



Waste Management

Types of Wastes

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Content



- **Introduction**
- **Kinds of wastes**
- **Why be concerned about hazardous waste?**
- **What is hazardous waste?**
- **Methods of Classification**
- **Characteristic Hazardous Wastes**
- **Listed Hazardous Wastes**



Introduction

- Environmental management of hazardous wastes has become a major concern as haphazard dumping of hazardous wastes results in severe environmental impairment.
- The adverse effects of hazardous wastes as well as the significant potential risks posed by them to the life and its supporting systems are increasingly recognized.
- Rapid growth of industries has resulted in generation of increasing volume of hazardous wastes.
- These wastes need scientific treatment and disposal
- Much work remains to be done to understand and find ways to reduce and mitigate the effects of harmful substances and hazardous waste on human health and the environment.

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What are Wastes?

Basel Convention Definition of Wastes

“substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of the law”

Disposal means

“any operation which may lead to resource recovery, recycling, reclamation, direct re-use or alternative uses (Annex IVB of the Basel convention)”

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Solid wastes: domestic, commercial and industrial wastes especially common as co-disposal of wastes

Examples: *plastics, styrofoam containers, bottles, cans, papers, scrap iron, and other trash*

Liquid Wastes: wastes in liquid form

Examples: *domestic washings, chemicals, oils, waste water from ponds, manufacturing industries and other sources*

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Types of Waste

- Solid Waste
- Liquid Waste
- Gaseous Wastes
- Animal by-products
- Biodegradable waste
- Biomedical waste
- Bulky waste
- Business waste

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Types of Waste



- Chemical waste
- Clinical waste
- Coffee wastewater
- Commercial waste
- Construction and demolition waste (C&D waste)
- Controlled waste
- Consumable waste
- Composite

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Classification of Wastes according to their Properties



Bio-degradable

can be degraded (paper, wood, fruits and others)

Non-biodegradable

cannot be degraded (plastics, bottles, old machines, cans, styrofoam containers and others)

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Classification of Wastes according to their Effects on Human Health and the Environment



Hazardous wastes

Substances unsafe to use commercially, industrially, agriculturally, or economically that are shipped, transported to or brought from the country of origin for dumping or disposal in, or in transit through, any part of the territory of the Philippines

Non-hazardous

Substances safe to use commercially, industrially, agriculturally, or economically that are shipped, transported to or brought from the country of origin for dumping or disposal in, or in transit through, any part of the territory of the Philippines

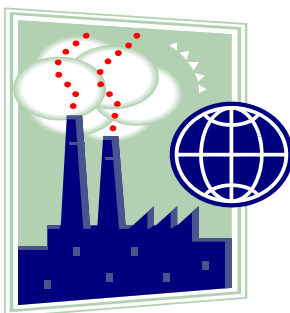
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Sources of Wastes



Households

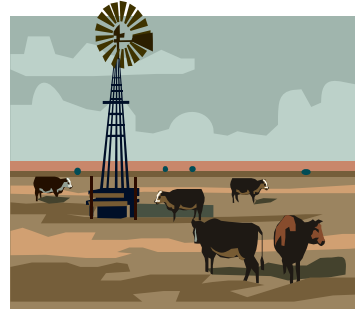


Commerce and Industry

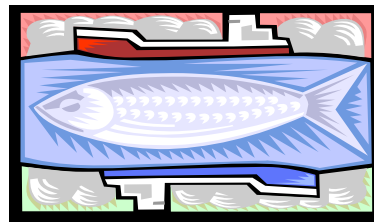
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Agriculture



Fisheries



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Solid Waste

➤ It is defined as:

“Non-liquid, non-soluble materials ranging from municipal garbage to industrial wastes that contain complex and sometimes hazardous substances”

- Solid wastes also include:
 - Sewage sludge
 - Agricultural refuse
 - Demolition wastes
 - Mining residues

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Types of Solid Waste

► Broadly there are 3 types of waste which are as follows:

1. Household waste is generally classified as **Municipal waste**

2. Industrial waste as **Hazardous waste**

3. Biomedical waste or **Hospital waste** as **Infectious waste**

➤ Municipal solid waste consists of:

- ✓ Household waste
- ✓ Construction and demolition debris
- ✓ Sanitation residue
- ✓ Waste from streets.



