Solid and Hazardous Waste Management

I. Course Overview - Course Description (3 Credit hours for 16 week duration)

Waste management is a very important field of study. Waste can be in different forms. It is interesting that some one produces the waste, some one collect and handle those wastes, some one transport them for storage or processing prior to disposing them appropriately. Some of these wastes can be very harmful and can cause irreparable damages to humans and other living organisms. It is therefore useful to gain the skills necessary for identifying, collecting, handling, transporting, treating, storing and disposing various types of wastes generated by anthropogenic activities. This course is designed to equip the engineering technology student with these necessary skills by exposing the student to the fundamentals of solid and hazardous wastes.

The primary emphasis of this course is to give broad perspective about solid and hazardous wastes, define key attributes of solid and hazardous wastes, identify pathways, fates and disposition of hazardous wastes releases, hazardous wastes sources / generators, handling, transportation, treatment, disposal and storage of solid and hazardous wastes. This course also intends to provide information on waste minimization, recycling, and reusing, management of various types of waste materials, assessment techniques for site remediation and health and safety of hazardous waste workers. Overall, the course consists of material and learning activities that would build and sustain the interest of the student in environmental engineering and that would produce perception and behavioral modification in the student to adequately prepare him/her for a successful academic and professional career in environmental engineering.

II. Expected Learning Outcome

The goal of this course is to provide broad perspective about various aspects of waste materials and defining their key attributes which would enable the student to have better understanding not only in identifying, collecting, handling, transporting, treating, storing and disposing various types of wastes generated by anthropogenic activities but also helps the student to develop strategies to minimize waste generation, reusing and recycling. It is anticipated that at the end of the course the student will be able to:

- Identify various types of waste commonly generated by human activities
- Interpret laws governing the handling of various types of wastes
- Identify techniques need to collect, handle, transport and transport specific waste types
- Appropriately treat, store, and dispose various classes of waste
- Evaluate waste materials
- Develop strategies or processes to minimize waste, reuse or recycle them in safely
- Identify and employ safety measures to minimize exposure and subsequent health effects of wastes
- Develop assessment techniques for cost effective site remediation process

Specific learning objectives for each instructional unit are discussed in the unit/module syllabus.
III. General Information for Students

Students may be directed to read additional information on selected topics from websites.

a. Prerequisites.  Admission to Engineering Technology or any other STEM degree program.

b. Necessary Competencies.  The student should be able to:

a. Express themselves clearly in written communications
b. Perform simple algebraic and calculus manipulations

IV. Instructional Units/Modules (Course Organization)

This course is designed to provide extensive theoretical understanding about solid and hazardous waste management. No laboratory exercises are involved. A full description of each of the following units is given in detail in the module syllabus:

Topics to be covered include:

1. The Hazardous Waste Perspectives
2. Definition of Hazardous waste
3. Pathways, Fates, and Disposition of Hazardous Waste Releases
4. Toxicology and the Standard-Setting Processes
5. Hazardous Waste Source/Generators
6. Transportation of Hazardous Wastes
7. Treatment and Disposal, Methods and Processes
8. Hazardous Waste Minimization, Reuse and Recycling
9. RCRA Permits, Compliance, and Enforcement
10. Assessment Techniques for Site Remediation
11. Site Remedial Technologies, Practices, and Regulations
12. Medical/Biomedical/Infectious Waste Management
13. Radioactive Waste Management
14. Underground Storage Tank Management

15. Hazardous Waste Worker Health and Safety

V. Evaluation of Learning Outcome

A variety of methods will be used to assess the knowledge and competencies acquired by student. These include written exams for every 3 chapters; comprehensive exam to measure the ability of the student to retain and synthesize information from various modules for an integrated body of knowledge; weekly surprise quiz to test the familiarity of various terminologies used in this subject area; and also a concept based term paper to assess the students’ ability to derive ideas from what was learnt from this course. More specifics are outlined as needed in each module syllabus.
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Instructional Unit – One:  The Solid and Hazardous Waste Perspective.

