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Environmental Management System Optimization Focusing on the Waste Environmental Media in the Chemical Industry

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Environmental management system optimization focusing on the waste environmental media in the chemical industry

By

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The first part of this project focused on evaluating aspects of the environmental management practices of Texas chemical industries, particularly waste generation and management of the data related to these processes. The waste generation data included Texas notifications required to track wastes. The next phase consisted of characterizing industrial waste disposal methods, waste container management, and transportation including an overview of required documentation for each activity. This led to identification of issues encountered from inefficient recordkeeping, ineffective internal communication, or inadequate environmental management systems. The result of an ineffective hazardous waste data management program can be fines, damage to the environment, and even adverse impacts on worker health and safety. For example, for the situations outlined in this document, violations could have resulted in penalties totaling $550,000 per day.

This led to an effort to evaluate and develop solutions needed to develop a robust management system. The goal was to provide an operating and hazardous waste management program which optimally resulted in "zero findings" by the state regulatory

agency. This would be achieved through personal experiences of this environmental engineer while working at a chemical plant augmented by information obtained through observations of others at the facility and a review of published documentation.

This document focuses on the redesign and automation of an ineffective, manual environmental management system by making modifications and enhancements with a focus on effective management of various waste media. The criteria used for determining system optimization includes regulatory compliance and noncompliance penalties, internal communication time, onsite storage accumulation time exceedances, recordkeeping efficiency, number of lost waste containers, and time needed to make waste classifications. Optimization is verified against other alternatives by comparing instances and severity of noncompliance with state and federal regulations. The result was a total environmental management system optimized in a way that ensured compliance and achieved the goal of eliminating violations. It also reduced cost, allowed automated data entry, supported rapid asset location and helped track performance.

Key words: environmental management systems optimization, waste, disposal, container, shipment, chemical industries, hazardous, nonhazardous, classifications, transportation, recordkeeping, environmental engineer, shipping documentation

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CHAPTER I

INTRODUCTION

Houston, Texas, Chemical Industry

Today Houston, Texas has a profitable and exuberant chemical industry. A diverse manufacturing industry, it got its beginning during World War I. At that time, chemical industries became the twenty-eighth ranked Texas industry in terms of revenues. Millions of dollars were invested in the Texas chemical industry business between 1939 and 1949 resulting in its substantial growth during World War II. Consequently, by 1989 the chemical industry accounted for over 51 percent of investment in the state.

Although the Houston area, shown in Figure 1, has steady and continuous growth in the chemical plant sector, the heaviest chemical industry concentration exists in the Freeport, Bay City, and Texas City areas.

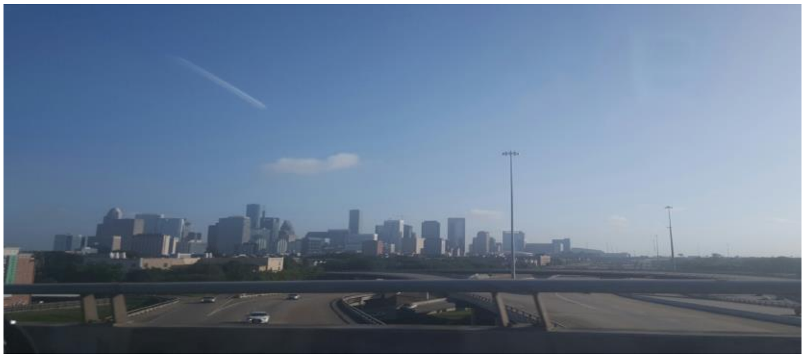

Figure 1 Houston, Texas

(Photo taken by the author)

After World War II, chemical plants in the Houston, Texas area produced:

- Hydrocyanic Acid
- Phosphate fertilizers
- Electrolytic chlorine
- Caustic soda
- Anhydrous hydrofluoric acid
- Sulphuric acid
- Superphosphate fertilizers
- Hydrochloric acid
- Xylene
- Phenathiazin
- Ammonium sulphate
- Toluene
- Butyl Rubber Polymerization
- Ethylene

The companies that produced these products included, but were not limited to, Dow Chemical, E.I. DuPont, Celanese, Occidental Chemical, Quantum Chemical, Huntsman Chemical, Union Carbide, and Exxon. Ethylene was the most widely produced chemical because it is an intermediate product that's used to make other products, such as polyethylene. Most of America's ethylene is produced in Texas (Ryan, 2010). Ethylene is abundant because it is produced in many petrochemical plants in Texas. Ethylene, benzene, xylene, toluene, propylene, and butadiene are basic petrochemicals and are used to make products that include, but are not limited to rubber, solvents, and plastics. Petrochemicals are chemical compounds that are from oil, natural gas, coal, or other sources (American Fuel & Petroleum Manufacturers, 2015).