Hazardous Wastes: Types

- Contains at least one toxic compound
- Catches fire easily
- Reactive or explosive
- Corrodes metal containers

Not Hazardous Wastes according to Resource Conservation and Recovery Act, (RCRA)

- Radioactive wastes
- Household wastes
- Mining wastes
- Oil and gas drilling wastes
- Liquids containing organic hydrocarbons
- Cement kiln dust



Hazardous Wastes

- Industrial and hospital waste is considered hazardous as they may contain toxic substances.
- Hazardous wastes could be highly toxic to humans, animals, and plants. They are
 - Corrosive
 - Highly inflammable, or explosive
 - React when exposed to certain things e.g. gases



Hazardous Wastes

► Household wastes that can be categorized as hazardous waste include:

- ❖ old batteries
- ❖ shoe polish
- ❖ paint tins
- ❖ old medicines
- ❖ medicine bottles.



Hazardous Wastes



- Hospital waste contaminated by chemicals used in hospitals is considered hazardous.
- These chemicals include formaldehyde and phenols, which are used as disinfectants.



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Hazardous Wastes



- ▶ In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries.
- ▶ Direct exposure to chemicals in hazardous waste such as mercury and cyanide can be fatal.



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Hospital Waste

- Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals
- It may include wastes like



- Sharps
- Soiled waste
- Disposables
- Anatomical waste
 - Cultures
- Discarded medicines
- Chemical wastes



Hospital Waste

- These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc.
- This waste is highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner
- It has been roughly estimated that of the 4 kg of waste generated in a hospital at least 1 kg would be infected



Sources and Other Types of Waste



Source	Typical Waste Generators	Types of solid wastes
1: Residential	Single and multifamily dwellings	<ul style="list-style-type: none"> ❖ Food wastes ❖ Paper ❖ Cardboard ❖ Plastics ❖ Textiles ❖ Leather ❖ Yard wastes ❖ Wood ❖ Glass ❖ Metals ❖ Ashes ❖ Special wastes <p>(e.g bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes.)</p>

2: Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants.	<ul style="list-style-type: none"> ❖ Housekeeping wastes ❖ Packaging ❖ Food wastes ❖ Construction and demolition materials ❖ Hazardous wastes ❖ Ashes ❖ Special wastes.
3: Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	<ul style="list-style-type: none"> ❖ Paper ❖ cardboard ❖ plastics ❖ wood ❖ food wastes ❖ glass ❖ metals ❖ special wastes ❖ hazardous wastes
4: Institutional	Schools, hospitals, prisons, government centers.	Same as commercial.

5:Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	<ul style="list-style-type: none"> ❖ Wood ❖ steel ❖ concrete ❖ dirt etc.
6:Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants.	<ul style="list-style-type: none"> ❖ Street sweepings ❖ landscape and tree trimmings ❖ General wastes from parks ❖ Beaches ❖ Recreational areas; sludge.
7:Process (manufacturing etc.)	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing.	<ul style="list-style-type: none"> ❖ Industrial process wastes ❖ Scrap materials ❖ Off-specification products.
8:Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms.	<ul style="list-style-type: none"> ❖ Spoiled food wastes ❖ Agricultural wastes ❖ Hazardous wastes (e.g., pesticides)



Why be concerned about hazardous waste?

- There are four main reasons should be concerned about hazardous waste: job safety, health, money and the environment
- 1. Incomplete understanding of hazardous waste concepts could not only jeopardize the operating condition, components, systems and instrumentation of the process but possibly endanger lives.
- 2. Improper handling of hazardous waste can threaten human health. For example,
 - Acids or bases (such as battery acids and metal cleaning solutions) can destroy or cause irreversible damage to normal living tissues, such as mucus membranes, eyes, gastrointestinal tract, respiratory passages and skin.
 - Toxins are another health hazard that poison your system. Toxic solvents, heavy metals, paint thinners and adhesives can accumulate in your body over time. This could affect your nervous system particularly the brain and circulatory system.



