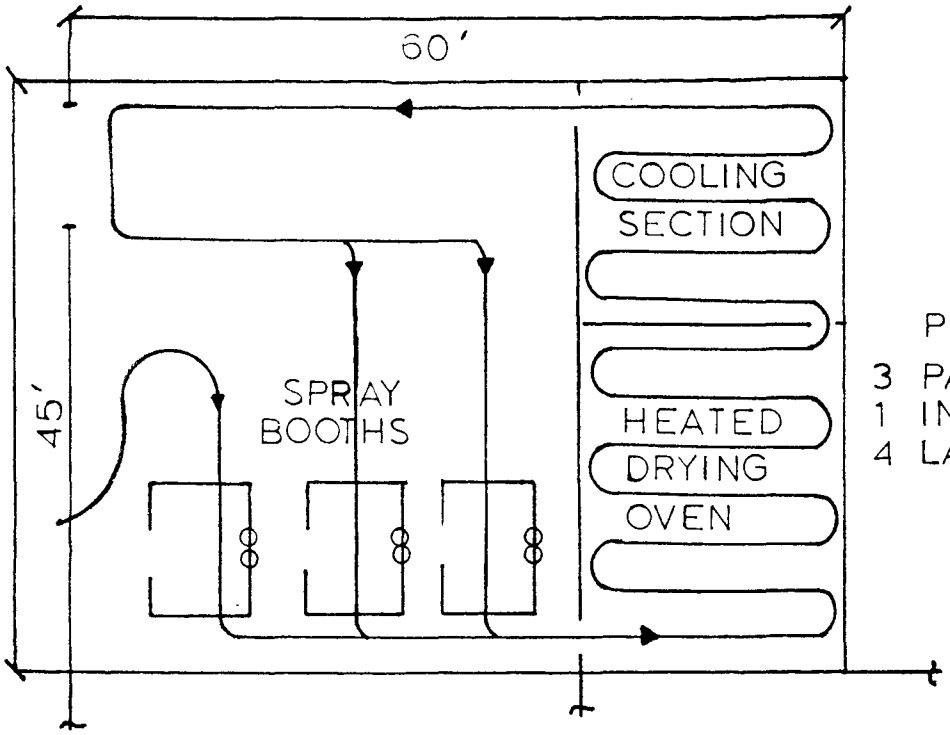
Galvanizing

1. Parts are delivered by hand cart to the overhead conveyor.
2. Parts are attached to the overhead conveyor, which is a manually operated motor-driven system, to move parts through the plating process.
3. A pre-plating acid cleaning process is accomplished by dipping the parts into a solution of sulfuric acid.
4. Galvanizing is accomplished by dipping parts into the molten zinc tank.
5. Galvanized parts are inspected on the conveyor.
6. Parts are removed from the conveyor to hand carts.

Case Study

Paint Shop

Module 1
Unit 1
Lesson 2



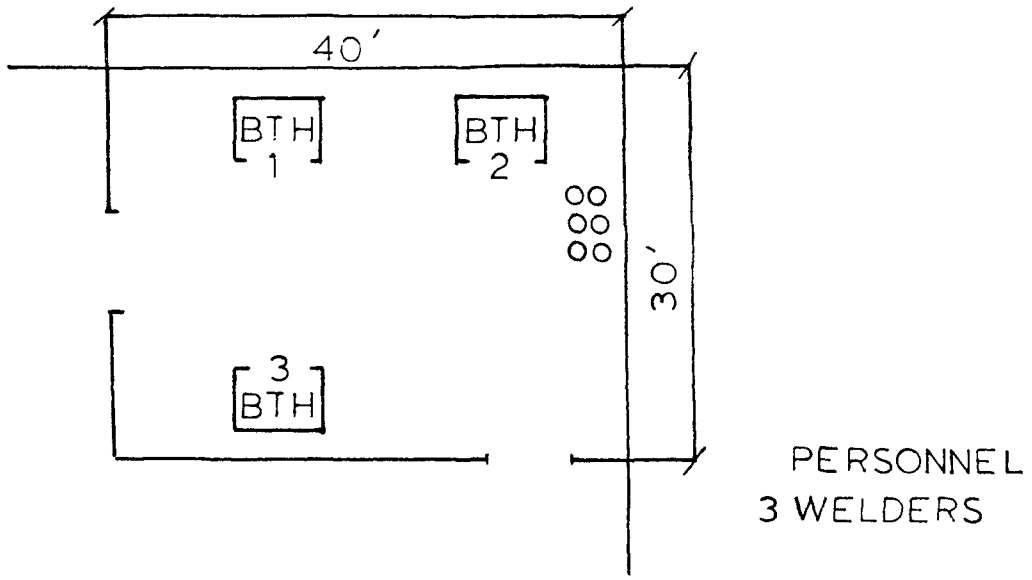
N.T.S.

Process Description

1. Small parts are delivered by hand cart and attached to one of two parallel overhead conveyors. Large parts that are to be painted are delivered to the spray booth conveyor. Parts not painted are removed from conveyor in paint shop and carried by hand cart to electroplating, welding, or storage as required.
2. Painter sprays parts using hand-held spray gun.
3. Paint used is leaded zinc oxide base paint.
4. Parts move from spray booth to a pickup conveyor.
5. Parts are moved continuously through drying oven operating at 300°F.
6. Final stage of drying is at cool temperature, 60°-70°F.
7. Parts are removed from conveyor and placed on cart equipped with racks to be moved to storage by forklift truck.

Case Study

Welding Shop	Module 1 Unit 1 Lesson 2



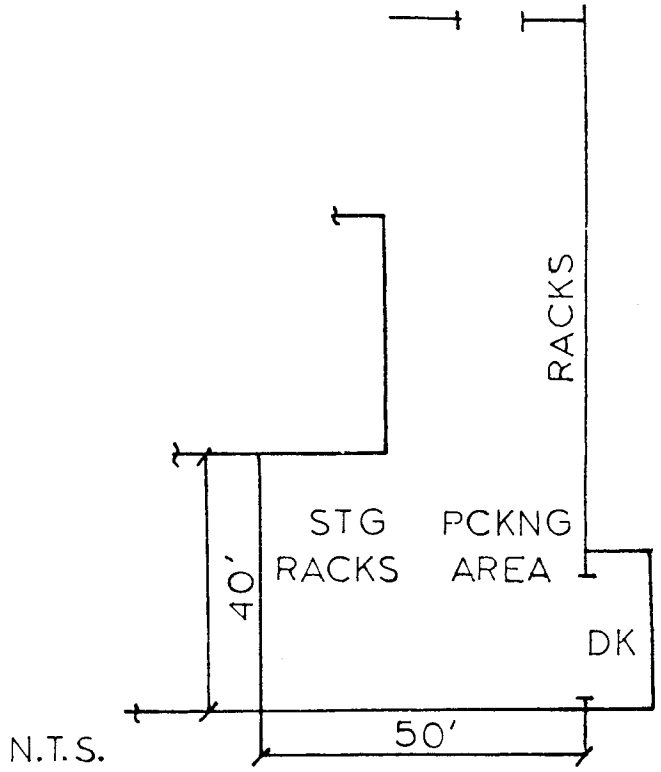
N.T.S.

Process Description

1. Parts are delivered to the welding shop by hand truck.
2. Welding is done to specification on cleaned parts.
3. Some of the galvanized parts are sent to welding.
4. Booths #1 and #2 are used for acetylene cutting and welding using an oxygen assist.
5. Booth #3 is used for gas shielded metal arc welding. Carbon dioxide is used as the gas shield.
6. Parts are moved from welding by cart pulled manually or by forklift.

Case Study

Finished Storage	Module 1 Unit 1 Lesson 2



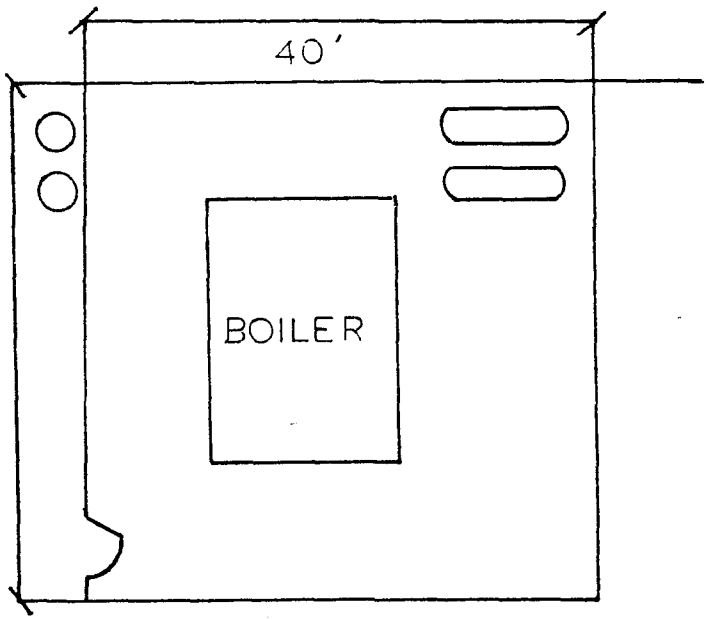
PERSONNEL
3 PACKERS
1 FORKLFT. DVR.
2 WAREHSMEN
1 SHIPPING CLK.

Process Description

1. Parts are moved to storage racks by cart pulled manually or by forktruck.
2. Parts are stored by type on storage racks. Small parts are in tote boxes. Large parts are on pallets.
3. Storage racks are 12' high.
4. Parts are delivered to the packing area by forktruck or by cart pulled manually.
5. Parts are manually packed in boxes and palletized.
6. Pallets are loaded into trucks by forklift truck.