Today, the chemical industry in Texas accounts for over 50 percent of chemical production in the United States. Over 400 chemical plants and refineries are located along the Texas Gulf Coast. The chemicals produced in this region are used in making automobiles, pharmaceuticals, computers, cloths, homes, etc. Currently, Houston is noted for containing over 40 percent of the nation's petrochemical capacity (Texas Economic Development Corporation, Texas Wide Open for Business, 2016).

Port of Houston

As a result of the decades of investment and industrial development related to petroleum production and refining, a $15 billion petrochemical complex is now located at the Port of Houston. The port is instrumental in linking Houston to global markets. The port stretches 25 miles along the Gulf of Mexico and it ranks first in United States foreign waterborne tonnage, imports, and export tonnage. The revenues generated by the port include $4.5 billion in state and local taxes (Port of Houston Authority of Harris County, 2016).

Figure 2 shows 1 of 14 segments of the Houston Ship Channel which are part of the Port of Houston. The Houston Ship Channel stretches for approximately 50 miles to the San Jacinto River and eventually meets the Galveston Bay. (Sibley, 2010). A study conducted by the Texas Department of State Health found excessively high levels of polychlorinated biphenyl (PCB) in fish. This resulted in the issuance of fish and shellfish consumption advisories for the Houston Ship Channel and upper Galveston Bay area (Department of State Health Services, 2013).