Why be concerned about hazardous waste?

A list of some materials and their hazardous health effect(s).

MATERIALS		HEALTH EFFECT(S)
Beryllium	Infrared waves	Causes or promotes cancer
Cadmium	Ultraviolet light	
Chromic acid		Inflammation of skin and mucous membranes
Alkaline dust	Halogens	
Ozone	Phosgene	
Nitrogen	Carbon Dioxide	Displaces oxygen in tissues
Hydrogen	Helium	
Halogenated hydrocarbons		Depressant effect upon the central nervous system
Alcohols		

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Why be concerned about hazardous waste?

3. Improper handling, storage, transportation and/or disposal of hazardous waste can lead to financial penalties (Regulatory penalties can range from \$100 to \$50,000 per violation per day), job loss or worse, imprisonment.

➤ following is a list of their costly violations:

- Failure to notify as a hazardous waste generator.
- Failure to label all hazardous waste containers with accumulation start dates and the words “hazardous waste.”
- Failure to keep all containers holding hazardous waste closed at all times (i.e., except when actually adding or removing waste).
- Failure to perform a hazardous waste determination on spent rags contaminated with listed waste.
- Failure to use the manifest system for off-site removal of hazardous waste.
- Failure to maintain inspection logs for hazardous waste containers.
- Allowed hazardous waste to be taken off-site without utilizing a Land Disposal Certification/Notification.

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Why be concerned about hazardous waste?

4. Improperly handled hazardous waste can destroy natural waterways, poison or kill wildlife and contaminate food and drinking water.

- Used oil from a single automotive oil change can spoil one million gallons of fresh water for an entire year
- Used oil in surface waters can also threaten wildlife. Oil depletes the oxygen supply for many aquatic organisms such as fish and inhibits the flying ability of water fowl.



Figure Courtesy of Department of Environmental Protection

- Furthermore, contaminated water with high concentrations of metals from the oil are absorbed by plants and accumulate in their tissues. In return, by contaminating the food supply, it can ultimately affect human health.



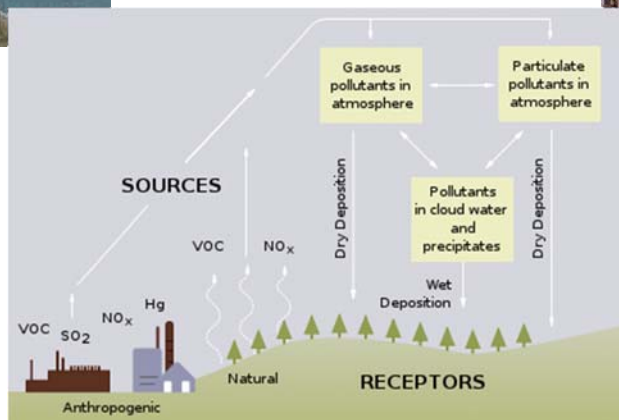
Why be concerned about hazardous waste?



The coal-fired Gavin Power Plant in Cheshire, Ohio



Trees killed by acid rain



What is hazardous waste?

- Hazardous waste is a discarded substance that because of its quantity, concentration, physical, chemical or infectious characteristics may cause or contribute to a serious illness or pose a substantial or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of
- Hazardous waste can take the form of a solid, liquid or compressed gas.
- They can be the by-products of manufacturing processes, discarded used materials, or discarded unused commercial products, such as cleaning fluids (solvents) or pesticides.
- It is the material that exhibits one of the four characteristics of a hazardous waste - ignitability, corrosivity, reactivity, or toxicity.
- The term hazardous waste is often used in conjunction with hazardous materials, chemicals and substances.
 - HAZARDOUS CHEMICAL: is any chemical which has properties that present either physical or health hazards.
 - Hazardous chemicals from Occupational Safety and Health Administration (OSHA) include both physical and health hazards

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What is hazardous waste?