Introduction  This unit introduces the student to the complex problem of ever increasing solid and hazardous waste management by presenting a perspective on the evolution of solid and hazardous wastes problems and approaches to management in the United States and other industrialized nations. This unit also presents different kinds of waste management and mismanagement practices and their impact on the environment, human health and the economy. The laws (RCRA, CERCLA) dealing with waste management are discussed. Political and administrative approaches to government control of solid and hazardous wastes are also discussed.

Required Entry Behavior:  Students are expected to be familiar with common types of wastes generated by human activity and are able to distinguish hazardous and non-hazardous types of wastes. Prior knowledge of the various laws governing the management of solid and hazardous wastes would be advantageous.

Behavioral Objectives:  At the completion of this unit, the student will be able to:

- Describe the past hazardous waste problems and approaches to management in the U.S. and other industrialized nations.
- Discuss the impact of mismanagement practices of hazardous wastes.
- Discuss and describe laws such as RCRA and CERCLA that are related to hazardous waste management.
- Discuss the political and administrative approaches to governmental control of hazardous waste.

Equipment and Supplies:  None

Learning Activities and Strategies:  This unit mainly consists of classroom presentations. These presentations cover the following instructional materials for achieving unit objectives.

- Discussion on evolution of hazardous waste problems and approaches  30 minutes
- Discussion on mismanagement practices of hazardous waste management  30 minutes
- Discussion on laws such as RCRA and CERCLA related to hazardous waste management  30 minutes
- Discussion on political and administrative approaches to government control of hazardous waste  30 minutes
- Short quiz or exam  30 minutes

Total time  150 minutes (one week)

Unit Evaluation  30 minutes short quiz or exam or both

Instructional Unit - Two: Definition of Solid and Hazardous waste.

Introduction This unit tries to provide a better understanding of solid and hazardous wastes generated by human activities and to relate that with the Resource Conservation and Recovery Act (RCRA) definition. Also covered in this unit are the importance, application, and limitations of using RCRA definition along with characteristics features of solid and hazardous waste. The differences in perception of hazardous waste and hazardous materials management by regulators, environmentalists, the public, and the media are explained. Solid and hazardous waste classifications and management plans are also briefly discussed.

Required Entry Behavior: Students are expected to be familiar with common types of solid and hazardous wastes generated by human activities. Students should be able to distinguish hazardous and non-hazardous types of wastes by identifying specific characteristics.

Behavioral Objectives: At the completion of this unit, the student will be able to:

- Identify different types of waste materials such as hazardous waste, nuclear waste, medical waste, and biological waste.
- Explain the RCRA definition of hazardous wastes and solid waste and their relationship
- Identify the various professional skills required in the management and control of hazardous wastes and their perception.
- Discuss the rules and regulations governing solid and hazardous wastes management.

Equipment and Supply None

Learning Activities and Strategies: This unit mainly consists of classroom presentations. These presentations will cover the following instructional materials for achieving the unit objectives.

- Types of solid and hazardous wastes such as nuclear waste, medical waste, and biological waste and RCRA’s definition of hazardous wastes. 15 minutes
- The relationship between RCRA’s for solid waste and RCRA’s hazardous waste. 30 minutes
- Hazardous waste management and control. 30 minutes
- Solid and hazardous wastes management rules and regulations 45 minutes
- Short quiz or exam 30 minutes

Total time 150 minutes (One Week)

Unit Evaluation: 30 minutes short quiz or exam or both

Instructional Unit - Three: Pathways, Fates, and Disposition of Hazardous Waste Releases.

Introduction  This unit tries to provide the student a better understanding of the basic theories of movement, mobility, dispersion and natural break down mechanisms of various waste materials. Also covered is an overview of the generally accepted and established pathways of releases of hazardous waste materials and relate these with impacts on human health, environment, land, and aquatic life.

Required Entry Behavior: Students are expected to be familiar with common types of hazardous waste material commonly released into the atmosphere, surface water and land, and their subsequent (physical, chemical, and biological) fate in those respective mediums. An in-depth understanding of these concepts will be advantageous but not necessary.