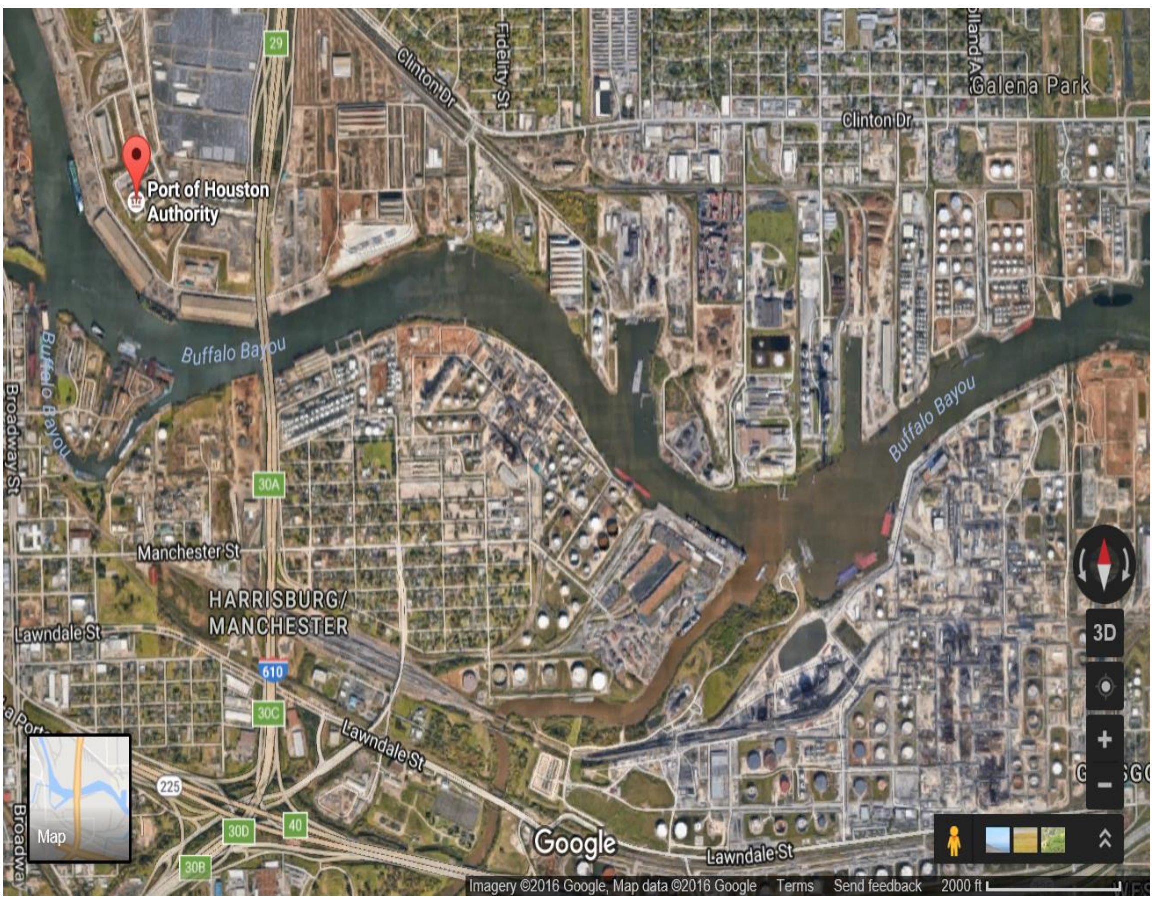

Figure 2 A Section of the Houston Ship Channel from Google Earth

The area where the Houston Ship Channel connects to the San Jacinto River is another example of improper management of chemical wastes. The area is called the San Jacinto River Wastes Pits. This site is about 20 acres and received wastes containing polychlorinated dibenzodioxins (PCDDs), otherwise known as dioxins. Portions of this site have subsided into the San Jacinto River. Although this site is currently inactive, studies conducted by Texas Department of State Health Services (DSHS) showed blue crab and fish that continue to contain PCBs and PCDDs at concentrations that exceed human health protection guidelines stated by the DSHS. (Department of State Health Services, 2013).

The San Jacinto River is in a coastal watershed that serves over 6 million people through its drinking water, recreation, and seafood supply. Over the years, companies began "storing" quantities of mixed dioxin compounds in waste pits. Over time, these businesses completed their profitable transaction and essentially walked away from what is known as the San Jacinto Waste Pits.

Port of Texas City

The facility used as a basis of investigation for this study is approximately 40 miles from the Houston Ship Channel in Texas City, Texas. For various reasons, the author cannot disclose the specific facility or the parent company which owned and operated it. However, Figure 3 shows the main highway running through Texas City near the facility. The area has a population of approximately 47,000 and is home to a large number of chemical plants. Texas City is located in Galveston County along the shoreline of Galveston Bay.

Figure 3 Texas City, Texas

(Photo taken by the author)

The Port of Texas City is a deepwater port and has principal import cargoes containing crude oil and principal export cargoes containing gasoline, diesel, jet fuel, intermediate chemicals, and petroleum coke. Figure 4 shows the location of the Port of Texas City relative to the Houston Ship Channel which indicates that it is in the center of one the most important shipping hubs in the region (Texas Welcomes Friends, 2016).