Case Study

Boiler Room	Module 1 Unit 1 Lesson 2



PERSONNEL

2 BOILER OPRS.

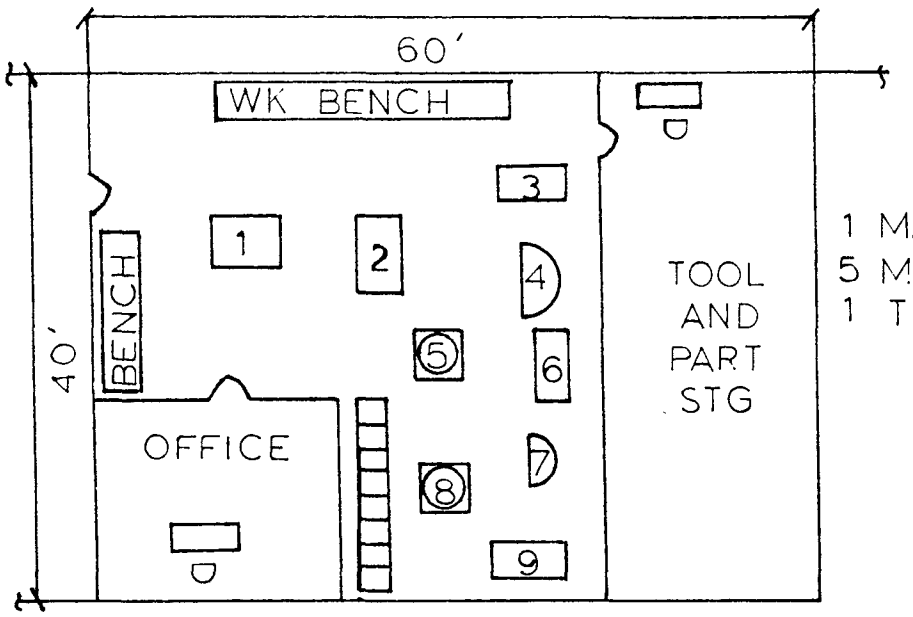
N.T.S.

Description

1. Boiler is gas fired with a capacity of 750,000 lbs of steam/hour at 2000 psi and 1000°F.
2. One stack is used for boiler flue gas exhaust.
3. The second stack is used for ventilation of gases gathered from the Degreasing and Paint shops.
4. Two feedwater treatment tanks are located in the boiler room.

Case Study

Maintenance and Machine Shop	Module 1 Unit 1 Lesson 2



PERSONNEL
1 MAINT. SUPVSR.
5 MAINT. WORKERS
1 TOOL CLERK

N.T.S.

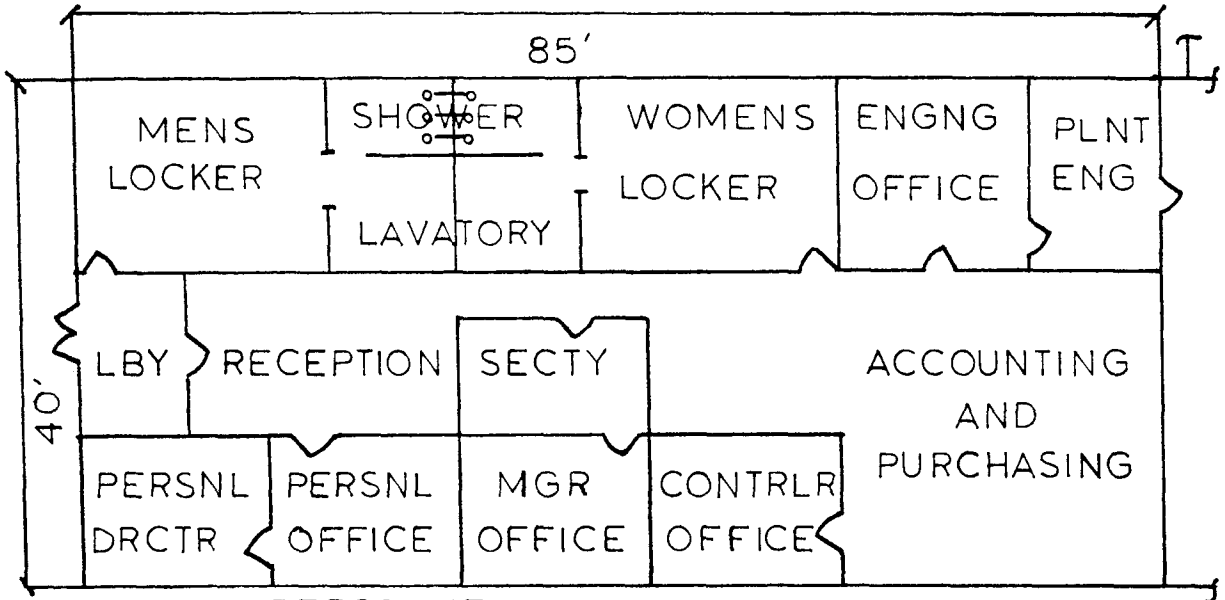
Description

1. Miscellaneous small parts required for maintenance operations are fabricated here.
2. Equipment includes
   a. wood working
      1. table saw
      2. jointer
      3. sander
      4. band saw
      5. drill press
   b. metal working
      6. lathe
      7. band saw
      8. drill press
      9. pipe cutter
3. The Tool and Part Storage area is adjacent to the maintenance facility.

Case Study

General Office

Module 1
Unit 1
Lesson 2



PERSONNEL

1	PLANT MGR	1	CONTROLLER
1	PERSNL DRCTR	6	ACCTG AND PRCHNG
1	GENERAL FRMAN	3	DRAFTSMEN
1	PLANT ENGINEER	5	SECRETARIES

N.T.S.

Description

1. The General Office area is a single story area which is air conditioned.
2. Wall between the office area and plant is exterior brick covered by lath and plaster since this area was added to the plant 10 years after the plant was built (3 years ago).

Practice Exercise	
Methods for Measuring and Evaluating Health Hazards	Module 1 Unit 1 Lesson 2

1. As a member of an assigned group or as an individual, review at least one area of the case study (as assigned by the instructor). Each individual or group is responsible for completion of the following activities:

   a. Review of the case study material.

   b. For the area assigned to each group by the instructor

      --identify potential hazards
      --develop a plan(s) to measure and evaluate the extent of the hazard(s) present
      --be prepared to present your plan to the plant manager (the instructor)

2. Be prepared to present to the instructor a summary of your investigation. The following outline will assist you in preparing the presentation.

Suggested Presentation Outline

A. Briefly describe the area under consideration.

B. Identify the potential hazards recognized.

C. Identify the potential hazard selected for study and why it was selected.

D. Study design to determine hazard extent.

   1. Preliminary hazard determination method(s)
   2. Alternative measurement methods available.
   3. Measurement method selected and why this method was chosen.
   4. The procedure to be used to measure.
   5. The methods of evaluation to be used.
   6. The criteria used to determine that a hazard exists.

Practice Exercise	
Methods for Measuring and Evaluating Health Hazards	Module 1 Unit 1 Lesson 2

Case Study Outline

1. Area assigned _____

2. What potential hazards might exist in this area?

3. How might each of these hazards be investigated initially?

4. Select one potential hazard (give priority to air quality or noise if present in the area) and design a complete study to determine the extent of the hazard. See Suggested Presentation Outline on the preceding page.

Title Page	
The Effects of Health Hazards on Man	Module 1 Unit 2

UNIT 2

THE EFFECTS OF HEALTH HAZARDS ON MAN

Performance Objectives		
Lesson	The Effects of Health Hazards on Man	Module 1 Unit 2

1 1. Given a description of each of the following terms:

a. anatomy
b. physiology
c. biochemistry
d. biophysics

the student will be able to recognize and associate the label for each term with the appropriate description.

1 2. Given a description of each of the following terms:

a. homeostasis
b. cell
c. protein
d. carbohydrate
e. lipid
f. nucleic acid
g. DNA
h. RNA
i. metabolism

the student will be able to recognize and associate the label for each term with the appropriate description.

1 3. Given a description of each of the following terms

a. skeleton
b. muscle
c. respiratory system
d. digestive system
e. circulatory system
f. nervous sytem
g. renal system
h. reproductive system
i. endocrine system

the student will be able to recognize and associate the label for each term with the appropriate description.

1 4. Given a description of the following terms related to the respiratory system

a. airway
b. mucous membrane
c. cilia
d. larynx
e. pharynx
f. pulmonary
g. thorax
h. lung
i. bronchi
j. alveoli
k. air

the student will be able to recognize and associate the label for each term with the appropriate description.

1 5. Given a description of the following terms related to the digestive system:

a. salivary glands
b. esophagus
c. stomach
d. liver
e. pancreas
f. gall bladder
g. small intestine
h. colon
i. gastro-intestinal
j. enzyme

the student will be able to recognize and associate the label for each term with the appropriate description.

Performance Objectives		
Lesson	The Effects of Health Hazards on Man	Module 1 Unit 2

1 6. Given a description of the following terms related to the circulatory system:

a. heart
b. atria
c. ventricles
d. arteries
e. veins
f. pulmonary artery
g. aorta
h. arterioles
i. capillaries
j. pulmonary vein
k. venae cavae
l. venules
m. red cells
n. white cells
o. hemoglobin
p. platelets
q. plasma
r. vasoconstriction
s. vasodilation
t. lymph
u. lymph nodes
v. spleen
w. tonsils
x. thymus

the student will be able to recognize and associate the label for each term with the appropriate description.

1 7. Given a description of the following terms related to the renal system:

a. kidneys
b. ureter
c. bladder
d. urethra

the student will be able to recognize and associate the label for each term with the appropriate description.

1 8. Given a description of the following terms related to the nervous system:

a. brain
b. spinal cord
c. peripheral nervous system
d. autonomic nervous system

the student will be able to recognize and associate the label for each term with the appropriate description.

1 9. Given a statement describing a function performed by a system or subsystem of the human body, the student will be able to recognize the system or subsystem name that the statement describes.

1 10. Given a statement describing a hazard that a worker might encounter, the student will be able to recall those defensive mechanisms that can act to protect the worker from the hazard.

2 11. The student will be able to recall the major characteristics that can determine the hazardous effect of a toxic substance on the human body.

Performance Objectives		
Lesson	The Effects of Health Hazards on Man	Module 1 Unit 2

2 12. Given the following:

a. LD_{50}
b. LC_{50}
c. dose response

the student will be able to recall and write a brief definition for each term.

2 13. The student will be able to recall and list the five routes of entry to the human body for toxic substances.

2 14. The student will be able to recall and list the five mechanisms that can protect the human system from toxic substances.

2 15. Given a statement describing the following agents:

a. irritant
b. asphyxiant
c. anesthetic
d. hepatoxic
e. nephrotoxic
f. neurotoxic
g. blood damaging
h. lung damaging

the student will be able to recognize the term from a list of terms to which the statement applies.

2 16. Given the above classification of agents, the student will be able to recall and write, for each type of agent, the chemical name of one toxic substance that acts in the manner appropriate for that agent.

2 17. Given a statement describing the following terms:

a. gas
b. vapor
c. particulate matter
d. aerosol
e. smoke
f. fog
g. mist
h. fume

the student will be able to recognize the term that best matches the description given.

