
HW-E - Hazardous Waste Management and Pollution Prevention



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Short Description

This manual provides an excellent introduction to mastering the management of hazardous waste materials as well as preventing contamination of the environment. Other areas covered are: legal and regulatory aspects of pollution handling hazardous waste materials within your plant reducing the amount of hazardous waste produced ways to save money through preventing personal injury and preventing or limiting the effects of accidental pollution.

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First Chapter

Introduction to hazardous waste management

1 Introduction

1.1. Introduction

Hazardous waste management is an international problem and is one of the deleterious by-products of the Industrial Revolution of a developed country. It is a multidisciplinary field which deals with water pollution, air pollution, solid waste and ground water pollution aspects that affect the environment and human health. The world is under threat due to hazardous waste and its improper disposal; the problem is further compounded by technical obstacles, financial constraints and lack of adequate public awareness in this regard. In this new century, there is a general trend for waste reduction per unit of product produced, due to a very high remediation and disposal cost, stringent regulatory enforcement, legal liability, public scrutiny and the need to project an environment-friendly corporate image. There is an overall tendency of corporations towards source reduction, embracing smarter production methods, material substitution and reuse etc., for a greener and a healthier world by means of technical and managerial innovation to achieve a higher net yield at a lower environment cost. The management of hazardous wastes has changed drastically since the 1960s and is still evolving with time and need.

1.2. Objective

This manual will provide a brief overview of how to approach hazardous waste problems; it will include potential sources of pollution in and around the plant, the latest technologies and techniques for preventing contamination / pollution of the environment and the methods of handling hazardous waste materials. Also examined is the detection and measurement of the incidence of contamination as well as contingency plans for handling of emergencies.

1.3. Definition

The word '*hazardous waste*' was first introduced during 1970 with the first national study and during mid-1970, the US legislature took the initiative to regulate it. The US Environmental Protection Agency (EPA) introduced the first hazardous waste law in 1976.

The definition of the word '*waste*' is as follows:

“A waste is a movable object which has no direct use and is discarded permanently.”

Here the term waste indicates the solid waste and the entire regulation of hazardous waste. The term solid waste covers only solids, sludges, tars, etc. Many concentrated liquids are also considered hazardous waste as they are a mixture of hazardous waste with water. Because of this, it is the characteristics of the waste that is important in defining it to be hazardous, not the form.

A waste can be *hazardous* if it exhibits any of the following characteristics:

- Ignitable
- Flammable
- Reactive
- Explosive
- Corrosive
- Radioactive
- Infectious
- Irritating
- Sensitizing
- Bioaccumulative.

The United Nations Environment Program prepared a working definition of hazardous waste in December 1985.

Hazardous wastes mean wastes (solids, sludges, liquids, and containerized gases) other than radioactive (and infectious) wastes which, by reason of their chemical activity or toxic, explosive, corrosive, or other characteristics, cause danger or likely will cause danger to health or the environment, whether alone or when coming into contact with other waste.

1.4. Background

Toxicity due to several human activities is observed in air, water and soil. Hazardous waste is one of the several causes for toxic contamination of the environment. Mismanaged hazardous waste storage, treatment and disposal facilities have an adverse effect on the health of living beings. The development of advanced analytical chemistry and its subsequent application to the environmental field yielded a new ability to detect contamination or toxicity at ‘part per billion’ levels or at levels still lower.

During the early 1980s, hazardous waste became the most important

environmental issue. Hazardous waste accounted for about 50% of the \$8.2 billion environmental consulting market in 1991 (See Fig. 1.1(a)) and remediation technology, including hazardous waste management, in 1998 accounted for 36% of the \$11.1 billion environmental consulting and remediation market (See Fig. 1.1(b)).

(a)

(b)

Figure 1.1

Hazardous waste markets share (a) Consulting and (b) Remediation.