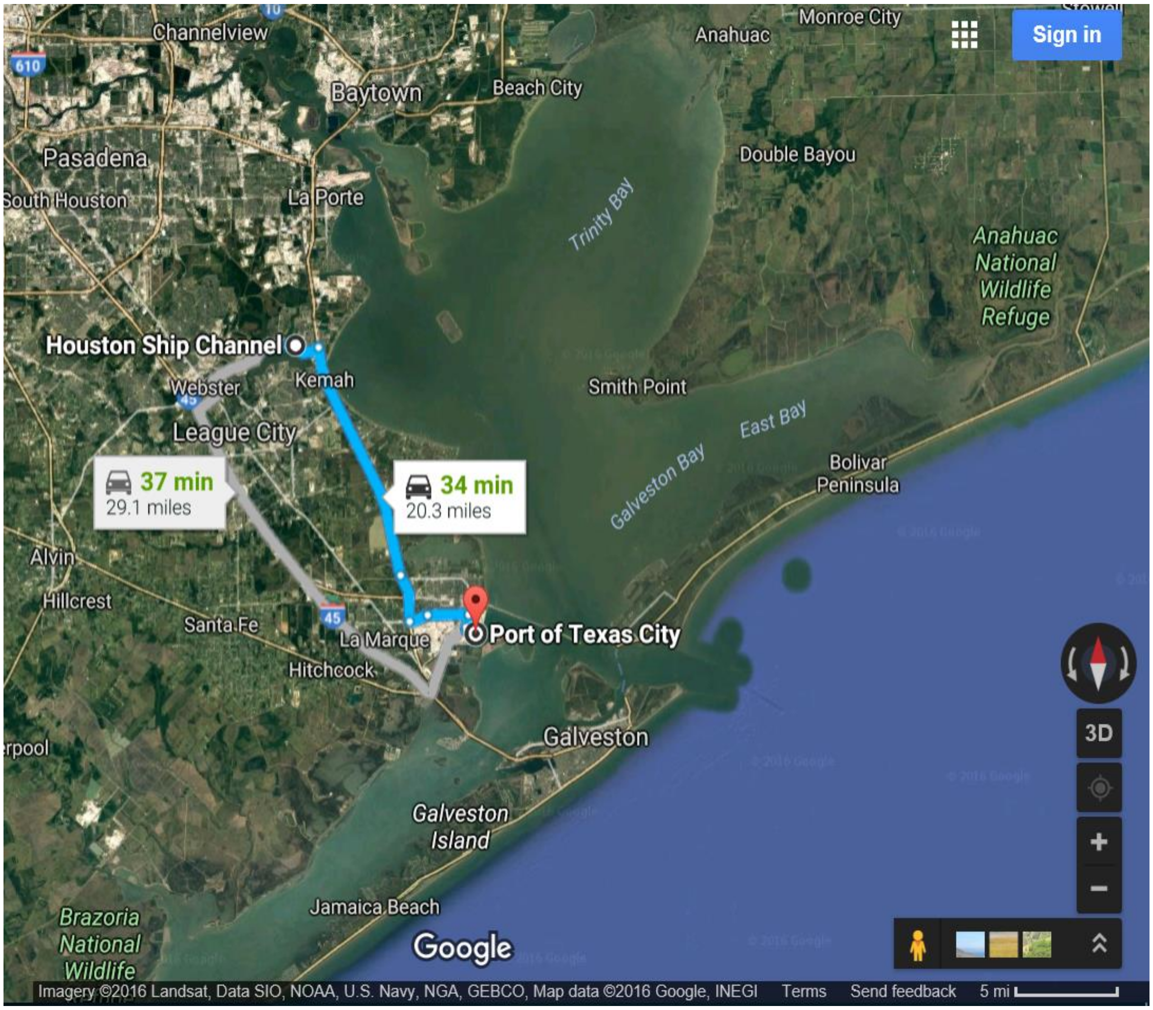

Figure 4 Map of Houston Ship Channel and Port of Texas City by Google Maps

Similar to the Houston Ship Channel and Galveston Bay, the Texas State Department of Health Services (DSHS) has issued fish advisories in the Port of Texas City Area. Figure 5 shows the fish advisory warning notice that resulted from fish and water samples taken by DSHS for the Port of Texas City waters. The samples indicated that PCB and Dioxin concentrations exceeded guidelines established by DSHS Texas Department of State Health Services Fish and Shellfish Consumption Advisory ADV-50, June 26th, 2013 by Dr. David L. Lakey. Currently the source of PCBS and Dioxins along the Houston Ship Channel and Galveston Bay is unknown. However, there are many potential sources because these chemicals are byproducts of industrial and chemical production processes and incineration of solid wastes. Also, PCBs take long periods of time to breakdown and can be found in sediments, rainfall, in leaching water from landfills, and inflow from contaminated tributaries (Texas Parks and Wildlife Foundation, 2008). Therefore, the origin of the contamination could have been facilities operating decades previous to the study.

Fish Consumption Advisory Area	Affected Species	Contaminants of Concern
Galveston Bay and All Contiguous Waters	All Species of catfish, spotted trout, and blue crab	Dioxins and PCBs

Figure 5 Fish Advisories near the Port of Texas City
(Texas Parks and Wildlife Foundation, 2008)

A less ambiguous example of improperly managed wastes near the Port of Texas City is a site previously owned by Texas City Chemicals. Texas City Chemicals produced uranium from a phosphate fertilizer plant. Texas City Chemicals declared bankruptcy and the facility was demolished. The vacant lot is shown in Figure 6. Recent surveys have not identified radiation/contamination levels above normal values expected for a phosphate fertilizer plant (The Wall Street Journal, 2013).