Behavioral Objectives: At the completion of this unit, the student will be able to

- Discuss the release of various chemicals in the form of hazardous wastes and the basic theories governing the movement, mobility, dispersion and natural breakdown mechanisms
- Describe, in detail, the generally accepted and established pathways and measurements of hazardous waste releases to the environment.
- Relate some important pathways and movement mechanisms to impacts on human health, the environment, land and aquatic life.

Equipment and Supply  None

Learning Activities and Strategies: This unit mainly consists of classroom presentations. These presentations covers the following instructional materials for achieving unit objectives.

- The release of various chemicals in the form of hazardous wastes to the atmospheres, surface waters, and to the land.  30 minutes
- The movement, fate and disposition of hazardous waste  45 minutes
- The relationship between some important pathways and movement mechanisms to the impacts on human health, the environment, land and aquatic life.  45 minutes
- Short quiz or exam  30 minutes

Total time  150 minutes (One Week)

Unit Evaluation  30 minutes short quiz or exam or both

Additional web-based information (EPA Website)
Instructional Unit - Four: Toxicology and the Standard-Setting Processes.

Introduction  It is very important to know the impact of various hazardous wastes on health of human and aquatic organisms when exposed. In this unit, the student is given information about the basic mechanisms of human exposure to various hazardous waste and hazardous materials, and how to relate these mechanisms to the pathways discussed in unit-three. In addition, this unit provides the student some guidance for locating appropriate toxicological data of the chemical constituents commonly found in hazardous wastes. Components of the general risk assessment process and their relationships to each other are also presented. Also covered in the unit are information on how various laws (such as RCRA) governing hazardous waste materials address toxicology and human health considerations, and how RCRA attempts to minimize toxic and health impacts of hazardous wastes.

Required Entry Behavior:

- Students are expected to be familiar with basic mechanisms of human exposure to various hazardous wastes in general.
- Students are expected to be able to locate information (such as components of waste materials and their associated risk factor) from the internet.

Behavioral Objectives: At the completion of this unit, the student will be able to

- Identify the release of various chemicals in the form of hazardous wastes
- Discuss the basic theories governing the movement, mobility, dispersion and natural breakdown mechanisms of hazardous wastes
- Describe in detail about the generally accepted and established pathways and measurements of hazardous waste releases to the environment.
- Relate some important pathways and movement mechanisms to impacts on human health, the environment, land and aquatic life.

Equipment and Supply   None

Learning Activities and Strategies: This unit mainly consists of class room presentations. These presentations cover the following instructional materials for achieving the unit objectives.

- Public health impacts of hazardous wastes  30 minutes
- Toxicity hazards and toxic actions of hazardous wastes  45 minutes
- Toxicity assessment, exposure assessment and risk characterization  30 minutes
- Regulatory applications of health standards and criteria, and RCRA Standards.  30 minutes
- Short quiz or exam  15 minutes

Total time  150 minutes (One Week)

Unit Evaluation:  30 minutes short quiz or exam or both

Instructional Unit - Five: Composition, and Characteristics of Solid and Hazardous Wastes and their Sources/Generators.

Introduction  This unit focuses on the composition and characteristics of solid and hazardous wastes, and their sources or generators. This information is essential for an effective waste management system. This unit also provides familiarity with some common sources / generators of solid and hazardous wastes. Hazardous wastes need further attention due to the nature of those wastes. It is important to understand the Resources Conservation and Recovery Act (RCRA) approach to regulate wastes from specific sources and processes. We need to understand the role that the generator plays in the “cradle-to-grave” management of hazardous wastes and the basic requirements RCRA imposes upon generators. RCRA is discussed in greater detail, focusing on controls based upon the three classifications of generators and regulatory requirements related to accumulating, record keeping, reporting, and export and import of hazardous wastes is given.

Required Entry Behavior:  Students are expected to be familiar with sources / generators of solid and hazardous wastes.

Behavioral Objectives:  At the completion of this unit, the student should be able to:

- Identify common type of solid and hazardous wastes generated by domestic and industrial activities.
- Discuss RCRA and approaches to regulate wastes or waste materials from specific industries or processes.
- Outline the role that the waste generator plays in the “cradle-to-grave” management of hazardous wastes and basic requirements RCRA imposes upon generators.
- Explain RCRA focus on controls based upon the three classification of generators, i.e., nature and composition of a waste, environmental and health impacts of a waste, and / or quantity of waste produced.