3 18. Given a statement describing a typical hazard, the student will be able to recognize the classification of the hazard as being either a toxic hazard or a physical hazard.

3 19. Given a statement describing a typical hazard, the student will be able to recall the classification label(s) most applicable to the hazard from the following list of classification labels:

a. noise
b. vibration
c. ionizing radiation
d. nonionizing radiation
e. thermal
f. mechanical
g. abnormal pressure
h. illumination
i. traumatic
j. biological
k. psychological

Performance Objectives		
Lesson	The Effects of Health Hazards on Man	Module 1 Unit 2
3	20. Given a classification of a hazard from the list presented in statement 19, the student will be able to recall and describe in writing at least one potential hazardous effect on the worker which is caused by the classification of hazard.	
3	21. Given a classification of hazard from the list presented above, the student will be able to recall and describe in writing at least one protective mechanism which is present in the human system to protect the worker from the effects of the hazard.	

Unit Activities--Instructor	
The Effects of Health Hazards on Man	Module 1 Unit 2

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

Lesson 1--Human Systems

Classroom Presentation

Present a lecture related to the anatomy and physiology of the human body. The lecture is designed to provide the student with an introduction to the functions performed by the systems and subsystems that comprise the human body as well as an introduction to the terminology associated with human systems.

Time Allotted

1 hour

Demonstration

No demonstrations are required.

Supervised Practice

No supervised practice is required.

Lesson 2--Industrial Toxicology

Classroom Presentation

Present a lecture to introduce the field of Industrial Toxicology. The lecture is designed to familiarize the students with the study of Industrial Toxicology. The emphasis is on the classification of toxic substances in relation to their effect on the human system and the physical form which the toxic substances may take. The routes of entry of a toxic substance to the human system are included in the lesson.

Time Allotted

1 hour

Demonstration

No demonstrations are required.

Supervised Practice

No supervised practice is required.

Lesson 3--Physical Hazards

Classroom Presentation

Present a classroom lecture to review the various physical hazards which might be encountered by the industrial hygienist. The lecture serves as an introduction to physical hazards. Most of the physical hazards will be discussed in greater detail in succeeding modules.

Alternate Classroom Presentation--3A

This lesson is prepared as an alternate approach to covering the topic. This lesson can be used in place of lesson 3; as an introduction to Lesson 3; or as a summary following Lesson 3. The lesson may also be used as an out-of-class assignment prior to or after the lecture. The choice of approach depends upon the time available and the composition of the class. If the class is composed of individuals with significant experience in industrial hygiene, Lesson 3A should be used in place of Lesson 3. Conversely, Lesson 3 is more appropriate for a class composed of individuals with little experience in industrial hygiene.

Time Allotted

1 hour

Demonstration

No demonstrations are required.

Supervised Practice

No supervised practice is required unless Lesson 3A is used.

Unit Activities--Student	
The Effects of Health Hazards on Man	Module 1 Unit 2

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

Lesson 1--Human Systems

Classroom Activity

Attend a classroom lecture on the subject of human systems.

Assignment

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

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 1 Chapter 3	Section 1 Chapter 3
the Industrial Environment-- its Evaluation and Control		Chapter 6
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 1 Chapter 2

Unit Activities--Student	
The Effects of Health Hazards on Man	Module 1 Unit 2

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

Lesson 2--Industrial Toxicology

Classroom Activity

Attend a classroom lecture on the topic of industrial toxicology.

Assignment

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

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 1 Chapter 4	Section 1 Chapter 4
the Industrial Environment--its Evaluation and Control		Chapters 7, 33, 34
PROBLEMS		
Industrial Hygiene Engineering and Control		Section 1 Chapter 3

The Effects of Health Hazards on Man	Module 1 Unit 2

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

Lesson 3--Physical Hazards

Classroom Activity

Attend a classroom lecture on the subject of physical hazards or participate in a work session and discussion related to the case study.

Assignment

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

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

Facilities, Equipment, and Materials	
The Effects of Health Hazards on Man	Module 1 Unit 2

Facilities

Lecture and/or Discussion--Normal classroom

Equipment and Materials

Educational Materials

Chalkboard
Chalk
Eraser
35 mm slide projector with remote control
Screen

Optional with Lesson 3A

Overhead projector
Visual pen

Health and Safety

None required

Visuals

Slide Series--Industrial Hygiene Engineering and Control--
Module 1, Unit 2

Series of anatomical charts or anatomical model

Optional with Lesson 3A

Visual 1.1.3

References Used in Class

Industrial Hygiene Engineering and Control
the Industrial Environment--its Evaluation and Control
Toxic Substances List
The Wonderful Human Machine

Lesson Outline	
Human Systems	Module 1 Unit 2 Lesson 1

TOPIC	REMARKS
	This lesson is prepared as a one-hour lecture. The purpose of the lesson is to acquaint the students with the functions of the human body and to familiarize the students with the terminology related to the anatomy of the human body. Given this introduction, the student will have a basis for determining the effects of the hazards of the occupational environment upon the functions of the human body.
I. Introduction A. The occupational environment can affect the performance of the human system 1. Physical health 2. Emotional health 3. Traumatic injury B. To assess the extent of hazard, it is necessary to determine the effect of a hazard on the human system C. A change in the normal function of a system within the human body may indicate a problem 1. Problem may or may not be indicated by change. 2. If a problem does exist, it may or may not be occupationally related. 3. Determination of the existence of a problem is the responsibility of the physician. 4. Determination of the possible cause-effect relationship is the responsibility of the health researcher.	

Lesson Outline	
Human Systems	Module 1 Unit 2 Lesson 1

TOPIC	REMARKS
5. Determination of the existence of the probable occupational cause is the responsibility of the industrial hygienist.	
II. The Study of Human Systems	
A. Anatomy--The form of living systems	
1. Anatomy is concerned with terminology used to describe the body parts.	
2. Anatomy is concerned with the structure of the various body parts and the body as a whole.	
3. Anatomy is concerned with the location of the various body parts.	
B. Physiology--The function of living systems	
1. What the system does.	
2. Why the system does what it does.	
3. How the system performs its function.	
C. Biochemistry--The chemistry of living systems	
1. The body is a chemical system.	
2. Chemical changes often indicate a problem exists--e.g., urinalysis	
D. Biophysics--The study of the physical methods of living systems	
1. Body is composed of bones, joints, and muscles.	
2. How the muscles, bones, and joints work to accomplish a given task.	

Lesson Outline	
Human Systems	Module 1 Unit 2 Lesson 1

TOPIC	REMARKS
III. Basic Unit of Life--Cell	
A. Anatomy of the cell	Slide 1.2.1.1.--Structure of the Cell
1. Cell structure.	
2. Water (approximately 80%).	Slide 1.2.1.2.--Cell Composition
3. Organic molecules (compounds of carbon).	
a. proteins b. lipids c. carbohydrates d. nucleic acids--RNA, DNA	
B. Physiology of the cell	
1. The principles of cells are essentially the same.	Slide 1.2.1.3.--Cell Functions
a. exchanging materials with immediate environment b. production of energy from nutrients c. synthesizing proteins d. reproduction	
2. The difference in cells is a result of specialization within tissue structure.	Slide 1.2.1.4.--Types of Cells
a. epithelial tissue b. connective tissue c. muscle tissue d. nervous tissue e. blood cells	
3. Food to energy.	Slide 1.2.1.5.--Food to Energy
a. protein is transformed into simple amino acids in digestive system b. carbohydrates and fats are similarly broken down c. these are absorbed into the blood stream d. penetrate cell membrane e. metabolism--the chemical reaction in the cell which changes nutrients to energy.	

Lesson Outline		
Human Systems		Module 1 Unit 2 Lesson 1
TOPIC		REMARKS
C. System balance		
1. Human systems are in balance--homeostasis.		
2. The internal environment must be in or near a constant state.		Slide 1.2.1.6.--Balance Factors
a. temperature b. oxygen supply c. carbon dioxide level d. nutrient supply e. water supply f. inorganic-ion concentration		
3. The systems of the body contribute to this balance.		
4. The regulatory process starts when an imbalance is present.		
IV. The Structure of the Body--Skeleton		
A. The structure which supports the body--bones		
1. Axial skeleton.		Slide 1.2.1.7.--The Skeleton
a. skull b. vertebral column c. thorax		
2. Appendicular skeleton.		
a. upper extremities		
(1) pectoral girdle (2) arms and hands		
b. lower extremities		
(1) pelvic girdle (2) legs and feet		
B. Connections which allow movement--articulations (joints)		
1. Types of articulations		Slide 1.2.1.8.--Types of Articulations
a. gliding--vertebrae b. hinge--knee c. ball and socket--hip and shoulder		

TOPIC	REMARKS
d. pivot--forearm rotation e. ellipsoidal--wrist f. saddle--thumb	
2. Function--The type of movements include, as examples	
a. flexion b. extension c. rotation	
C. Connecting tissue	Slide 1.2.1.9.--Connective Tissue
1. Tendons--attach muscles to bones. 2. Ligaments--connect bones together. 3. Cartilage--Cushions the connection between bones.	
V. The Moving Force--Muscles	
A. Classifications of components	Slide 1.2.1.10.--Muscle Types
1. Voluntary--e.g., biceps, triceps, flexors, extensors. 2. Involuntary--e.g., diaphragm, esophageal, stomach. 3. Cardiac.	
B. Function of muscles	
1. Involuntary	Slide 1.2.1.11--Function of Involuntary Muscles
a. propulsion of substances through body passages b. expulsion of stored substances c. regulation of the size of openings d. regulation of the size of tubes	
2. Voluntary	Slide 1.2.1.12.--Function of Voluntary Muscles
a. maintenance of posture b. movement	

Lesson Outline	
Human Systems	Module 1 Unit 2 Lesson 1

TOPIC	REMARKS
3. How muscles work.	Slide 1.2.1.13.--How Muscles Work
a. stimulus sent from brain through nerves to muscle b. muscle cells convert glucose to energy c. oxygen is required to burn glucose d. energy causes muscle to contract or expand e. heat is released	
4. Muscle fatigue.	
a. lack of nutrients b. lack of oxygen c. acid buildup (lactic acid)	
5. Oxygen debt.	
VI. The Control System--Nervous System	
A. Components of the nervous system	Slide 1.2.1.14.--The Nervous System
1. Anatomic divisions.	
a. central nervous system	
(1) brain (2) spinal cord	
b. peripheral nervous system	
--transmits messages to the skeletal muscles	
2. Functional divisions.	
a. autonomic nervous system	
--transmits messages to the visceral organs	
b. voluntary nervous system	
--transmits messages for voluntary actions	