Initially, the consequences of such waste on the environment as well as on health was not understood or recognized. With the developments of epidemiology, toxicology, and analytical chemistry, it is now easy to understand the long-term effect of waste on humans and the environment. Rachel Carson's publication, *Silent Spring* in 1962, explains how DDT residuals affect bird populations and goes on to discuss the effects of the mercury poisoning in Japan. The publication also examines the hazardous waste of Times Beach, Missouri, the Seveso (Italy) chemical factory explosion in 1976 and the Bhopal tragedy of December, 1984. The paper also dwells on advancing the public awareness and public concern and pushes ahead the environmental movement and prompts the hazardous waste legislation that drives how waste is handled today.

1.4.1. Regulatory Initiatives

The US congress, in conjunction with the state and local governments, enacted legislation in two fronts:

- Management of currently generated hazardous waste
- Remediation of already contaminated sites

Earlier, the waste generators tended to dispose waste without any consideration of its long-term effect because cost was the main concern for them. An EPA

report in 1973 stated that the magnitude of the hazardous waste problem was larger than originally anticipated and that disposal practices were inadequate. In 1976, the Resource Conservation and Recovery Act (RCRA) evolved. The Act focused on recovery and recycling of solid waste. The EPA assigned the generator of hazardous waste a "cradle to grave" responsibility for the proper management of these substances after the point of generation. During the same time, other developed countries also formulated laws to control hazardous waste. In 1972, the UK passed a *Deposit of Poisonous Waste Act* after an incident of cyanide waste disposal in a children's playground. Similar legislation was introduced in the European Union on managing *Toxic and Dangerous Waste* in 1978.

Factors that were taken into consideration for developing the legislations are as follows:

- How do we define soil pollution?
- What are the acceptable risk levels and how do we confine contamination within those limits?
- Should we draft generic clean-up criteria or introduce site-specific waste disposal approaches?
- Should we draft generic soil quality criteria or introduce site-specific quality criteria?
- How do we formulate the priority list and what is the objective of remediation?

The RCRA did not have the mechanisms to address these issues related to past practices. The US congress formulated an act in 1980, the Comprehensive Environment Response, Compensation, and Liability Act (CERCLA), commonly known as the "Superfund."

The RCRA and the CERCLA regulatory programmes are operated separately. Currently, generated waste (RCRA waste) is generally a residue of an industrial operation and is more in concentration when compared to contamination of soil and ground water due to past practices (CERCLA waste) but both are equally threatening for the environment and health.

The EPA conducted a technical ranking (1987) of the relative risks posed by different environmental threats based on comparative evaluations. This is given in the following table:

Table 1.1

Ranking of environmental threats

Problem	Relative Risk
Consumer exposure to chemicals	High
Indoor air pollutants	High
Pesticide residue on foods	High
Hazardous waste sites (active/inactive)	Low - Medium

1.4.2. Classification of Hazardous Waste

Whether a waste is hazardous can be identified in the following ways:

- Laboratory Test
- Inclusion in the list of specific waste compiled by the government.

Testing

Waste, which exhibits any of the following characteristics, is considered as hazardous:

- Corrosive waste that is highly acidic or alkaline
- Ignitable waste being ignited easily and causing a fire hazard while handling
- Potentially harmful reactive waste which may cause sudden explosions after reactions
- Toxic waste releasing specified substances in water beyond certain concentrations.

Lists

In 1980, the EPA formulated a separate designation for hazardous waste, called "listed" waste, though their test results were below the characteristically hazardous levels. The four criteria that had been identified for a waste to be so listed are as follows:

- The waste is toxic as it contains a constituent that exhibits toxic, carcinogenic or mutagenic effect on humans or other life forms

- The waste contains hazardous constituents which can be fatal for humans and all living life
- It exhibits one of the hazardous characteristics
- The waste fits the definition of hazardous waste prompted by the US congress as a part of RCRA

The codification of hazardous waste is based on test results viz.,

T - Toxic

H - Highly hazardous

I – Ignitable

R - Reactivity

C – Corrosivity

The following four lists of hazardous waste have been identified by the EPA:

F List –Wastes resulting from chemicals generally used in chemical plant for their intended purpose and subsequently becoming waste. The initial chemicals generally contain at least 10% solvent (v/v).