Equipment and Supply:  None

Learning Activities and Strategies:  This unit mainly consists of classroom presentations. These presentations cover the following instructional materials for achieving the unit objectives.

- Solid wastes, composition and handling  30 minutes
- Hazardous wastes and the three categories of generators  15 minutes
- Regulatory requirements of hazardous wastes by EPA and RCRA  30 minutes
- Pre transport regulations, accumulation of waste, and the manifest.  30 minutes
- Record keeping and reporting requirements  15 minutes
- Regulatory requirements of export and imports of hazardous wastes  15 minutes
- Short quiz or exam  15 minutes

Total time  150 minutes (One Week)
Field Activities  None

Unit Evaluation  15 minutes short quiz


Instructional Unit - Six: Transportation of Solid and Hazardous Wastes.

Introduction  This unit focuses on the storage, collection, and transportation of solid and hazardous wastes. This unit discusses factors such as the effects of storage on the waste, the type of containers to be used, the location of the containers, and public health and aesthetics considerations. In addition, types, methods, equipments and transportation needs and cost will be discussed. This unit also focuses on storage, collection, and transportation of hazardous wastes. It is imperative for the unit to focus on the advantages / disadvantages of the modes of transportation of hazardous wastes while informing the student of the required action to be taken by transporters in the event of a release during transportation. This unit also discusses the general nature of the regulation on the transportation of hazardous wastes by RCRA and hazardous materials transportation act (HMTA), and their relationships to each other.

Required Entry Behavior:  Students are expected to have a general idea about the storage, collection, and transportation of non-hazardous solid (domestic and industrial, agricultural) wastes. It would be advantageous, if the students are familiar with sources / generators of hazardous wastes and their storage, collection and transportation procedures.

Behavioral Objectives:  At the completion of this unit, the student should be able to:

- Identify the common types of storage, collection methods, and transportation modes for solid wastes generated from domestic and industrial activities.
- Identify the common types of transportation modes for solid wastes and hazardous wastes.
- Discuss the advantages/disadvantages of the modes of transportation of hazardous wastes.
- Take actions required of a transporter in the event of a release or spill of hazardous wastes during transportation.
- Discuss the general nature of the regulation imposed upon transport of hazardous wastes by the RCRA and HMTA regulations and their relationship to each other.

Equipment and Supply  None

Learning Activities and Strategies:  This unit mainly consists of class room presentations. These presentations cover the following instructional materials for achieving the unit objectives.

- Modes and scope of storage, collection and transportations of solid and hazardous waste transportation.  30 minutes
Instructional Unit - Seven: Treatment, Disposal Methods and Processes for Solid and Hazardous Wastes

Introduction  Processes associated with the treatment and disposal of hazardous and non-hazardous wastes are entirely different and will be discussed separately. In the case of solid wastes, this unit pays special attention to the recovery of materials, separation, and processing of solid waste components, as well as the transformation processes that convert waste to useful products. It is important to know that pre-processing of solid waste is done to produce a waste stream with a greater homogeneity and to permit recovery of materials such as aluminum, glass, and ferrous materials.

Dealing with hazardous waste is difficult and needs special attention since it can have significant impact on human health, the environment, and land and aquatic life. It is important to understand the abuses that were associated with accumulation of hazardous wastes and associated impacts on human health, environment, and other living things. This unit intends to provide an overview of the historical and traditional methods along with current methods of treatment and disposal of hazardous wastes, and the environmental impacts of each method. In essence, this chapter unit also focuses on technologies, practice, and regulatory requirements associated with the ultimate disposition of hazardous wastes.

Required Entry Behavior:  Students are expected to have general idea about the differences between generally classified non-hazardous solid (domestic and industrial, agricultural) wastes and hazardous waste materials. Some familiarity with the fundamental characteristics of hazardous wastes and knowledge of basic chemistry would be advantageous.