Lesson Outline	
Human Systems	Module 1 Unit 2 Lesson 1

TOPIC	REMARKS
B. Function of central nervous system	
1. Brain	Slide 1.2.1.15.--Function of the Brain
a. regulatory center b. seat of consciousness c. seat of sensations d. source of voluntary acts e. seat of emotions f. seat of higher mental processes	
2. Spinal cord.	Slide 1.2.1.16.--The Spinal Cord
a. conducting pathway b. simple reflexes centered in spinal cord	
C. Function of the nervous system	
1. Peripheral nervous system	Slide 1.2.1.17.--Function of the Peripheral Nervous System
a. afferent--impulses to the brain b. efferent--impulses from the brain	
2. Autonomic nervous system.	Slide 1.2.1.18.--Function of the Autonomic Nervous System
a. regulates body functions b. maintains body balance	
3. How the nervous system works.	
a. combined electrical-chemical process b. electrical impulse is transmitted along nerve fibers c. chemicals help or retard impulses at the synapses (junctions)	
VII. Fuel Processing--Digestive System	
A. Major components	Slide 1.2.1.19.--The Digestive System
1. Mouth--initial breakdown of food	
a. chewing b. salivary glands	

TOPIC	REMARKS
2. Esophagus. 3. Stomach--the processing plant. a. liver b. gall bladder c. pancreas 4. Small intestine--absorbing the processed materials. 5. Large intestine--waste product preparation.	
B. Function 1. Food is input. 2. Proteins, carbohydrates, and fats are broken down into simple compounds. 3. Compounds are absorbed by villi into the blood stream. 4. Waste products are excreted.	
VIII. The Distribution System--Circulatory System	
A. Components	Slide 1.2.1.20.--The Circulatory System
1. Heart a. atria b. ventricles	
2. Arteries. a. pulmonary b. aorta c. arterioles d. capillaries	
3. Veins. a. pulmonary b. venae cavae c. venules	
4. Fluid--blood. a. red cells b. hemoglobin c. white cells d. platelets e. plasma	

Lesson Outline	
Human Systems	Module 1 Unit 2 Lesson 1

TOPIC	REMARKS
B. Function	
1. Obtaining oxygen.	Slide 1.2.1.21.--Function of the Circulatory System
a. from veins to right atrium	
b. to right ventricle	
c. from right ventricle to pulmonary artery to lungs	
d. pulmonary vein to left atrium	
e. to left ventricle	
f. to arteries	
2. Distribution of oxygen and nutrients.	
a. from left ventricle to aorta	
b. nutrients are metabolized in liver and other organs	
c. from arteries to arterioles to capillaries	
d. cells burn nutrients and oxygen	
e. capillaries pick up products including carbon dioxide	
f. flow to venules to venae cavae to right ventricle	
g. muscles move blood which is inferior to heart with help of valves	
3. 50% of the O_2 is distributed to the brain.	
C. Lymphatic system	
1. Components	Slide 1.2.1.22.--The Lymphatic System
a. capillaries, vessels, ducts	
b. special function tissue	
(1) nodes	
(2) spleen	
(3) tonsils	
(4) thymus	

TOPIC	REMARKS
2. Function. a. tissue fluid is filtered out of the blood capillaries b. fluid (lymph) is returned to bloodstream by lymphatic system c. special function tissues add lymphocytes and antibodies d. maintains plasma volume of the system	
IX. The Combustible Fuel Supply System--Respiratory System	
A. Components 1. Nose. 2. Turbinates. 3. Sinus. 4. Mouth. 5. Epiglottis. 6. Trachea. 7. Larnyx. 8. Lung. 9. Bronchi. 10. Alevoli.	Slide 1.2.1.23.--The Respiratory System
B. Function 1. Air inspired into lungs. 2. Oxygen attaches to hemoglobin in alveoli. 3. Blood carries hemoglobin to cells. 4. Cells use oxygen to burn glucose for energy. 5. Carbon dioxide is released. 6. Carbon dioxide is carried in blood back to lungs. 7. Lungs expire. 8. Other functions. a. heat air b. cool body c. remove particulates	Slide 1.2.1.24.--Function of the Respiratory System

Lesson Outline	
Human Systems	Module 1 Unit 2 Lesson 1

TOPIC	REMARKS
C. Normal state	
1. Respirations at 12-18/minute average depending on activity.	
2. Four to six minute supply of oxygen in the system.	
3. Carbon dioxide level in blood triggers respirations.	
4. Oxygen debt can be built up for a short time.	
X. The Filtering System--Renal System	
A. Components	Slide 1.2.1.25.--The Renal System
1. Kidneys--filter.	
2. Ureter.	
3. Bladder--storage of waste.	
4. Urethra.	
B. Function	
1. Filtration of the blood.	
2. Elimination of toxic substances from blood.	
3. Maintenance of the salt and water balance.	
4. Maintenance of the acid-base balance.	
XI. The Defensive Systems--Skin and Sense Organs	
A. Components	Slide 1.2.1.26.--Defensive Systems
1. Skin.	
2. Sense organs.	
a. eye	
b. tongue	
c. ear	
d. nose	
3. Other protective mechanisms.	
a. liver	
b. kidney	
c. autonomic nervous system	
d. involuntary muscles	
e. lymph nodes	

Lesson Outline		
Human Systems		Module 1 Unit 2 Lesson 1
TOPIC		REMARKS
B. Functions 1. Eyes--sight. 2. Ears--hearing. 3. Nose--smell. 4. Tongue--taste. 5. Skin. a. pain b. touch c. heat-cold d. pressure e. traction f. tickle 6. Liver--detoxification. 7. Kidney--detoxification. 8. Lymph nodes--removal of particulates, bacteria, and toxins. 9. Autonomic nervous system--regulates system balance. 10. Involuntary muscles--regulate system balance.		Slide 1.2.1.27.--Defensive Functions
XII. Other Systems A. The production of the species--reproductive system B. Chemical control--endocrine system 1. Hormones. 2. Pituitary gland. 3. Thyroid gland. 4. Adrenal glands.		Slide 1.2.1.28.--Other Systems

Lesson Outline	
Industrial Toxicology	Module 1 Unit 2 Lesson 2

TOPIC	REMARKS
	This lesson is prepared as a one-hour lecture. The purpose of the lesson is to familiarize the students with the study of Industrial Toxicology. The emphasis is on classification of toxic substances in relation to their effect on the human system and the physical form that the toxic substances may take. The routes of entry that a toxic substance may take into the human system are included in the lesson.
I. Introduction A. Interface between the human system and the occupational environment 1. The human system is bombarded with many foreign substances and physical phenomena while at work. 2. Some present a potential danger to the human system. 3. Many are harmless. B. Major considerations to determine the hazardous effect of a material or phenomenon 1. Type of substance or phenomenon--some are more dangerous than others. 2. Route of entry of hazardous material. a. inhalation b. absorption c. digestion 3. Amount of exposure--how much is present. a. too much of anything can be hazardous b. the more toxic, the less amount of exposure can be tolerated.	

TOPIC	REMARKS
4. Duration of exposure--how long exposed. 5. Individual response--not all people respond equally (e.g., age, sex, and general health). 6. Other system interfaces that an individual may have.	
C. Discussion	See if the students can name some toxic substances and how these substances affect the human system. List the substances and effects on the board for further reference.
II. Toxicology	
A. Toxicity	
1. Related to chemical agents. 2. Toxic agents have a harmful effect upon the function of the human system.	
B. Determination of toxicity	
1. Based on animal studies.	Slide 1.2.2.1.--Basis of Toxic Studies
2. Dose--response determines the toxicity.	
a. death is most common response for preliminary testing.	Slide 1.2.2.2.--Response
b. LD_{50}--the dose that produces death in 50% of the animals studied	Slide 1.2.2.3.--Dose
c. LC_{50}--the concentration in air that produces death in 50% of the animals studied.	
3. Information presented from toxicological study in literature.	Slide 1.2.2.4.--Toxicological Studies
a. compound b. animal used c. route of administrations	

Lesson Outline	
Industrial Toxicology	Module 1 Unit 2 Lesson 2

TOPIC	REMARKS
d. transport medium e. time period elapsed f. LD_{50} or LC_{50} g. confidence limits	
C. Toxicity classes as reported in studies	Slide 1.2.2.5.--Toxicity Classifications
1. Extremely toxic. 2. Highly toxic. 3. Moderately toxic. 4. Slightly toxic. 5. Practically nontoxic. 6. Relatively harmless.	
D. Discussion	Using toxic substances listed previously, refer to the Toxic Substances List, NIOSH publication, and look up each substance. Copies of book should be made available to each student. Review standard abbreviations as presented in the Toxic Substances List.
III. Exposure Routes and Protective Mechanisms	
A. Oral route--eating and smoking	Slide 1.2.2.6.--Oral Route
1. Absorption generally low in this case. 2. Danger is in corrosive action to gastrointestinal tract. 3. Protection--poor permeability of the gastrointestinal lining to many substances.	
B. Inhalation	Slide 1.2.2.7.--Inhalation Route
1. Major area of concentration by industrial hygienist. 2. Dose rate is difficult to determine. a. respiration rate varies b. respiration depth varies	

Lesson Outline	
Industrial Toxicology	Module 1 Unit 2 Lesson 2

TOPIC	REMARKS
c. concentration may vary at different locations d. concentration may vary in terms of time	
3. Protective mechanisms of the body.	Slide 1.2.2.8.--Respiratory System
a. gases that are soluble are somewhat absorbed in the upper respiratory tract b. particulate matter	Give SO_2 as an example of absorption because gas is soluble and is absorbed in upper respiratory tract.
(1) nasal structure and turbulent air flow (2) mucous membrane (3) cilia (4) branching of bronchi (5) phagocytic cells (macrophages)--entrap particles (6) lymphatic system	
C. Cutaneous--skin	Slide 1.2.2.9.--Cutaneous Route
1. Most common though not most severe. 2. Material may react with skin. 3. Material may be absorbed through skin.	
4. Protective mechanisms.	Slide 1.2.2.10.--Skin Protection
a. skin layers b. sweat c. lipid film d. sebaceous glands	
D. Ocular--eyes	Slide 1.2.2.11.--Ocular Route
1. Subjected to splashing, mists, vapor, and gases. 2. Protective mechanisms.	
a. eyelids b. lachrymal action--tears	
E. Review of routes	Slide 1.2.2.12.--Routes of Entry

Lesson Outline	
Industrial Toxicology	Module 1 Unit 2 Lesson 2

TOPIC	REMARKS
IV. Physiological Classification of Toxic Materials in Air	
A. Irritants	Slide 1.2.2.13.--Irritants
1. Cause inflammation of the mucous membrane of the respiratory tract. 2. Primary irritant--inflammation mainly (e.g., acids). 3. Secondary irritant--inflammation along with more serious toxic action (e.g., hydrogen sulfide and many aromatic hydrocarbons).	
B. Asphyxiants	Slide 1.2.2.14.--Asphyxiants
1. Deprive cells of oxygen supply. 2. Simple asphyxiants--inert elements that in sufficient quantity exclude oxygen supply (e.g., nitrogen, carbon dioxide, helium). 3. Chemical asphyxiants--take action on the body to disable use of adequate oxygen supply (e.g., carbon monoxide, cyanides).	
C. Anesthetics	Slide 1.2.2.15.--Anesthetics
1. Depress the central nervous system. 2. Examples include alcohol, acetylene hydrocarbons, ethyl ether, paraffin hydrocarbons, and aliphatic ketones.	
D. Hepatotoxic agents	Slide 1.2.2.16.--Hepatotoxic Agents
1. Damage function of liver. 2. Examples include carbon tetrachloride, tetrachloroethane, nitrosamines, and compounds of plant origin.	