A listing of OSHA (Occupational Safety and Health Administration) hazardous chemicals

PHYSICAL HAZARDS

Fire Hazards

combustible liquids
flammable aerosols
gases, liquids & solids
oxidizers
pyrophoric



Explosion Hazards

compressed gases
explosives



Reactive Hazards

organic peroxides
reactive material



HEALTH HAZARDS

Acute Hazards

corrosive materials
irritants
sensitizers
toxic agents
agents affecting target organs



Chronic Hazards

carcinogens
agents affecting target organs



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What is hazardous waste?

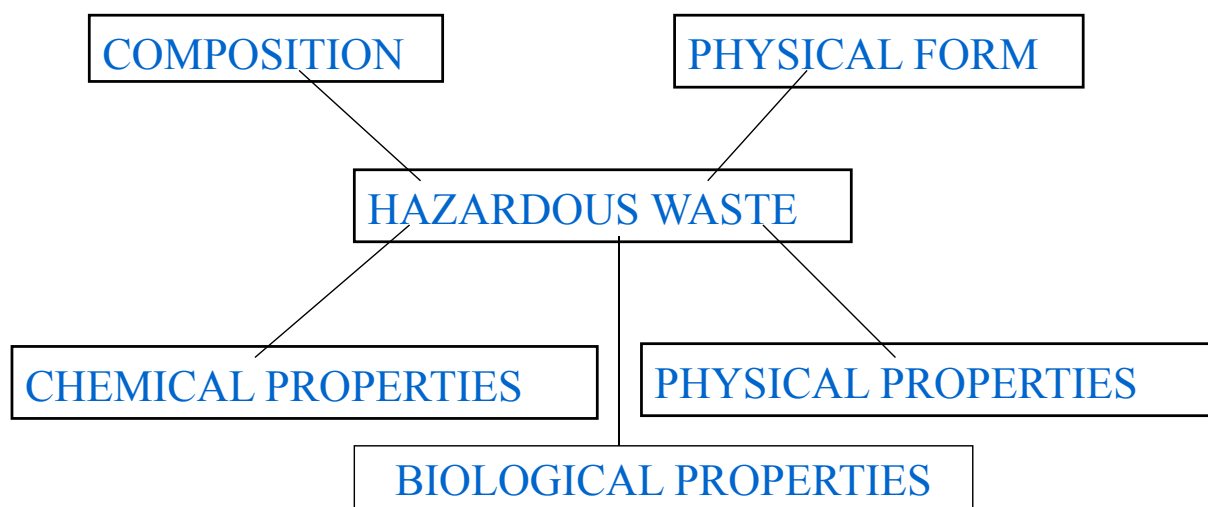
- **HAZARDOUS MATERIAL:** is a substance or material which is capable of posing an unreasonable risk to health, safety and property when transported in commerce.
- Hazardous materials are divided into nine classes that include: Explosives gases, flammable liquid, combustible liquid, flammable solids, oxidizers, organic peroxides, poisonous materials, radioactive materials, corrosives
- **HAZARDOUS SUBSTANCE:** is a listed substance that is deemed as hazardous if spilled in excess.

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What is hazardous waste?

The hazard associated with a waste depends on:



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Methods of Classification

- Lists e.g. Basel Convention Annex I, Basel List A, EU European Waste Catalogue, US EPA list
- Origin e.g, processes, Basel Convention Annex II
- Hazardous characteristics eg toxicity, reactivity, Basel Convention Annex III
- Chemical and physical properties eg inorganic, organic, oily, sludges
- Need to match classification to objectives
- No method will suit all cases

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Methods of Classification

Classification by Origin

- Waste streams eg Basel Convention
- Miscellaneous or ubiquitous wastes eg
 - contaminated soils
 - dusts
 - redundant pesticides from agriculture
 - hospital wastes
- The Basel Convention's List of Hazardous Waste Categories (Y1-Y18) identifies wastes from specific processes
- eg Y1 Clinical wastes
- Y6 Wastes from the production and use of organic solvents
- Y18 Residues from industrial waste disposal operations