Behavioral Objectives:  At the completion of this unit, the student should be able to

- Participate effectively at a resource recovery facility to separate non-hazardous waste (pre-processing steps)
Describe the physical processing steps of non-hazardous solid wastes and how they are achieved.  
Describe various chemical transformation processes such as combustion or incineration, key features of incinerators and new federal regulations for combustors. 
Implement and satisfy regulatory processes at various levels (local, regional, state and federal).  
Describe biological transformation processes such as composting of non-hazardous waste materials and various disposal means. 
Describe past and present practices of land treatment and disposal, environmental impacts, and the RCRA land disposal restrictions.  
Determine on point-source water quality impacts of hazardous waste treatment and disposal operations. 
Discuss air quality implications, residue management, and waste destruction capabilities of burning vs. incineration and the RCRA approach to each. 
Employ reuse and recycling processes as management approach 
Describe the basic differences between treatment, immobilization, and destruction and the processes associated with each category.  
Discuss history and practice of ocean dumping and underground injection and with concerns regarding potential environmental impacts of each

Equipment and Supply
None

Learning Activities and Strategies:  This unit mainly consists of class room presentations. These presentations cover the following instructional materials for achieving the unit objectives. Non-hazardous solid wastes and hazardous wastes will be handled separately.

a. Non Hazardous Solid Wastes

- Pre-processing steps involved in non-hazardous solid wastes material as separation and recovery of materials.  
  45 minutes
- Chemical transformation steps and technology involved in processing of non-hazardous solid wastes.  
  45 minutes
- Biological transformation steps and technology involved in processing processes non-hazardous solid wastes.  
  30 minutes

b. Hazardous Wastes

- Historical and traditional methods of treatment and disposal of hazardous wastes and their environmental impacts.  
  20 minutes
- Administrative and non-technical requirements associated with the treatment and disposal of hazardous wastes.  
  20 minutes
- General technical standards for Interim status facilities.  
  15 minutes
- Waste management options and priority, and hazardous waste treatment.  
  45 minutes
- Storage of hazardous wastes.  
  15 minutes
- Land disposal of hazardous wastes.  
  30 minutes
Instructional Unit - Eight: Waste Minimization, Reuse and Recycling

Introduction

“Waste that is not produced does not have to be collected” is a very good concept. Consequently, preventing waste and pollution has become a major issue. Therefore, a source reduction program to minimize waste involves changing the way that products are made and marketed. Through source reduction, landfill capacity and natural resources are conserved, less energy is used in manufacturing, and land, air, and water pollution are reduced. Components of source reduction activities include product reuse, reduced material volume, reduced toxicity, increased product life, and decreased consumption. In this unit, we will focus on all aspects noted above and also talk about RCRA regulatory mechanisms and program incentives to achieve waste minimization. This unit also discusses Pollution Prevention Act and implementing mechanisms.

Required Entry Behavior: Students are expected to intuitively know the economic value of reusing a product or material when ever possible.

Behavioral Objectives: At the completion of this unit, the student should be able to:

- Practice waste minimization from various approaches
- Perform waste reduction assessment
- Discuss the imperatives of waste minimization, reduction, reuse, and recycling
- Discuss the RCRA regulatory mechanisms and program incentives to achieve waste minimization, the national policy aspects, and the local impediments
- Discuss the objectives of the Pollution Prevention Act (PPA) and the implementing mechanisms

Equipment and Supply: Nothing

Learning Activities and Strategies: This unit mainly consists of classroom presentations. These presentations tentatively cover the following instructional materials for achieving the unit objectives.

- Waste minimization techniques. 30 minutes
- Hazardous waste recycling. 30 minutes
Instructional Unit - Nine: RCRA Permits, Compliance, and Enforcement

Introduction
This chapter deals with three related aspects of RCRA – permitting process, corrective action process, and enforcement process. All these processes are important to keep the entire waste management as a safe enterprise without having any significant impacts on human health, the environment, land and aquatic life.