Lesson Outline	
Industrial Toxicology	Module 1 Unit 2 Lesson 2

TOPIC	REMARKS
E. Nephrotoxic agents 1. Damage to kidney function. 2. Examples include some halogenated hydrocarbons and uranium.	Slide 1.2.2.17.--Nephrotoxic Agents
F. Neurotoxic agents 1. Damage to nervous system. 2. Examples include organometallic compunds (methylmercury, tetraethyl lead) and carbon disulfide.	Slide 1.2.2.18.--Neurotoxic Agents
G. Blood damaging agents 1. Break down red cells or affect hemoglobin. 2. Examples include benzene, arsine, and aniline.	Slide 1.2.2.19.--Blood Damaging Agents
H. Lung damaging agents 1. Damage pulmonary tissue beyond that of irritant action. 2. Examples include silica, asbestos, coal dust, and organic dusts.	Slide 1.2.2.20.--Lung Damaging Agents
I. Discussion	Review the toxic substances listed by the class and determine the category of effect which each agent exhibits.
V. Physical Classifications of Toxic Materials	
A. Gases and vapors 1. Gas--a material that is a gas at 25°C and 760 mm Hg. 2. Vapor--gaseous stage of a material that is a liquid or solid at 25°C and 760 mm Hg.	Slide 1.2.2.21.--Gases and Vapors

Lesson Outline	
Industrial Toxicology	Module 1 Unit 2 Lesson 2

TOPIC	REMARKS
B. Particulate matter 1. General form is an aerosol--dispersion of solid or liquid particles in a gas. 2. Types of aerosols (particulates). a. smoke--particles that result from incomplete combustion b. fog--visible aerosols of condensed liquid c. mist--dispersion of liquid particles many of which are individually visible d. fume--solid particles generated by condensation from the gaseous state, generally a result of volitization from molten metal. e. dust--solid particles that result from mechanical action on a solid or granulated solid	Slide 1.2.2.22.--Particulates
C. Liquid	Slide 1.2.2.23.--Liquid
D. Solid	Slide 1.2.2.24.--Solid

Lesson Outline	
Physical Hazards	Module 1 Unit 2 Lesson 3

TOPIC	REMARKS
	This lesson is prepared as a one-hour lecture. The purpose of the lesson is to review the various physical hazards that might be encountered by the industrial hygienist. The session serves as an introduction to physical hazards. Most of the hazards will be discussed in greater detail in succeeding modules.
I. Introduction	
A. Three major classifications of hazards to the worker	Slide 1.2.3.1.--Hazards to the Worker
1. Toxic hazards--as a result of a chemical action on the human system. 2. Physical hazards--as a result of a physical force exerted on the human system. 3. Other--psychological stress, biological hazards.	
B. Physical hazards may result in--	Slide 1.2.3.2.--Result of Physical Hazards
1. Damage to the health of the worker. 2. Traumatic injury to the worker. a. generally the responsibility of safety professional. b. may be secondary to a toxic hazard or another physical hazard.	
C. Physical hazards	Slide 1.2.3.3.--Physical Hazards
1. Noise. 2. Vibration. 3. Ionizing and nonionizing radiation. 4. Thermal. 5. Mechanical. 6. Pressure. 7. Illumination. 8. Traumatic.	

Lesson Outline	
Physical Hazards	Module 1 Unit 2 Lesson 3

TOPIC	REMARKS
D. Other hazards	
1. Biological--could be classified as a toxic hazard.	
2. Psychological.	
II. Physical Hazards--Noise	
A. Cause of noise hazard	Slide 1.2.3.4.--Noise Hazard Factors
1. Overall noise level.	
2. The time of exposure.	
3. The frequency of the noise.	
4. Type of noise--continuous vs. intermittent.	
B. Effect of noise	Slide 1.2.3.5.--Effects of Noise
1. Temporary hearing threshold shift.	
a. a loss of hearing occurs on a temporary basis after exposure to excessive noise.	
b. this loss is related to a long-term loss for exposure to the same excessive noise for a long period of time.	
c. temporary loss recovers quickly.	
2. Permanent hearing threshold shift.	
a. does not recover	
b. 3000-6000 Hz range	
3. Interference with communication.	
4. Annoyance.	
5. Reduced efficiency.	
6. Temporary physiological changes; e.g., heart rate, blood pressure.	

Lesson Outline	
Physical Hazards	Module 1 Unit 2 Lesson 3

TOPIC	REMARKS
C. Protective mechanisms 1. For a temporary hearing loss the major portion repairs itself in one or two hours with complete recovery in about four hours. 2. First loss can be diagnosed in 3000-6000 Hz range prior to loss in speech range.	
III. Physical Hazards--Vibration	
A. Cause 1. Mechanical shaking of human body. 2. Transmitted through solid objects. 3. May be accompanied by noise. 4. Two types. a. whole body b. segmental	Slide 1.2.3.6.--Vibration Hazards
B. Effect of vibration 1. Research has only begun to indicate where problems might exist. 2. Whole body vibration. a. increased physiological activity of heart, respiration b. inhibition of tendon reflexes c. reduced ability to perform complete tasks d. potential damage to other systems of body 3. Segmental vibration. a. impaired circulation to appendage (Raynaud's Syndrome) b. loss of sense of touch c. decalcification of bones in hand d. muscle atrophy	Slide 1.2.3.7.--Effects of Vibration

Lesson Outline		
Physical Hazards		Module 1 Unit 2 Lesson 3
TOPIC		REMARKS
C. Protective mechanisms 1. Body can withstand short-term vibration. 2. Certain frequencies of vibration are the most dangerous (resonance frequencies).		
IV. Physical Hazards--Ionizing and Nonionizing Radiation A. Cause 1. Rays from electromagnetic spectrum. 2. Types. a. ionizing--energy sufficient to cause loss of electron (1) X (2) gamma (3) alpha (4) beta (5) neutron b. nonionizing--energy insufficient to cause loss of electron (1) ultraviolet (2) infrared (3) microwave (4) laser		Slide 1.2.3.8.--Radiation Hazards
B. Effects of radiation 1. Nonionizing. a. not well documented b. eye damage c. damage to reproductive system d. skin burns		Slide 1.2.3.9.--Effects of Radiation

Lesson Outline	
Physical Hazards	Module 1 Unit 2 Lesson 3

TOPIC	REMARKS
2. Ionizing.	
a. skin burns	
b. deep tissue burns	
c. chronic	
(1) carcenogenic	
(2) genetic	
3. Internal vs. external exposure.	Slide 1.2.3.10.--Internal vs. External Exposure
a. internal results in long-term exposure	
b. if external source is removed, radiation exposure is removed	
C. Protective mechanisms	
1. Skin from small doses.	
2. Respiratory protection mechanisms for inspired radioactive dust.	
V. Physical Hazards--Thermal	Slide 1.2.3.11.--Thermal Hazards
A. Cause	
1. Heat.	
a. physiological	
(1) loss of salt	
(2) loss of water	
(3) fatigue of sweat glands	
(4) pooling of blood	
b. results	Slide 1.2.3.12.--Effects of Thermal Stress
(1) heat cramps	
(2) heat exhaustion	
(3) heat stroke	
(4) skin rashes	
2. Cold.	
a. frostbite	
b. low core temperature	

Lesson Outline	
Physical Hazards	Module 1 Unit 2 Lesson 3

TOPIC	REMARKS
C. Protective mechanisms 1. Sweating. 2. Dilation-constriction of blood vessels. 3. Acclimatization. 4. Muscle movement in cold--shivering.	Slide 1.2.3.13.--Protective Mechanisms
VI. Physical Hazards--Mechanical	
A. Cause 1. Structural stress on human muscoskeletal system beyond limits of system. 2. Fatigue of muscles.	Slide 1.2.3.14.--Cause of Mechanical Hazards
B. Effects of mechanical hazards 1. Traumatic injury. 2. Chronic disability.	Slide 1.2.3.15.--Effects of Mechanical Hazards
C. Protective mechanisms 1. Fatigue. 2. Recuperative power of muscles at rest.	
VII. Physical Hazards--Abnormal Pressure	Slide 1.2.3.16.--Pressure Hazards
A. Cause 1. Higher than atmospheric pressure. 2. Lower than atmospheric pressure.	
B. Effects of abnormal pressure 1. High pressure. a. oxygen poisoning b. nitrogen poisoning c. decompression sickness--the bends d. compression of fluid or tissue into cavities of body e. ear and sinus pressure unequal f. bone necrosis (osteonecrosis)	Slide 1.2.3.17.--Effects of Abnormal Pressure