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Methods of Classification

Classification by hazardous characteristics

- Main characteristics:
 - Toxic
 - Corrosive
- UN Committee on the Transport of Dangerous Goods by Road or Rail (ADR) lists waste characteristics. These have been adopted by Basel Convention - Annex III gives 13 characteristics, based on ADR rules, including:
 - Explosive
 - Flammable
 - Toxic and eco-toxic
 - Represented as codes H1-H13



Methods of Classification

Classification by chemical, biological and physical properties

- Inorganic wastes eg acids, alkalis, heavy metals, cyanides, wastewaters from electroplating
- Organic wastes eg pesticides, halogenated and non-halogenated solvents, PCBs
- Oily wastes eg lubricating oils, hydraulic fluids, contaminated fuel oils
- Sludges eg from metal working, painting, wastewater treatment



Exclusions from control systems

- Some wastes may be excluded from the legal definition of hazardous wastes, and thus not subject to controls. These vary, but may include:
 - Hazardous waste from households - outside the controls in many countries
 - Small quantity generators - often placed outside the system, at least initially
 - Aqueous effluents discharged to sewer or treated on-site - controlled separately from hazardous wastes in most countries
 - Sewage sludge - excluded in some countries
 - Mining wastes - often excluded
 - Agricultural waste - often excluded
 - Nuclear waste - always excluded

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Characteristic Hazardous Wastes

Ignitability

- Ignitable wastes can create fires under certain conditions, undergo spontaneous combustion.
- A waste is characteristic for ignitability if it has any one of the following properties:
 - a liquid with a flash point less than 140° F (60° C);
 - a solid, capable under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes, and when ignited, burns vigorously and persistently;
 - an ignitable compressed gas; or,
 - an oxidizer.

Examples include, but are not limited to, most organic solvents such as:

Acetone	Ethyl ether	Pentane
Benzene	Heptane	Petroleum Ether
Ethanol	Hexane	Toluene
Ethyl acetate	Methanol	Xylene



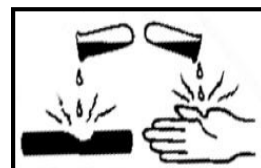
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Characteristic Hazardous Wastes

Corrosivity

- Corrosive wastes include highly acidic or highly alkaline chemicals and those that are capable of corroding metal.
- A waste has the characteristic of corrosivity if it has one of the following properties:
 - an aqueous waste with pH 2 or less, OR pH 12.5 or greater; or,
 - a liquid that corrodes steel at a rate greater than 6.35mm (0.25 inches) per year.



Reactivity

- Reactive wastes are unstable under normal conditions
- A waste has the characteristic of reactivity if it
 - is normally unstable and readily undergoes violent change without detonating;
 - reacts violently with water;
 - forms potentially explosive mixtures with water;
 - mixes with water to generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment;



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Characteristic Hazardous Wastes

- is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment;
- is capable of detonation or explosive reaction if subjected to a strong initiating source or heated under confinement;
- is readily capable of detonation or explosive; or,
- is a forbidden explosive or a Class A or Class B explosive.

Toxicity

- Toxic wastes are harmful or fatal when ingested or absorbed (e.g., toxic metals such as lead and mercury, organics such as benzene and chloroform, and pesticides such as endrin).
- When toxic wastes are disposed, the toxic constituents may leach from the waste and pollute ground water



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Characteristic Hazardous Wastes

- Toxicity is determined by the “Toxicity Characteristic Leachate Procedure” (TCLP), a laboratory test that measures the concentration of the toxic material that could leach into ground water if improperly managed.
- The TCLP must be conducted on any waste that contains any of the specified TCLP contaminants.
- This waste is considered “toxic” if:
 - it has an oral LD₅₀ for a rat of less than 500 mg/kg;
 - the container that the chemical came in identifies it as a toxic or poisonous material; or,
 - the chemical is a known or suspected carcinogen, mutagen or teratogen.