Required Entry Behavior: Students are expected to have some knowledge of the importance of compliance with RCRA statutes and regulations

Behavioral Objectives: At the completion of this unit, the student should be able to:

- Outline of the RCRA permitting process.
- Undertake the four steps of the RCRA corrective action process and the application of each of the steps.
- Discuss the goals of the RCRA enforcement program and the actions which may be taken to achieve these goals.
- Comply fully with the administrative, civil, and criminal enforcement provisions of RCRA.

Equipment and Supply
None

Learning Activities and Strategies: This unit mainly consists of classroom presentations. These presentations cover the following instructional materials for achieving the unit objectives.
Total time 150 minutes (One week)

Unit Evaluation 30 minutes test

Additional web-based information (EPA Website)

Instructional Unit - Ten: Assessment Techniques for Site Remediation

Introduction  The primary objective of hazardous waste management is the handling of the waste in a manner that prevents harm to the public health and the environment. During the 1970s, Americans learned the dangers of dumping waste on land. Contamination of New York’s Love Canal due to buried hazardous chemicals, and contamination of land and water in the small Missouri community of Times Beach due to toxic dioxins are two widely talked examples during 1970 and 1980 respectively among various hazardous waste problem sites. There have also been several complaints in the mass media about land contamination near Savannah, GA in 2004. Contaminated sites must be remediated, whether preparatory for transfer of ownership or as a result of regulatory requirements. Individuals and organizations having responsibility for remediating contaminated sites must have generally recognized and accepted procedures for assessment of site clean up needs. This unit will discuss the techniques and regulatory procedures for accomplishing these tasks.

Required Entry Behavior: Students are expected to have some knowledge of the mechanism of land contamination and its effect on land value due to its potential harm to human health.

Behavioral Objectives: At the completion of this unit, the student should be able to:

- Conduct appropriate site environmental assessment.
- Conduct site assessments for property transactions and for environmental remediation.
- Provide background information needed for establishing compliance history, assessing the need for additional or new data, designing new information/data gathering activity, ensuring safety of the investigators and public, and protecting the rights of the responsible parties.
- Determine specific and necessary site assessment factors such as information-gathering activity appropriate to the problem site, behavior of site owner/manager, severity of the threat to the health and welfare of the public, safety of workers on the site, and the applicable laws and regulations.
- Perform effective, efficient and accurate record keeping, documentation, and chain-of-custody procedures, irrespective of the nature of the corrective action contemplated.

Equipment and Supply  None

Learning Activities and Strategies: This unit mainly consists of class room presentations. These presentations cover the following instructional materials for achieving the unit objectives.
The primary objective of hazardous waste management is the handling of the waste in a manner that prevents harm to public health and the environment. Once contaminated site has been evaluated to determine the extent and nature of contamination we need to identify appropriate remedial technologies to clean up the contaminated site. This unit is an overview of site clean up procedures. Various remedial technologies and established practices for site clean up are discussed. Further, the unit provides an overview of the options and / or requirements as applied to various regulations such as RCRA.

**Required Entry Behavior:** Students are expected to be familiar with commonly used clean up technologies. Students are also expected to have broader understanding of regulations governing contamination clean up processes.

**Behavioral Objectives:** At the completion of this unit, the student should be able to:

- Determine appropriate technologies for a site remediation.
- Comply with applicable RCRA and CERCLA (Comprehensive Environmental Response, Compensation and Liability ACT) requirements and policies.
- Effectively referrence RCRA and CERCLA in site remediation.
- Resolve “How Clean is Clean” issues and their basis.
- Deploy current National Contingency Plan (NCP) and maintain currency with it.

**Equipment and Supply** None

**Learning Activities and Strategies:** This unit mainly consists of class room presentations. The following instructional materials are covered in this module for achieving the unit objectives.
Remedial programmatic and remedial objectives. 30 minutes
Site remedial (treatment) technologies such as containment, extraction, treatment and destruction methods. 30 minutes
Removal technologies and practices such as excavation, mechanical and hydraulic dredging. 30 minutes
RCRA and Superfund remedial actions. 30 minutes
Review with video presentations and short quiz 30 minutes

Total time 150 minutes (One week)