Lesson Outline	
Physical Hazards	Module 1 Unit 2 Lesson 3

TOPIC	REMARKS
2. Low pressure. a. reduced O_2 metabolism b. increased CO_2 release c. decompression sickness d. ear and sinus pressure unequal	
C. Protective mechanisms 1. Acclimatization to lower pressure at high altitudes. 2. Increase in red blood cells at higher altitudes. 3. Increased respiration rate in low pressures.	
VIII. Physical Hazards--Illumination	Slide 1.2.3.18--Illumination Hazards
A. Cause 1. Inadequate illumination. 2. Glare.	
B. Effects of illumination hazards 1. Eye strain. 2. Potential accidents. 3. Errors and reduced efficiency.	
C. Protective mechanism--pupil dilation	
IX. Physical Hazards--Traumatic	
A. Cause 1. Fire and explosion. 2. Mechanical accident. 3. Electrical accidents. 4. Falls.	Slide 1.2.3.19.--Cause of Traumatic Hazards
B. Effects of traumatic hazards 1. Lost time injuries. 2. Property damage. 3. Irreparable physical harm. 4. Death.	Slide 1.2.3.20.--Effects of Traumatic Hazards

Lesson Outline	
Physical Hazards	Module 1 Unit 2 Lesson 3

TOPIC	REMARKS
C. Protective mechanisms--the use of the senses to identify and avoid unsafe situations.	
X. Other Hazards--Biological	Slide 1.2.3.21.--Biological Hazards
A. Cause	
1. Bacteria. 2. Virus. 3. Parasites.	
B. Effects--transmission of disease.	
C. Protective mechanisms	
1. Immumization--antibodies. 2. White blood cells.	
XI. Other Hazards--Psychological	Slide 1.2.3.22.--Psychological Hazards
A. Cause--job stress	
B. Effects--research is only beginning and no conclusions have been reached. Hypothesized effects include:	
1. Physiological. 2. Behavior. 3. Illness. 4. Psychosomatic complaints. 5. Higher accident rate.	
C. Protective mechanisms	
1. Self-selection of job. 2. Modified behavior patterns.	

Lesson Outline	
Physical Hazards	Module 1 Unit 2 Lesson 3

TOPIC	REMARKS
XII. Summary A. Many hazards on job. B. Not all are important to any one job or group of jobs. C. Must identify the potential hazards on the job. D. When stress on the human system cannot be compensated for by internal mechanisms without strain, a hazard exists. Identification, measurement, evaluation, and control of such hazards then becomes the responsibility of the industrial hygienist.	Slide 1.2.3.23.--The Stresses on the Human System

Lesson Outline	
Physical Hazards (Alternate Lesson)	Module 1 Unit 2 Lesson 3A

TOPIC	REMARKS
	This lesson is prepared as an alternate approach to covering the topic. The lesson can be used in place of Lesson 3, as an introduction to or as a summary following the completion of Lesson 3. The lesson may also be used as an out-of-class assignment prior to or after the lecture. The choice of approach depends upon the time available and the composition of the class. If the class is composed of individuals with significant experience in industrial hygiene, Lesson 3A should be used in place of Lesson 3. Conversely, Lesson 3 is more appropriate for a class composed of individuals with little experience in industrial hygiene.
I. Introduction	
A. Case Study	Refer the class to the case study discussed in Unit 1.
B. Assignment	
1. Work alone. 2. List all potential hazard exposures for each area. 3. Where are these exposures found. 4. Classify the identified hazard exposure. a. toxic b. physical--identify the classification of type of physical hazard. 5. Identify probable cause or causes of the hazard. 6. Identify the possible effects. 7. Identify the defensive mechanisms that the human system can employ as protection.	The worksheet in the student's text can be used as the format for the student response. The students should attempt to identify the potential hazard exposures for all areas of the plant.

Lesson Outline	
Physical Hazards (Alternate Lesson)	Module 1 Unit 2 Lesson 3A

TOPIC	REMARKS
II. Work Period	If the lesson is being done in class, allow approximately 20 minutes for the students to work alone on the assignment.
III. Discussion	Use Visual Form 1.2.3. presented with this lesson as the format for classification.
A. Reclassify the hazards by type.	
1. Group by type of hazard classification.	
a. toxic b. noise c. vibration d. ionizing and nonionizing radiation e. thermal f. mechanical g. abnormal pressure h. illumination i. traumatic j. biological k. psychological	
2. List each hazard identified by class. 3. List where identified. 4. List the cause of the hazard. 5. List the possible effects. 6. Identify the protective mechanisms that are employed by the human system.	
B. Discuss classifications where hazards have not been identified.	Some of the classifications will not contain hazards that have been or can be identified in the case study. These should be discussed in general terms. The outline in Lesson 3 will provide a basis for discussion. It might be helpful to identify where these hazards might be found in the work environment.

STUDENT WORKSHEET

Module 1
Unit 2
Lesson 3

HAZARD	WHERE FOUND	TOXIC	PHYS.	TYPE PHYSICAL	CAUSE	EFFECTS	PROTECTIVE MECHANISMS

VISUAL 1.2.3

Module 1
Unit 2
Lesson 3

HAZARD	WHERE FOUND	CAUSE	EFFECTS	PROTECTIVE MECHANISMS

Title Page	
General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3

UNIT 3

GENERAL METHODS OF CONTROL AVAILABLE TO THE INDUSTRIAL HYGIENIST

Performance Objectives		
Lesson	General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3

1 1. Given a list of hazards that might be encountered in the work environment, the student will be able to recall and list at least three potential methods that can be used to control each of the hazards.

1 2. Given a statement describing an application of the following general methods of control:

a. equipment substitution
b. process substitution
c. material substitution
d. isolation of source
e. comfort ventilation
f. local exhaust ventilation
g. local supply ventilation
h. make-up ventilation
i. dilution ventilation
j. natural ventilation
k. administrative
l. personal protective equipment

the student will be able to recognize the label most appropriate to the description from a list of labels.

1 3. Given a statement describing a hazard requiring the use of ventilation, the student will be able to recall the label for the most appropriate ventilation system to use for control from the following list of labels:

a. comfort ventilation
b. local exhaust ventilation
c. local supply ventilation
d. make-up ventilation
e. dilution ventilation
f. natural ventilation

1 4. The student will be able to recall and list the four steps used to determine the appropriate method to apply in controlling a hazard.

Unit Activities--Instructor	
General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3

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

Lesson 1--General Methods of Control Available to the Industrial Hygienist

Classroom Presentation

The purpose of the lecture is to introduce the general methods of control that are available to the industrial hygienist. The topic is covered in general terms with emphasis on procedure. Some specific examples are presented. Control of airborne particulates using ventilation methods, control of noise, control of radiation, and specific personal protective methods are covered in more detail in later modules.

Time Allotted

1 hour

Demonstration

No demonstrations are required.

Supervised Practice

No supervised practice is required.

General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3

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

Lesson 1--General Methods of Control Available to the Industrial Hygienist

Classroom Activity

Attend a classroom lecture on the subject of general control methods.

Assignment

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

READING	SHORT COURSE	EXTENDED 1-HOUR
Industrial Hygiene Engineering and Control	Section 1 Chapter 6	Section 1 Chapter 6
PROBLEMS		
Case Study (Optional)		Lesson 3A

Facilities, Equipment, and Materials	
General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3

Facilities

Lecture and/or Discussion--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 1, Unit 3

References Used in Class

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

Lesson Outline	
General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3 Lesson 1

TOPIC	REMARKS
	This lesson is designed as a one-hour lecture. The purpose of the lecture is to introduce the general methods of control that are available to the industrial hygienist. The topic is covered in general terms with the emphasis on procedure. Some specific examples are presented. Control of airborne particulates using ventilation methods, control of noise, control of radiation, and specific personal protective methods are covered in more detail in later modules.
I. Introduction	
A. The job of the industrial hygienist	Slide 1.3.1.1.--The Industrial Hygienist
1. Recognize potential hazards in the work environment. 2. Measure the work environment to determine the extent of hazard present. 3. Evaluate the measurements obtained to determine if a hazard exists. 4. Identify and recommend controls that can be implemented to remove or reduce the hazard exposure of the worker.	
B. Principles relating to the control of hazards	Slide 1.3.1.2.--Principles of Control
1. All hazards can be controlled. 2. There are usually many alternate methods of control available. 3. Some methods of control are better than others in a given situation. 4. Some situations require more than one control method to obtain optimum results.	

Lesson Outline	
General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3 Lesson 1

TOPIC	REMARKS
II. General Methods of Control--Substitution	
A. Substitution can take three forms 1. Substitution of materials. 2. Substitution of process. 3. Substitution of equipment.	Slide 1.3.1.3.--Three Forms of Substitution
B. Material substitution 1. Is there a material that can do the job that is less toxic, flammable, etc.? 2. Examples. a. trichloroethylene for carbon tetrachloride b. aliphatic chlorinated hydrocarbons for benzene c. tetrium-activated phosphors for radium base paints d. alkali and water detergent solutions for solvents	Slide 1.3.1.4.--Material Substitution The instructor is encouraged to give examples of substitution based upon experience in the field.
C. Subsitution of process 1. Is there a better way to do the job? 2. Process or procedures may be changed. 3. General principle--a continuous process is less hazardous than an intermittent process. 4. Examples a. dipping for spraying b. automated material handling for manual or mechanical methods c. closed system continuous processing for batch processing d. safety lids for screw lids on aspirin bottles e. containers that are processed along with contents	Slide 1.3.1.5.--Process Substitution The instructor is encouraged to give examples of substitution based upon experience in the field.

Lesson Outline	
General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3 Lesson 1

TOPIC	REMARKS
D. Substitution of equipment 1. Is there a better type of equipment to do the job? 2. Can engineering changes be made to make the equipment less hazardous? 3. Examples a. machine guards b. automated equipment for manual methods c. catalytic converter in automobile d. LPG lift trucks for gasoline powered trucks e. electric powered lift trucks for LPG trucks	Slide 1.3.1.6.--Equipment Substitution The instructor is encouraged to give examples of substitution based upon experience in the field.
III. General Methods of Control--Isolation of Source	
A. Generally can be accomplished by worker or source isolating 1. Separating from work area. 2. Enclosing or shielding source with physical barriers. 3. Automating the process in a closed system. 4. Isolation of stored material.	Slide 1.3.1.7.--Isolation of Source
B. Examples of isolation 1. Tank farms for storing materials. 2. Automated chemical processing. 3. Separation of air handling equipment from work area. 4. Heat barriers in front of hot operations. 5. Enclosed control rooms.	The instructor is encouraged to give examples of isolation based upon experience in the field.