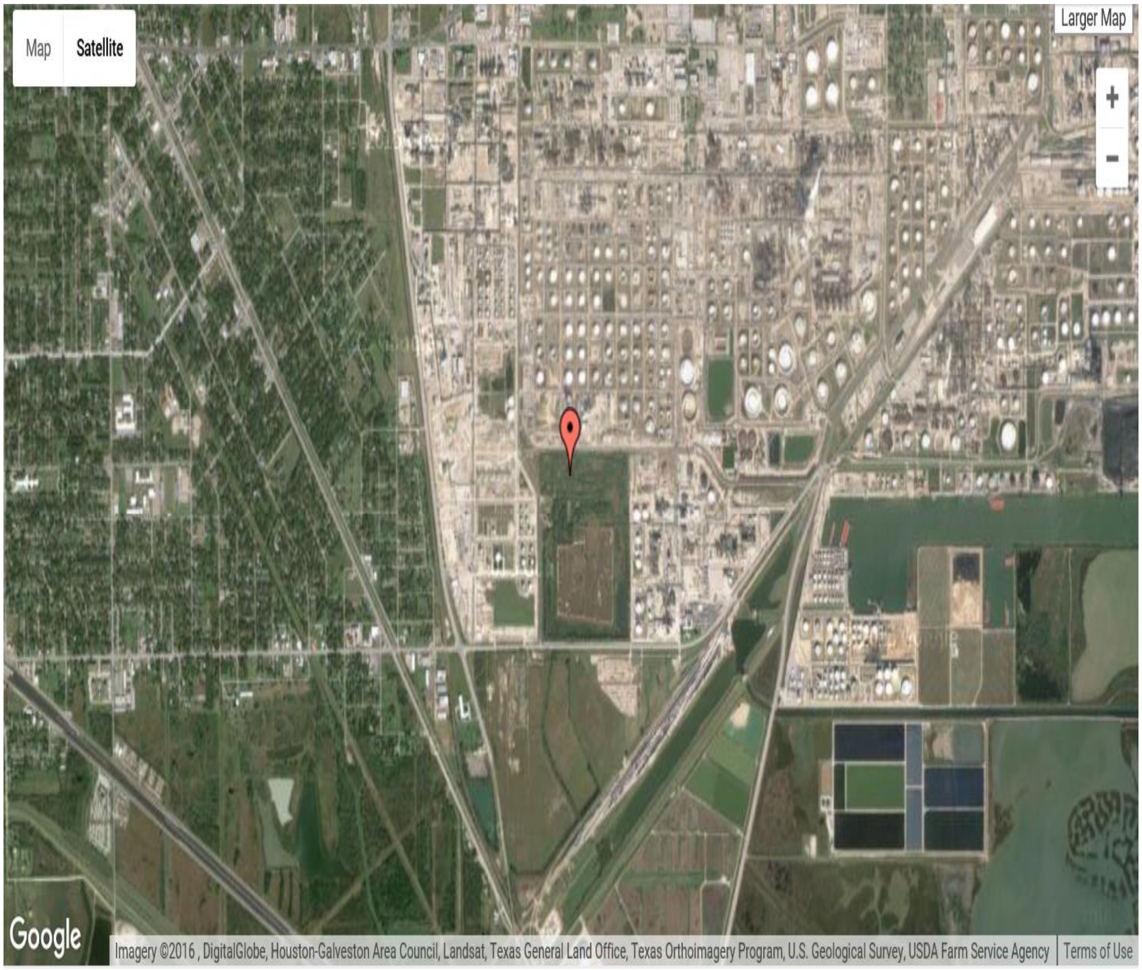

Figure 6 Former Texas City Chemicals Site from Google Maps

This property was eventually sold to a facility that is the area of study for optimizing environmental systems. Although the previously owned Texas City Chemicals site continues to be inactive, in recent years waste containers were found on the site. These failing waste containers were not labeled and were not identified in any environmental management system. There were no records of these containers and the contents were unknown. Figure 7 shows runoff from the property that frequently occurs during rainfall periods. The runoff eventually flows to the Galveston Bay and any contaminated water can affect the fish, ecosystem, and human health.

Figure 7 Rainwater Runoff
(Photo taken by the author)

The facility used for this project also includes active sites shown in Figure 8. The active sites have three operating units and a dock chemical storage area located at the Port of Texas City. The operating units produce metaxylene and paraxylene. The active site and dock area are also permitted for several discharges; however, adequate testing must be conducted before a discharge can occur based on the Texas Pollutant Discharge Elimination System Requirements.

(a)  (b) 

Figure 8 Active Site

(Photos taken by author)
(a) Process Units at Active Site without Storage Tanks
(b) Process Units at Active Site with Storage Tanks

To summarize, there are many opportunities for waste generation at these various facilities. The waste generation could be associated with production operations as well as general site activities such as painting, maintenance, and material storage. Construction activities can also represent a source of waste generation. Hence, some of the hazardous waste generated on site on a regular basis includes contaminated insulation or debris, metals contaminated sandblasting, aluminum chloride, residue from equipment cleaning, process sludge, process wastewater, contaminated soils, contaminated site and construction debris, non-empty aerosol cans, and contaminated materials from spill clean-up events.

Texas Commission on Environmental Quality

The Texas Commission on Environmental Quality (TCEQ) is a regulatory agency charged with insuring that industries or facilities in Texas maintain environmental compliance in order to protect human health and the environment. In the area of waste management, TCEQ requires that industries or facilities maintain records which identify and prove environmental compliance. For example, the state agency requires that facilities conduct weekly inspections on waste containers to insure that containers are in good condition and do not promote pathway exposure and therefore pose a threat to the environment and human health. The TCEQ uses the records to evaluate against compliance, however, this becomes difficult when there are inefficiencies of recordkeeping due to a paper driven system. In order for a facility to manage wastes, TCEQ requires that a generator must report the types and amount generated or disposed. Before a site can generate or store hazardous or industrial wastes, an initial notification package for hazardous or industrial wastes, wastes streams, and waste management units has to be submitted. All of this is consistent with the requirements of the Resource Conservation and Recovery Act (RCRA) as promulgated by the United States Environmental Protection Agency. Furthermore, TCEQ has accepted the USEPA's guidelines for violations and will take formal actions against industries or facilities in noncompliance. TCEQ uses the likelihood of exposures of contaminants to the environment and human health to make determinations on significant noncompliance. (Texas Commission on Environmental Quality, 2009). At the facility used as a basis for this research, the accumulated paper associated with documenting waste management per

TCEQ requirements was enough to fill two 40-foot long solid waste roll-off containers. At a minimum, the facility's paper driven processes made compliance all but impossible.