Characteristic Hazardous Wastes

Acute toxicity

- Waste exhibits the characteristics of being acutely hazardous if a representative sample contains any of the following:
 - Wastes generated in the manufacturing process of halogenated phenols and other halogenated compounds
 - Wastes generated in the manufacturing/formulating process of pesticides or pesticide derivatives
 - Wastes generated during the manufacturing process of halogenated benzene under alkaline conditions
 - Off-specification or discarded products generated from the above processes containers used for handling hazardous/toxic substances/wastes



Characteristic Hazardous Wastes

Table 1 - Examples of Hazardous Characteristics: Extracted From U.N. Listing (1989)

U.N. Class Number	Hazardous Characteristic
1	Explosive
3 - 4	Flammable
5	Oxidising
6	Poisonous/Infectious
7	Radioactive
8	Corrosive
9	Toxic (Delayed or Chronic)/Ecotoxic

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Characteristic Hazardous Wastes

Infectious property

- Wastes containing viable micro-organisms or their toxins which are known or suspected to cause disease in animal or humans fall under this category.

Eco-toxicity

- Eco-toxic wastes are harmful or fatal to other species or to the ecological integrity of their habitats



- Examples:
- Heavy metals
- Detergents
- Oils
- Soluble salts

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Listed of Hazardous Wastes

- Approximately 500 chemicals and hazardous wastes are listed by their technical name in 40 CFR Part 261.
- These listed wastes are generated either as “process wastes” or “discarded wastes”.
- Process wastes are industrial chemicals that are used for their intended purpose and are under the F-List and K-List.
- Discarded wastes are commercial chemical products that even unused can cause a threat to human health and the environment.
- The P-List and U-List catalog chemicals that when discarded are hazardous in their pure formulas. The following describes the differences between the F, K, P and U Lists in greater detail.

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Listed of Hazardous Wastes

The F-LIST

- The *F-LIST* contains hazardous wastes from non-specific sources and is located in 40 CFR 261.31.
- This list consists of commonly used solvents in cleaning, degreasers and extraction processes.
- It also includes wastes from electroplating, metal refinishing, pesticide manufacturing, wood preserving, petroleum refining and other processes. S
- Solvents on the *F-LIST* are assigned a three digit number preceded by a “F”. Halogenated, spent solvents are numbered F001 and F002.
- Non-halogenated, spent solvents are numbered F003 to F005.
- Examples of materials on the F-List are benzene, carbon tetrachloride, methyl ethyl ketone, methylene chloride, trichloroethane, toluene and trichloroethylene.

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Listed of Hazardous Wastes

The K-LIST

- The *K-LIST* contains hazardous wastes from specific source and is located in 40 CFR 261.32.
- These sources would come from specific industrial processes such as wood preservation and from the production of pigment, chemicals, iron, steel and pesticides.
- Specific source wastes on the K-List are assigned a three digit number preceded by a “K”.

The U-LIST

- The *U-LIST* contains toxic commercial chemical products and is located in 40 CFR 261.33(f). This list includes toxic wastes from discarded chemical products, off specification materials and spill residues.
- Toxic wastes from the U-List are assigned a three digit number preceded by a “U”.

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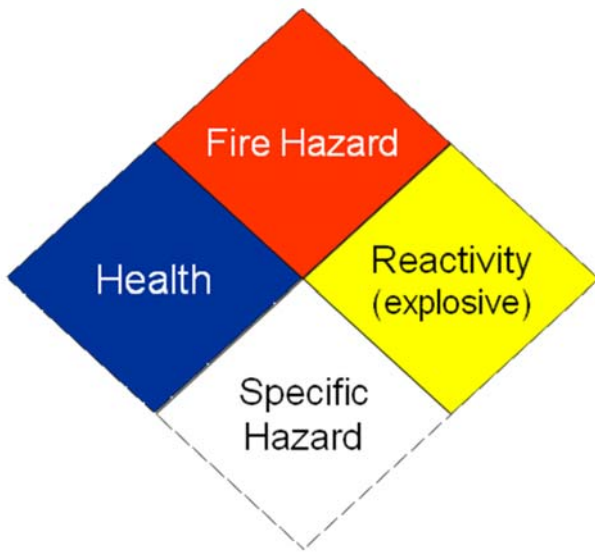
Listed of Hazardous Wastes