Lesson Outline	
General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3 Lesson 1

TOPIC	REMARKS
IV. General Methods of Control--Ventilation	
A. Ventilation can be used for:	Slide 1.3.1.8.--Ventilation Uses
1. Removal of air pollutants from the breathing zone of workers. 2. Conditioning of the air for worker comfort. 3. Supply of air to assure proper operation of the removal system.	
B. Categories of ventilation	
1. Comfort ventilation--moves and conditions the air to assure comfort of worker.	Slide 1.3.1.9.--Comfort Ventilation
a. heat b. cold c. humidity d. odor	
2. Local exhaust--to remove contaminants generated at a local source.	Slide 1.3.1.10.--Local Exhaust
3. Local supply--air supplied to a specific point where it is needed.	Slide 1.3.1.11.--Local Supply
a. spot cooling for worker b. push-pull ventilation	
4. Make-up air--air supplied to make up for air that is being exhausted through a local system.	Slide 1.3.1.12.--Make-up Air
5. Dilution--air that is supplied and exhausted to control a source that is widespread by diluting the source.	Slide 1.3.1.13.--Dilution
a. not applicable to toxic hazards b. expensive	

Lesson Outline	
General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3 Lesson 1

TOPIC	REMARKS
6. Natural--use of characteristics of air to attain air movement without mechanical assistance.	Slide 1.3.1.14.--Natural Ventilation
C. Examples 1. Comfort ventilation--air conditioning of an office building or computer room. 2. Local exhaust--exhaust hoods over laboratory bench. 3. Local supply--push-pull ventilation over open tank. 4. Dilution ventilation--air movement in tunnel to eliminate carbon monoxide buildup. 5. Natural ventilation--exhaust of materials away from plant through stacks.	The instructor is encouraged to give examples of ventilation control based upon experience in the field.
V. General Methods of Control--Administrative	
A. General administrative controls available 1. Training of workers. 2. Monitoring of the work area or worker. 3. Biological monitoring of the worker. 4. Scheduling workers. 5. Preventive maintenance.	Slide 1.3.1.15.--Administrative Controls
B. Administrative controls--training 1. Identify the hazards. 2. Identify the procedures or method that can be used to avoid hazards. 3. Training should be directed toward error avoidance.	Slide 1.3.1.16.--Training

Lesson Outline	
General Methods of Control Available to the Industrial Hygienist	Module 1 Unit 3 Lesson 1

TOPIC	REMARKS
C. Administrative controls--monitoring the work area or worker 1. Continuous monitoring equipment can be placed in work area. 2. Personal samplers or dosimeters can be used by the workers.	Slide 1.3.1.17.--Monitoring the Worker
D. Administrative controls--physiological monitoring 1. Pre- and post-employment medical exams. 2. Periodic medical examinations.	Slide 1.3.1.18.--Physiological Monitoring
E. Administrative controls--scheduling of workers 1. Rotation out of hazardous area during shift. 2. Rescheduling workers to different areas after a period of time. 3. Rest periods. 4. Use of buddy system.	Slide 1.3.1.19.--Scheduling
F. Administrative controls--preventive maintenance 1. Maintenance on a regularly scheduled basis for potentially hazardous operations. 2. Maintenance of control and monitoring equipment.	Slide 1.3.1.20.--Preventive Maintenance
G. Administrative controls--other 1. Injury and illness reports and statistics. 2. Adequate emergency aid. 3. Adequate emergency procedures. 4. Regular inspections to identify potential hazard exposures.	Slide 1.3.1.21.--Other Administrative Controls

Lesson Outline		
General Methods of Control Available to the Industrial Hygienist		Module 1 Unit 3 Lesson 1
TOPIC		REMARKS
H. Examples of administrative controls 1. Indoctrination training. 2. Film badges for workers potentially exposed to radiation. 3. Periodic audiometric tests. 4. Rotation of workers in hot or cold areas.		The instructor is encouraged to give examples of administrative controls based upon experience in the field.
VI. General Methods of Control--Personal Protective Equipment		
A. General comments 1. Should be used as a last resort and as a temporary measure. 2. All equipment and clothing should be tested to assure that it will do the job. 3. Be sure protective equipment and clothing are adequate for the hazard.		Slide 1.3.1.22.--Personal Protective Equipment
B. General categories of protective equipment		
1. Skin protection. a. gloves b. suits c. aprons		Slide 1.3.1.23.--Skin Protection
2. Eye protection. a. safety glasses b. goggles c. face shields d. hoods		Slide 1.3.1.24.--Eye Protection
3. Ear protection. a. plugs b. muffs		Slide 1.3.1.25.--Ear Protection
4. Respiratory protection. a. air purifying respirators b. air supplied respirators c. self-contained breathing units		Slide 1.3.1.26.--Respiratory Protection

Lesson Outline		
General Methods of Control Available to the Industrial Hygienist		Module 1 Unit 3 Lesson 1
TOPIC		REMARKS
5. Other.		Slide 1.3.1.27.--Other Protection
a. hard hats b. safety shoes c. diving suits d. environment control suits		
VII. Determining the Control Method to Use		
A. Be sure the hazard has been identified correctly		Slide 1.3.1.28.--What Control to Use
1. Must know what is being controlled. 2. Must be aware of the entry routes of the hazard.		
B. Identify alternate methods for controlling the hazard		Slide 1.3.1.29.--Identify Alternatives
1. The first method chosen may not be the best. 2. May require that a combination of controls be implemented.		
C. Compare the alternative(s)		Slide 1.3.1.30.--Compare Alternatives
1. Effectiveness. 2. Cost of implementation. 3. Operational costs.		
D. Select the best alternative for implementation.		Slide 1.3.1.31.--Select Control
E. Implement control(s) chosen.		Slide 1.3.1.32.--Implement Control
F. Evaluate the results obtained		Slide 1.3.1.33.--Evaluate Results
1. Periodic. 2. Control mechanisms can become inoperable and thus present a hazard. 3. Changes can occur that result in controls becoming ineffective. 4. Proper maintenance is necessary. 5. Rules and procedures must be enforced.		

Self-Test	
Introduction to Industrial Hygiene Engineering and Control	Module 1

1. List at least 5 hazards and indicate the category of each hazard by type of exposure and level of effect.

	Hazard	Type of Exposure	Level of Effect
a.			
b.			
c.			
d.			
e.			

2. Match the following methods for recognizing hazards with the statement that best describes the method.

____a. walk-through method

____b. fault tree analysis

____c. sampling inspection

____d. failure mode and effect

____e. continuous monitoring

____f. preliminary hazard analysis

1. A thorough review of the process and procedures to identify potential hazards.
2. A method in which a malfunction, its cause and result is traced throughout a system.
3. A nonscheduled inspection of a given area of a plant to identify potential hazards.
4. An initial review of the existence of potential hazards prior to a complete study.
5. A review of potential malfunctions and their effect based upon the probability of the series of malfunctions occurring.
6. A systematic method for flow charting the system to identify the potential for any given event to occur.
7. A method in which a deviation from normal is indicated immediately.
8. A statistical method that is used to determine where an inspection should be made.

3. List 5 methods which can be used to recognize hazards not including those identified in question 2.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

4. Refer to the case study description and identify the potential health hazards and safety hazards that are present in the Stamping and Punch Press Shop.

   Potential Health Hazards _____

   _____

   _____

   _____

   Potential Safety Hazards _____

   _____

   _____

   _____

5. List the major steps that should be carried out to determine if a hazard exists.

   _____

   _____

   _____

   _____

6. Match the term with the statement which best describes the term.

   ____a. the study of the functions of the human system.

   ____b. the study of the mechanical functioning of the human system.

   ____c. the study of the structure of the human body.

   1. Anatomy
   2. Physiology
   3. Biochemistry
   4. Biophysics

7. Match the appropriate subsystem or component label with the statement describing a function performed by that subsystem or component.

____a. component in which glucose is converted to energy.

____b. system that supplies the combustion support for energy conversion.

____c. small pockets where transfer of oxygen to the blood stream occurs

____d. combustion support for conversion of glucose to energy.

____e. small hair-like filters that capture particles in upper respiratory tract.

____f. eliminates toxic substances from blood through filtration.

____g. the chemical control system of the body.

____h. adds antibodies to the blood stream.

____i. component that carries oxygen and carbon dioxide.

____j. transmits messages to the skeletal muscles.

____k. attach muscles to bone.

____l. maintains the salt and water balance of the body.

____m. processes the fuel for the body.

1. tendons
2. endocrine system
3. autonomous nervous system
4. atria
5. white cells
6. hemoglobin
7. respiratory system
8. digestive system
9. alveoli
10. lymphatic system
11. ligaments
12. carbon dioxide
13. renal system
14. oxygen
15. cell
16. peripheral nervous system
17. cilia

8. List the components of the body's major defense system.

_____

_____

_____

9. List the major characteristics that determine the hazardous effects of a toxic substance on the human body.

_____

_____

_____

_____

10. Briefly describe the following:

LD_{50} _____

_____

LC_{50} _____

_____

dose-response _____

_____

11. List the 4 routes of entry to the human body for a toxic substance.

a. _____ d. _____

b. _____

c. _____

12. List 5 mechanisms which can protect the human body from toxic substances.

a. _____

b. _____

c. _____

d. _____

e. _____

13. Match the following terms for types of agents with the statement best describing the type of agent.

____a. Neurotoxic
____b. Lung damaging
____c. Anesthetic
____d. Irritant
____e. Asphyxiant
____f. Nephrotoxic
____g. Blood damaging

1. affects the liver
2. affects the mucous membrane
3. affects the oxygen-carrying ability of the blood
4. affects the nervous system
5. affects the capacity of the lungs to transfer oxygen
6. affects the red cells
7. affects the kidney function
8. affects the reactivity of the nervous system

14. List one toxic substance for each classification of agent given below.

Type Agent	Toxic Substance
a. Irritant	_____
b. Asphyxiant	_____
c. Anesthetic	_____
d. Hepatotoxic	_____
e. Nephrotoxic	_____
f. Neurotoxic	_____
g. Blood damaging	_____
h. Lung damaging	_____

15. Match the label that is most appropriate to the description of the physical classification of toxic substances.

____a. gaseous stage of a material that is a liquid or solid at 25°C and 760 mm Hg.

____b. particles resulting from incomplete combustion.

____c. solid particles generated by condensation from the gaseous state.

____d. dispersion of solid or liquid particles in a gas.

1. gas
2. liquid
3. vapor
4. aerosol
5. smoke
6. fog
7. mist
8. fume

16. For each of the following operations, list the classification(s) of potential hazard that may be identified with the operations, describe one hazardous effect to the human system, list one protective mechanism for the hazardous effect that is present in the human system, and list a potential general control method that can be used. The classifications to be used are:

a. toxic
b. noise
c. vibration
d. ionizing radiation
e. nonionizing radiation
f. thermal
g. mechanical
h. pressure
i. illumination
j. traumatic
k. biological
l. psychological