However, the frustrations of workers tasked with managing this mountain of paper, exacerbated by a culture which considered state and federal regulations as excessive and intrusive, often led to violations of the environmental compliance regulations.

CHAPTER II

WASTE GENERATION BY THE CHEMICAL INDUSTRY

Notice of Registration

Chemical plants produce many types of waste on a regular basis. Before a Texas industrial facility can manage or transport wastes (Figure 9) that are generated onsite, an Industrial and Hazardous Waste (IHW) Notice of Registration is required by the Texas Commission on Environmental Quality (TCEQ). The Texas Commission on Environmental Quality is the environmental regulatory agency for the state of Texas. During the period of research, the TCEQ conducted onsite inspections to verify recordkeeping for the Notice of Registration.

Figure 9 Waste Container Being Transported

(Photo taken by the author)

The Texas Commission on Environmental Quality requires the Notice of Registration in order to track solid waste activity statewide in their environmental management system. Tracking is important at the site level to maintain compliance. During inspections at the facility studied, TCEQ inspectors verified the waste codes against the waste description on the Notice of Registration to insure compliance with environmental regulations. Adequate recording of waste codes is important because it shows justification of waste code determination and verifies how the waste was transported.

The Notice of Registration includes a large amount of information. However, the most important and relevant information is the waste activities, waste description, and waste codes (Texas Commission on Environmental Quality, 2016). In accordance with US Environmental Protection Agency and TCEQ regulations, an industrial facility is required to provide a Notice of Registration if any of the following criteria, which also define the generation classification, are met (Texas Commission on Environmental Quality, 2009; Code of Federal Regulations, 2012):

- The facility generates less than 100 kg (220 lbs) per month of hazardous waste, or less than 1 kg (2.2 lbs) per month of acutely hazardous waste. In this case the facility is categorized as a Conditionally Exempt Industrial Generator.

- The facility is a Small Quantity Generator (SQG) if it generates less than 1 kg per month of acutely hazardous waste, or less than 1000 kg per month of hazardous waste.

The facility is a Large-Quantity Generators (LQG) if it generates 2,200 pounds (1,000) kg or more of hazardous waste or 2.2 pounds (1 kg) or more of acutely hazardous waste.

Waste Classification

To be classified as a hazardous waste, the material must be included in one of four "lists" (i.e.; F, K, P, or U) maintained by the United States Environmental Protection Agency or must exhibit one or more of four hazardous characteristics (APPENDIX B: Process Knowledge): ignitability, reactivity, corrosivity, or toxicity (Texas Commission on Environmental Quality, 2015). The listed wastes are classified as F, K, P, or U listed wastes (Code of Federal Regulations, 2012) and are deemed hazardous waste because of the origin and characteristics of these four families of waste. Hence, these designations are based on the sources by which the waste is derived (APPENDIX C: Listed Wastes).

Texas waste codes must be included on the Texas Notice of Registration and is also necessary for waste classification. This is identified in the Texas Administrative Code 30 TAC Section 335.503. The code states the following: "A waste code is represented by the following 8-digit character string: sequence number, form code (Figure 10), and classification code H, 1, 2, or 3. Classification Codes 1, 2, and 3 denotes Non-hazardous wastes and H denotes a hazardous waste." (Texas Administrative Code, 2015).