Unit Evaluation 30 minutes test

Reference Materials
Additional web-based information

Instructional Unit – Twelve: Medical/Biomedical/ Infectious Waste Management

Introduction For many years, health care workers and other allied professionals have understood the necessity to protect themselves and the general public from exposure to various types of medical wastes that might be reservoir of disease-transmitting organisms. There are several techniques and processes to deal with these types of wastes. As part of the regulatory process, in 1976, the enactment of the RCRA to include a definition of hazardous wastes which continue as a basis for federal regulation of infectious waste management. The primary objective of this instructional unit is to discuss various types of medical, biomedical wastes, the techniques currently available to manage, treat, and dispose safely, and to give an overview about the regulatory requirements in dealing with these types of hazardous wastes.

Required Entry Behavior: Students should be able to identify medical wastes and medical waste sites.

Behavioral Objectives: At the completion of this unit, the student should be able to:

• Identify the hazards associated with the traditional “red bag wastes” and the methods used to minimize the hazards.
• Practice effective traditional sanitation with regards to biomedical waste management
• Perform on site sterilization and incineration of various biomedical and infectious wastes.
• Train staff on the protocol in safe handling of biomedical wastes, emergency treatment and other contingency plans
• Implement the Substitute J regulations (40 CRF 259) and the use of tracking form

Equipment and Supply None
Learning Activities and Strategies: This unit mainly consists of classroom presentations. These presentations cover the following instructional materials for achieving the unit objectives.

- The definition and characteristics of medical waste. 30 minutes
- Infectious waste management including designation, segregation, packaging, storage, transport and treatment of infectious waste. 30 minutes
- Infectious waste sterilization, incineration. 30 minutes
- Emergency treatment technologies, disposal of treated waste, contingency planning and staff training. 30 minutes
- Review with video presentations and short quiz 30 minutes

Total time 150 minutes (One week)

Unit Evaluation 30 minutes test

Reference Materials  
Additional web-based information

Instructional Unit – Thirteen: Radioactive Waste Management

Introduction  Since the finding of X-rays by a German Scientist William Konrad Roentgen in 1895, radiation chemistry and nuclear technology have progressed very rapidly. These technologies have found applications everywhere including in the treatment of cancer and other diseases, fission and fusion weapons, and also in power generation. All these developments have practically saddled the major world powers with nuclear waste management problems of staggering proportions. This resulted in the establishment of the Office of Civilian Radioactive Waste Management (OCRWM) within the US Department of Energy in 1982 under the Nuclear Waste Policy Act (NWPA) to develop and manage a federal system for disposing spent nuclear fuel from commercial nuclear reactors and high-level radioactive waste from national defense activities. This unit of instruction attempts to introduce the student to the fundamentals of radioactivity, uses of nuclear energy and problems of nuclear waste contamination.

Required Entry Behavior: Students are expected to have some knowledge about the common uses of radiation, characteristics of radiation and the possible useful and harmful effects of radiation.

Behavioral Objectives: At the completion of this unit, the student should be able to:

- Discuss basic radioactivity, common uses of nuclear energy, and problems of nuclear waste contamination.
- Describe the basic physiological and human health effects of penetrating ionizing radiation and approaches to protection from exposure.
• Discuss the magnitude of the nuclear waste management problem in the United States, the causes, and the impediments to timely remedy thereof.
• Describe the four separate and distinct types of radioactive wastes and the management and regulatory approach to each.

Equipment and Supply

None

Learning Activities and Strategies: This unit mainly consists of class room presentations. These presentations cover the following instructional materials for achieving the unit objectives

• The effects and measurements of radioactivity. 30 minutes
• Radioactive protection. 30 minutes
• Regulatory structures and high level radioactive waste management. 30 minutes
• Transuranic and low level waste management 30 minutes
• Uranium mines and mill tailings management. 30 minutes
• Hi-lights of radiation problems (Video Presentation) 30 minutes
• Short quiz or test 30 minutes

Total time 210 minutes (One and a half week)

Unit Evaluation 30 minutes test

Additional web-based information

Instructional Unit – Fourteen: Underground Storage Tank Management

Introduction Several million underground storage tank (UST) systems in the United States contain petroleum or hazardous chemicals. The United States Environmental Protection Agency (EPA) estimates that about 1.2 million USTs buried at more than 500,000 sites are subject to federal regulation. Several hundred thousands of these tanks, including their piping, have leaked or are currently leaking. Many older tanks, and the associated piping, are of unprotected steel construction and can be expected to develop leaks unless they are removed or rehabilitated. Leaking of USTs can cause fires or explosions and/or contaminate groundwater. Since more than 50% of the population in the United States depend upon groundwater for domestic use, leaking of USTs is a major threat to public health and safety and to the environment.