The P-LIST

- The *P-LIST* contains discarded acutely hazardous commercial chemical products and is located in 40 CFR 261.33(e).
- Acutely hazardous waste are defined by the EPA to be wastes that are severely dangerous in small amounts that they are regulated the same as other hazardous wastes of larger amounts.
- This list contains wastes from discarded chemical products, off-specification material, containers and spill residues.
- The P-List includes chemicals found in herbicides, pesticides and other poisonous products. Acute discarded wastes from commercial chemical products are assigned a three digit number preceded by a “P”.
- For example, the waste characteristic code for a discarded container of arsenic acid is P010. Even when the acid was spilled and cleaned up using an absorbent, the spill debris number will remain the same as the acid.

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HEALTH HAZARD

- 4 - Deadly
- 3 - Extreme danger
- 2 - Hazardous
- 1 - Slightly hazardous
- 0 - Normal material

FIRE HAZARD

- Flash Point
- 4 - Below 73° F
- 3 - Below 100° F
- 2 - Below 200° F
- 1 - Above 200° F
- 0 - Will not burn

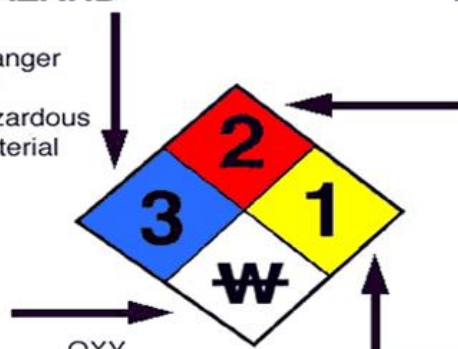
SPECIFIC HAZARD

- Oxidizer
- Acid
- Alkali
- Corrosive
- Use NO WATER
- Radiation Hazard

- OXY
- ACID
- ALK
- COR
- W
-

REACTIVITY

- 4 - May detonate
- 3 - Shock and heat may detonate
- 2 - Violent Chemical change
- 1 - Unstable if heated
- 0 - Stable



Some common hazardous chemicals



- Lead
 - paint, gasoline, pipes, accumulates in soil and water
 - neurological damage, slows brain development, kidney disorders; children especially vulnerable
- Mercury
 - paint, batteries, old thermometers, industrial processes, combustion of coal, dental fillings, contaminated historical mining sites
 - damages brain, kidneys, developing fetus, learning disabilities, death with high doses

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Some common hazardous chemicals



- Arsenic
 - treated wood, industrial processes, contaminated soil and water
 - impairs organ, heart, and blood functions; damages nervous system
- PCBs (Polychlorinated biphenyls)
 - industrial chemical (used in fire retardants, lubricants, insulation for electrical transformers, some printing inks)
 - carcinogenic, birth defects, lower IQ, learning disabilities, impairs neurological development

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- Waste breaks down in landfills to form methane, a potent greenhouse gas
- Change in climate and destruction of ozone layer due to waste biodegradable
- Littering, due to waste pollutions, illegal dumping, Leaching: is a process by which solid waste enter soil and ground water and contaminating them.



- It is estimated that food wasted by the US and Europe could feed the world three times over.
- Food waste contributes to excess consumption of freshwater and fossil fuels which, along with methane and CO₂ emissions from decomposing food, impacts global climate change.
- Every tonne of food waste prevented has the potential to save 4.2 tonnes of CO₂ equivalent.
- If we all stop wasting food that could have been eaten, the CO₂ impact would be the equivalent of taking one in four cars off the road.