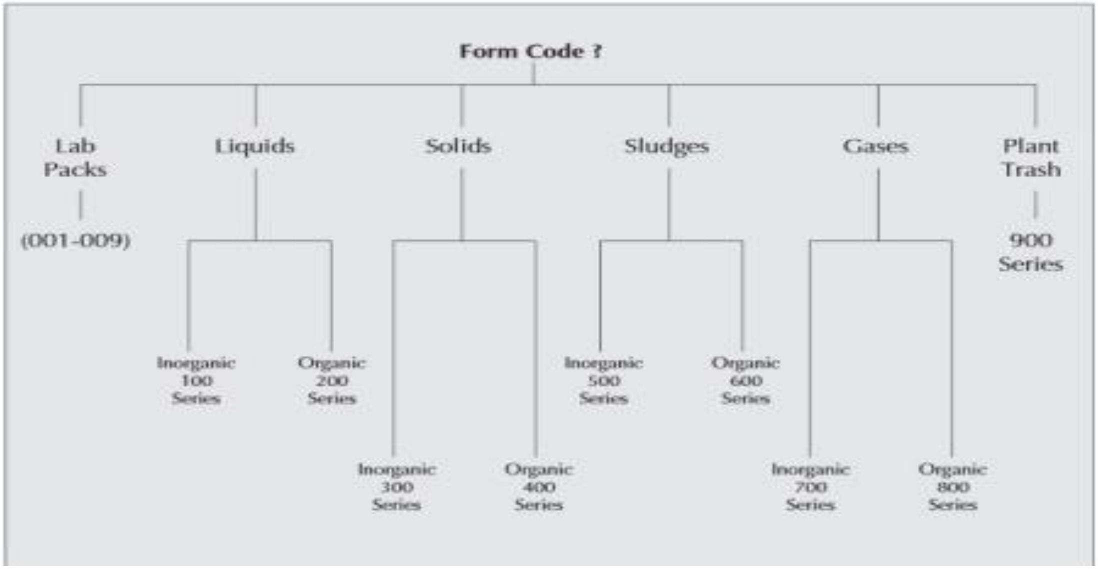

Figure 10 Texas Form Codes

(Texas Commission on Environmental, 2015)

Types of Hazardous Waste Found at Chemical Industries

Many types of hazardous waste are associated with the Chemical industry. During the research period, the researched chemical site disposed of approximately over 1900 pounds of hazardous waste annually and was classified as a Large Quantity Generator. This quantity was from many different onsite activities and the waste is transported and disposed of through incineration at disposal and treatment facilities. Clean Harbors is a disposal and treatment facility frequently used by the facility of interest. Figure 11 shows a photo of a Clean Harbors tanker connected with material that is ready to be unloaded for direct burning at the incinerator.

Figure 11 Tanker at Incinerator

(Photo taken by the author)

Identifying waste streams is important in setting goals for pollution prevention, classification, recordkeeping, shipment, and/or treatment. An optimized environmental system will assist in making the goals efficiently possible because all of the required information will be stored in the system and can be easily accessed. The hazardous wastes generated from the project's facility are listed in Figure 12.

The most prevalent hazardous waste that occurred during the researched period was aerosol cans from maintenance activities, contaminated soil from spills, and rinsate that occurred from an unusual tank cleaning event. The tank cleaning event was unusual because tank cleaning rinsate does not normally result in a hazardous liquid. It was determined that the tank cleaning solution was mixed improperly which resulted in a hazardous waste as the final product. Six tankers from Clean Harbors transported the rinsate waste to the incinerator for disposal.

Hazardous Waste Description	Sequence Number	Form Code	Texas Waste Code
Contaminated Organic Debris (wood, boom, sorbent pads, plastic hoses, rags)	0035	409	0035409H
Contaminated Inorganic Debris	0020	319	0020319H
Process Filters	0023	310	0023310H
Tank and Equipment Rinsate from equipment cleaning	0031	219	0031219H
Process Unit Separator Sludge	0008	609	0008609H
Process Wastewater containing Benzene	0009	102	0009102H
Benzene Contaminated Material (rags, sampling materials, etc.)	0011	409	0011409H
Contaminated Soil	0012	301	0012301H
Contaminated Refractory insulation and Organic Debris	0001	409	0001409H
Metals Contaminated Waste	0002	319	0002319H
Aluminum Chloride (equipment decommissioning)	0005	315	0005315H
Equipment Cleaning Residue (rust, scale, dirt)	0007	319	0007319H
Cylinders of Organic Gases	8002	801	8002801H
Lab Packs of Chemicals	8003	001	8003001H
Used Refrigerant Oils from equipment	8005	206	8005206H
Non-empty Aerosol Cans	8007	319	8007319H
Expired acid solutions	8010	113	8010113H
Equipment Degreasing Activities (trichloroethylene or tetrachlorothylene)	0004	202	0004202H
Spent Lead-acid Batteries	0006	309	0006309H
Tank Bottoms	0010	602	0010602H
Part Cleaning Solvents	0019	211	0019211H
Equipment Maintenance Waste Oil	0021	206H	0021206H

Figure 12 Hazardous Waste Description and Waste Codes

(Created by the author)

Types of Non-Hazardous Waste Found at Industrial Chemical Industries

Non-hazardous wastes are usually generated more routinely than hazardous wastes. Non-hazardous wastes are not listed wastes and do not exhibit hazardous characteristics; i.e., ignitability, reactivity, corrosivity, or toxicity. The facility used as a basis for this research generated over 118,000 pounds of class 1 nonhazardous waste and over 154,000 pounds of class 2 nonhazardous waste annually. The nonhazardous waste generated from the facility studied is listed in Figure 13.