K List –Wastes that are generated from the following industries from specially designated processes, some of these industries being wood preservation, inorganic pigment manufacturing, organic and inorganic chemical manufacturing, pesticide manufacturing, explosive manufacturing, petroleum refinery, iron and steel production, primary copper, lead, zinc and aluminum production, ferroalloys production, ink formulation, veterinary pharmaceuticals etc.

P List –Commercial chemicals which are unused and discarded are designated as acutely toxic waste. These chemicals are of 100% purity (or close to 100%) and the sole active ingredient.

U List –Waste falling under the category “P List” and exhibiting one or more hazardous waste characteristics. These chemicals are of 100% purity (or close to 100%) and the sole active ingredient.

In 1989, 116 countries had participated in the first global treaty on hazardous waste in Basel, Switzerland, known as The Basel Convention. The UNEP document, “Basel Convention for the Council of Transboundary Movements of Hazardous Wastes and Their Disposal” puts a limited ban on the transboundary movement of hazardous waste to countries that are producers of the hazardous waste but do not have the capacity to dispose of the waste within their own borders.

The *degree of hazard* of a waste considers individual constituents and characteristics such as their concentration, mobility, dosages, etc. Hazardous wastes are also classified as per the following criteria:

- Form or phase distribution
- Organic or inorganic
- Chemical class
- Hazardous waste constituent, as it affects treatability

1.5. Generation of Hazardous Wastes

Hazardous wastes are generated from different industrial, agricultural, commercial and household activities. All facilities or persons that produce hazardous waste are considered *generators*. Waste managed within the site is called on-site waste and that managed outside the site is called off-site waste.

In the manufacturing sector wastes are primarily generated from four sources:

- Spent Material
- Byproducts
- Treatment
- Commercial chemical products (e.g. spills or leaks, outdated product, cleaning of process equipments, etc.)

There are three categories of hazardous waste generators. These categories are determined by the amount of hazardous wastes or acutely toxic hazardous wastes they generate monthly and/or on the amount of such wastes they accumulate on site at any given time. There is an established specific hazardous waste regulation for large quantity generators and small quantity generators. Waste oil generators are assigned a separate status.

Small Quantity Generators (SQG): Those facilities or individuals who generate

more than 220 pounds, but less than 2200 pounds, of hazardous waste during any month of the previous year, or who accumulate (store temporarily) onsite at any one time a total of less than 13,227 pounds of hazardous waste, are considered Small Quantity Generators.

Large Quantity Generators (LQG): Those facilities or individuals who generate 2.2 pounds, or more, of acutely toxic hazardous waste in any month, or who accumulate on-site at any time 2.2 pounds, or more, of acutely toxic hazardous waste, regardless of the rate of generation, automatically is subject to all the requirements applicable to a Large Quantity Generator of hazardous waste.

1.6. Management of Hazardous Waste

All generators of hazardous waste are responsible for identifying their hazardous wastes and ensuring that their hazardous waste is properly handled on-site. They must ensure that wastes are only sent to an authorized facility for further treatment, storing or disposal.

A hazardous waste generator may temporarily store hazardous wastes on-site without a permit for a limited period, depending on whether the generator is classified as a large or small quantity generator. LQGs may only accumulate hazardous waste on-site for 90 days. SQGs may accumulate hazardous waste on-site for 180 days before it is properly shipped off-site to a licensed hazardous wastes treatment, storage, or disposal facility. SQGs that ship wastes to facilities more than 200 miles away may accumulate their hazardous waste on-site for up to 270 days.

General overviews of regulatory requirements applicable to most generators of hazardous waste are given below.