In the Hazardous and Solid Waste Amendments (HSWA) of 1984, US Congress added a new Subtitle I to the RCRA to address the problem of leaking underground storage tanks used for the storage of petroleum and hazardous substances. The implementing federal regulations are found
in 40 CFR. In this unit, we will look at the nature and causes of the problem, the related technologies, and the regulatory structures.

**Required Entry Behavior:** Students are expected to have some knowledge about the common uses of underground storage tanks in their local areas and able to forecast what would happen to the nearby environment if there is a leak or damage to the tanks.

**Behavioral Objectives:** At the completion of this unit, the student should able to:

- Determine the nature and magnitude of the environmental threat of leaking underground storage tanks.
- Determine the causes of underground storage tank and piping failures.
- Discuss the theories and practices of internal tank testing and external monitoring for leaks.
- Implement remediation measures, tank rehabilitation procedures, and follow requirements for new tanks installations.
- Comply with the RCRA Subtitle I requirements for underground storage tank management.

**Equipment and Supply** None

**Learning Activities and Strategies:** This unit mainly consists of classroom presentations. These presentations cover the following instructional materials for achieving the unit objectives.

- Principles of underground storage tanks. 15 minutes
- Problems and causes of leaking of underground storage tank. 30 minutes
- Protection of tanks and piping from corrosion. 30 minutes
- Detection of leaks from underground storage. 15 minutes
- RCRA regulatory requirements for leaking of storage tanks. 30 minutes
- Closure of underground storage tank facilities. 15 minutes
- Short quiz or test 15 minutes

**Total time** 150 minutes (One week)

**Unit Evaluation** 15 minutes test

Additional web-based information
Instructional Unit - Fifteen: Hazardous Waste Worker Health and Safety

Introduction

Workers face a formidable array of workplace hazards and potential hazards as they perform the many routine and non-routine tasks associated with the practice of hazardous waste management. In the past, the worker was characteristically ill-prepared, in terms of intellect, literacy, training, instruments, equipment, and supervision to perform the required tasks with relative safety to him/her, fellow workers, the public and the environment. Even though significant progress has been made toward improving workplace safety for the hazardous waste worker, currently much remain to be done due to inconsistency among employers and workplaces. Similar inconsistency has been noticed among the owners and operators of hazardous waste facilities and managers and supervisors of hazardous workers in terms of effective management, supervision, training, and equipping workers and facilities. In this unit, we will look at the nature and types of hazards generally encountered by workers on hazardous work sites; types of actions and preventive measures that is needed to be taken to minimize impacts; and the regulatory requirements for the protection of workers health and safety.

Required Entry Behavior: Students are expected to have some knowledge about the common types of hazards workers encounter on hazardous worksites.

Behavioral Objectives: At the completion of this unit, the student should be able to:

- Identify the types of hazards which may be encountered by the workers on hazardous waste sites.
- Take actions and preventive measures to minimize impacts of those hazards during both routine and emergency conditions.
- Enforce regulatory requirements for protection of worker health and safety on hazardous waste sites.

Equipment and Supply None

Learning Activities and Strategies: This unit mainly consists of classroom presentations. These presentations cover the following instructional materials for achieving the unit objectives.

- Hazards encountered on hazardous waste sites. 30 minutes
- Hazardous waste operations and emergency response. 30 minutes
- Standards applicable to cleanup sites. 30 minutes
- OSHA workplace standards which may apply to hazardous sites. 30 minutes
- Review with video presentation 30 minutes

Total time 150 minutes (One week)

Unit Evaluation 15 minutes test

Additional web-based information.