Operation	Class.	Effect	Protection	Control
1 Operate grinder to grind down brake shoes				
2 Operate paint sprayer to spray small parts				
3 Operate single die press to form metal caps				
4 Operate road grader to grade road and remove snow				
5 Operate vapor degreaser to prepare parts for painting				
6 Operate an electric welder to weld small parts				

17. Match the terms describing general methods of control for hazards with the statement that best describes the method.

____a.	a change in process, procedure, or equipment used	1.	local exhaust ventilation
____b.	air required to keep a ventilation system working	2.	protective equipment
____c.	changes in work schedule, training, etc.	3.	dilution ventilation
____d.	point source ventilation	4.	isolation
		5.	administration
		6.	make-up ventilation
		7.	substitution

18. List the ventilation method that seems most appropriate to control the situation presented.

	Ventilation Method
a. Warehouse with gas powered lift truck for moving stock.	_____
b. Inadequate air movement at the hood for a laboratory bench.	_____
c. An open vapor degreaser tank.	_____
d. Workers complaining that their work area is uncomfortably warm.	_____
e. A grinding operation.	_____
f. Work area in front of autoclave.	_____

19. Assume you are in charge of conducting an industrial hygiene study for the plant described in the Case Study. Identify the procedural steps you would carry out to recognize, measure, evaluate, and control hazards in the work environment.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Self-Test (Answers)	
Introduction to Industrial Hygiene Engineering and Control	Module 1

1. List at least 5 hazards and indicate the category of each hazard by type of exposure and level of effect.

	Hazard	Type of Exposure	Level/Effect
a.	*solvent-trichloroethylene*	*air quality*	*medium*
b.	*welding*	*air quality-radiation*	*medium*
c.	*cutting oils*	*hazardous materials*	*low*
d.	*punch press*	*physical (noise)-mechanical*	*medium*
e.	*benzene*	*air quality*	*high*

2. Match the following methods for recognizing hazards with the statement that best describes the method.

3	a.	walk-through method
2	b.	fault tree analysis
8	c.	sampling inspection
5	d.	failure mode and effect
7	e.	continuous monitoring
4	f.	preliminary hazard analysis

1. A thorough review of the process and procedures to identify potential hazards.
2. A method in which a malfunction, its cause and result is traced throughout a system.
3. A nonscheduled inspection of a given area of a plant to identify potential hazards.
4. An initial review of the existence of potential hazards prior to a complete study.
5. A review of potential malfunctions and their effect based upon the probability of the series of malfunctions occurring.
6. A systematic method for flow charting the system to identify the potential for any given event to occur.
7. A method in which a deviation from normal is indicated immediately.
8. A statistical method that is used to determine where an inspection should be made.

3. List 5 methods which can be used to recognize hazards not including those identified in question 2.

   a. *job safety analysis*

   b. *accident and injury reports*

   c. *critical incident technique*

   d. *physical examinations*

   e. *review of process flows*

4. Refer to the case study description and identify the potential health hazards and safety hazards that are present in the Stamping and Punch Press Shop.

   Potential Health Hazards *Noise exposure; vibration exposure; ergonomic exposure*

   Potential Safety Hazards *Mecnanical exposure to various equipment; falls and slips; accident as result of traffic flow; pinched or cut fingers handling material; dropping objects on toes; trauma to eye from projected metal*

5. List the major steps that should be carried out to determine if a hazard exists.

   1. Conduct preliminary hazard analysis

   2. Design measurement and evaluation study

   3. Inspect and observe process

   4. Analyze the results of study

   5. Determine hazards and extent

6. Match the term with the statement which best describes the term.

2	a.	the study of the functions of the human system	1. Anatomy
4	b.	the study of the mechanical functioning of the human system	2. Physiology
1	c.	the study of the structure of the human body	3. Biocnemistry
			4. Biopnysics

Self-Test (Answers)	
Introduction to Industrial Hygiene Engineering and Control	Module 1

7. Match the appropriate subsystem or component label with the statement describing a function performed by that subsystem or component.

15 a.	component in which glucose is converted to energy	1. tendons
7 b.	system that supplies the combustion support for energy conversion	2. endocrine system
9 c.	small pockets where transfer of oxygen to the blood stream occurs	3. autonomous nervous system
14 d.	combustion support for conversion of glucose to energy	4. atria
17 e.	small hair-like filters that capture particles in upper respiratory tract	5. white cells
13 f.	eliminates toxic substances from blood through filtration	6. hemoglobin
2 g.	the chemical control system of the body	7. respiratory system
10 h.	adds antibodies to the blood stream	8. digestive system
6 i.	component that carries oxygen and carbon dioxide	9. alveoli
16 j.	transmits messages to the skeletal muscles	10. lymphatic system
1 k.	attach muscles to bone	11. ligaments
13 l.	maintains the salt and water balance of the body	12. carbon dioxide
8 m.	processes the fuel for the body	13. renal system
		14. oxygen
		15. cell
		16. peripheral nervous system
		17. cilia

8. List the components of the body's major defense system.

Skin, sense organs, liver, kidney, autonomic nervous system, involuntary muscles, lymph nodes

9. List the major characteristics that determine the hazardous effects of a toxic substance on the human body.

Type of substance, route of entry; amount of exposure; duration of exposure; individual response; system interfaces

10. Briefly describe the following:

LD_{50} *The dose which produces death in 50% of animals in a study; oral, parenteral, intravenous, or absorption*

LC_{50} *The concentration in air which produces death in 50% of the animals in a study; inhalation*

dose-response *For a given dose of a compound, a particular statistical response in the experimental group is obtained*

11. List the 4 routes of entry to the human body for a toxic substance.

a. *oral*

b. *inhalation*

c. *cutaneous*

d. *ocular*

12. List 5 mechanisms that can protect the human body from toxic substances.

a. *skin*

b. *anatomy of the respiratory system*

c. *eyelids*

d. *gastrointestinal lining*

e. *lymphatic system*

13. Match the following terms for types of agents with the statement best describing the type of agent.

4	a. Neurotoxic	1. affects the liver
5	b. Lung damaging	2. affects the mucous membrane
8	c. Anesthetic	3. affects the oxygen-carrying ability of the blood
2	d. Irritant	4. affects the nervous system
3	e. Asphyxiant	5. affects the capacity of the lungs to transfer oxygen
7	f. Nephrotoxic	6. affects the red cells
6	g. Blood damaging	7. affects the kidney function
		8. affects the reactivity of the nervous system

14. List one toxic substance for each classification of agent given below.

Type Agent	Toxic Substance
a. Irritant	*aromatic hydrocarbons*
b. Asphyxiant	*carbon monoxide*
c. Anesthetic	*alcohol*
d. Hepatotoxic	*carbon tetrachloride*
e. Nephrotoxic	*uranium*
f. Neurotoxic	*mercury*
g. Blood damaging	*benzene*
h. Lung damaging	*asbestos*

15. Match the label that is most appropriate to the description of the physical classification of toxic substances.

3 a.	gaseous stage of a material that is a liquid or solid at 25°C and 760 mm Hg.	1. gas
5 b.	particles resulting from incomplete combustion.	2. liquid
7 c.	solid particles generated by condensation from the gaseous state.	3. vapor
4 d.	dispersion of solid or liquid particles in a gas.	4. aerosol
		5. smoke
		6. fog
		7. mist
		8. fume

16. For each of the following operations, list the classification(s) of potential hazard that may be identified with the operations, describe one hazardous effect to the human system, list the protective mechanism for the hazardous effect that is present in the human system, and list a potential general control method that can be used. The classifications to be used are:

a. toxic	e. nonionizing radiation	i. illumination
b. noise	f. thermal	j. traumatic
c. vibration	g. mechanical	k. biological
d. ionizing radiation	h. pressure	l. psychological

Operation	Class	Effect	Protection	Control
1 Operate grinder to grind down brake shoes	*a, b, c, g, j, k*	*inhalation of asbestos*	*respiratory anatomy (cilia)*	*ventilation*
2 Operate paint sprayer to spray small parts	*a, j, k*	*splash of spray enters eyes*	*eyelids and tear ducts*	*goggles*
3 Operate single die press to form metal caps	*b, c, g, j, l*	*traumatic injury if hand gets caught in press*	*sense organs to sense problem*	*guarding*
4 Operate road grader to grade road and remove snow	*b, c, f, g, i, j*	*glare from snow causes eyestrain*	*fatigue of eyes and pupil dilation*	*tinted or polarized glasses or windshield*
5 Operate vapor degreaser to prepare parts for painting	*a, f, g, j, k*	*inhalation of vapor*	*respiratory anatomy*	*ventilation*
6 Operate an electric welder to weld small parts	*a, e, f, g, i, j, k*	*ultraviolet and infrared radiation*	*skin and eyelids*	*face shield*

Self-Test (Answers)	
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17. Match the terms describing general methods of control of hazards with the statement that best describes the method.

7	a.	a change in process, procedure, or equipment used	1. local exhaust ventilation
6	b.	air required to keep a ventilation system working	2. protective equipment
5	c.	changes in work schedule, training, etc.	3. dilution ventilation
1	d.	point source ventilation	4. isolation
			5. administration
			6. make-up ventilation
			7. substitution

18. List the ventilation method that seems most appropriate to control the situation presented.

	Ventilation Method
a. Warehouse with gas powered lift truck for moving stock	*dilution*
b. Inadequate air movement at the hood for a laboratory bench	*make-up*
c. An open vapor degreaser tank	*push-pull local*
d. Workers complaining that their work area is uncomfortably warm	*comfort*
e. A grinding operation	*local exhaust*
f. Work area in front of autoclave	*spot cooling*

19. Assume you are in charge of conducting an industrial hygiene study for the plant described in the Case Study. Identify the procedural steps you would carry out to recognize, measure, evaluate, and control hazards in the work environment.

1. Review process flows and walk-through plant

2. Conduct a preliminary hazard analysis

3. Prioritize the hazard in terms of potential risk and hazardous effect

4. Select most critical hazard

5. Develop plan for measurement and evaluation of this hazard

6. Conduct appropriate measurements to gather data

7. Analyze and evaluate the hazard

8. Determine alternate controls and costs

9. Implement controls and follow up with evaluation of effect

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