Waste Identification: Hazardous waste includes substances that are solids, liquids and gases. The EPA definition of hazardous waste includes substances that possess a hazardous characteristic (e.g. toxic, ignitable, corrosive or reactive with other substances), or substances that are listed as hazardous waste by the EPA on the basis of their usage or chemical constituents.

Labeling: Containers which store hazardous waste must be properly and clearly labeled. This includes:

- The words "Hazardous Waste"
- The container contents in words (e.g., "WASTE OIL")
- The hazards associated with the waste in words (e.g., "TOXIC")

- The accumulation start date

Once a satellite accumulation becomes filled, the accumulation start date must be written on the label.

Accumulation and Storage: Hazardous waste regulations established a two-tiered waste accumulation and storage system: satellite accumulation and main accumulation.

Satellite Accumulation: Hazardous waste accumulation and storage, which is at the point of generation and under the control of the person generating the waste, is called satellite accumulation. Regulations allow a maximum of 55 gallons of hazardous waste or 1 quart of acutely hazardous waste at each satellite accumulation area. Satellite accumulation containers must be closed unless waste is being added or removed from the container. Full containers of hazardous waste may be stored at the point of generation for a maximum of 3 days before being transferred to a designated, main accumulation area having certain design and monitoring requirements. Hazardous waste should be stored in leak proof tubs or another type of containment device within satellite storage areas. All containers must be kept closed unless adding or removing waste material.

Main Accumulation: Main accumulation and storage of hazardous waste is subject to strict time limitations. LQGs of hazardous waste are allowed to store hazardous waste on-site for a maximum of 90 days.

Manifesting: Hazardous waste must be shipped with a special shipping paper called a hazardous waste manifest. Each location has a unique EPA Generator ID number that must appear on the manifest.

Transportation and Disposal: Hazardous waste may be transported only by a licensed hazardous waste transporter and may be sent only to a licensed treatment, storage and disposal facility.

Emergency Preparedness and Prevention: A Hazardous Waste Management Contingency Plan is designed to prevent and to minimize hazards to the public or to the environment from fires, explosions, spills or other unplanned releases of hazardous waste. Hazardous waste regulations also require generators to comply with emergency preparedness and prevention requirements. These requirements include a testing and maintenance program for various emergency equipments (e.g., fire and spill equipment, emergency alarms and communication systems).

Waste Minimization: Generators of hazardous waste are required by the EPA to minimize the volume and toxicity of the hazardous waste they generate.

Recycling: Hazardous waste recycling activities require a permit.

1.7. Training

Persons involved in the management of hazardous waste must complete a training program, which teaches them how to perform their duties in compliance with applicable hazardous waste regulations. Generators are required to maintain a written program which describes training program contents, as well as stating who is trained and why and record keeping procedures.

Reporting

Generators are required to submit a biennial hazardous waste report, which summarizes hazardous waste generation and management activity for the previous year. Hazardous waste manifests generally must be submitted immediately to the authority. Any change in generation status or types of hazardous waste generated requires prompt notification to the authority.

Inspections

Regulations require that hazardous waste areas (main accumulation areas) be inspected on a weekly basis. Satellite accumulation areas should also be inspected weekly.

Record keeping

Hazardous waste regulations require that the following records be maintained for a minimum of 3 years:

- Waste analysis / determination records
- Manifests
- Biennial reports
- Exception report

Land Disposal Restriction (LDR) notifications/certifications, which typically accompany hazardous waste manifests, are required to be maintained for a minimum of 5 years.

1.8. Present trend

With the increasing awareness of the long-term adverse effects of hazardous wastes on life forms, the prime generators are changing their approach to the entire problem. The focus today is shifting from just 'compliance' to a more futuristic 'prevention'. (See Fig. 1.2). Today's corporations are modifying and monitoring their product life-cycles to achieve this end. A systematic and holistic approach towards environment and health are of prime interest instead of just managing the hazardous waste (as shown in Fig. 1.3).

Figure 1.2

A new corporate direction

Figure 1.3

Product Life-cycle