Non Hazardous Waste Description	Sequence Number	Form Code	Texas Waste Code
Waste Ethylene Glycol Solution	1007	296	10072961
Sludge from Vessel Cleanout	1001	519	10015191
Friable and Nonfriable Asbestos Containing Material (insulation)	1002	311	10023111
Sludge from processing units	1005	609	10056091
Hydrocarbon Contaminated Materials	1010	409	10104091
Hydrocarbon Contaminated Soil/sediment	1011	301	10113011
Solvent Water Mixture	1021	201	10212011
Wood Debris (Hydrocarbon Contaminated)	1022	488	10224881
Oily Plant Trash	1026	319	10263191
Defective Capacitors	1027	397	10273971
Spent Catalyst	1032	393	10323931
PCB Transformers/Electrical Equipment	1033	496	10334961
Oil From PCB Transformer/Electrical Equipment	1034	297	10342971
Non asbestos Insulation	1035	319	10353191
Compressed Gas Cylinders	1036	801	10368011
Cooling Tower Sludge	1040	519	10405191
Rust and Scale from tank and equipment cleaning	1045	307	10453071
Rainfall Generated Stormwater	1046	119	10461191
Sandblasting Wastes	2001	389	20013892
Medical Wastes (syringes, bandages, etc.)	2005	409	20054092
Construction Debris (non asbestos)	2012	319	20123192
Refractory Insulation	2016	319	20163192
Soils Contaminated with Inorganic Wastes	2020	302	20203022
Storm Water System Equipment Cleanout	2026	512	20265122
Saltwater Filters	2027	310	20273102
Filter Clay from Maintenance Activities	2030	319	20303192

Figure 13 Non-Hazardous Waste Description and Waste Codes

(Created by the author)

These wastes are usually transported and disposed of through incineration, energy recovery for fuel usage, or by landfill or surface impoundments at disposal and treatment facilities. Figure 14 is an example of an onsite waste container filled with construction debris that would eventually be transported to a disposal site. Due to inadequate environmental systems, some waste containers, such as the one in Figure 14, became lost or overlooked at the facility studied. This presented noncompliance issues with environmental regulations and requirements. This also provided opportunities for pathway exposures to occur.

Figure 14 Waste Container Filled with Construction Debris
(Photo taken by the author)

Coastal Plains (Figure 15) is a non-hazardous landfill used by the facility used as a basis for this research and is located in Brazoria County. This landfill buries non-hazardous wastes and isolates it from the surrounding environment (rain, groundwater, and air). They are designed with a bottom liner and are covered with soil frequently.

Treating wastes in this manner results in decomposition (Texas Commission on Environmental Quality, 2006).

(a) 

(b) 

Figure 15 Coastal Plains Landfill

(Photos taken by the author)
(a) Coastal Plains Landfill Entrance
(b) Coastal Plains Landfill Active Site

CHAPTER III

WASTE MANAGEMENT AND DISPOSAL

All waste must me managed and disposed of properly. Improper management and disposal can result in environmental contamination through exposure pathways. In particular, the facility examined was located near highly populated residential areas. If a release occurs, there is a possibility of exposing the population. Leaking containers can result in leaching that can reach groundwater (LaGrega, Buckingham, & Evans, 2010). The population can also be exposed through inhalation or ingestion of contaminates. For example, contaminated runoff from the site can enter the Galveston bay where there are frequent occurrences of recreational and fishing activities.

Although non-hazardous wastes are considered less harmful to the environment or human health than hazardous wastes, landfills have a regulatory requirement to report this waste type. In addition non-hazardous waste still has an impact on the environment, human health, and wildlife. For example, discarded debris can become filled with water and act as a breeding ground for mosquitoes. There is also the issue of visible pollution which can remain in the environment for extended time periods.

The disposal of non-hazardous waste is outlined in Texas state regulation 30 TAC 335. It states that Class 1 wastes are special wastes and must be disposed of in an approved landfill. Class 2 wastes can be disposed of in any permitted municipal landfill. Class 3 wastes are inert and insoluble and can be disposed of at any permitted landfill as well (Texas Commission on Environmental Quality, 2015). The facility used as a basis for this research primarily had Class 1 and Class 2 non-hazardous waste.

Hazardous waste activities are regulated under Resource Conservation and Recovery Act (RCRA). RCRA governs hazardous waste management from the point of generation to the point of disposal. Generators of these type wastes are required to meet waste accumulation, manifesting, and recordkeeping standards. Some industrial facilities that treat, store, or dispose of hazardous waste must obtain a RCRA permit. The Code of Federal Regulations (CFR) under 40 CFR standards for the onsite management of wastes are:

- Large and Small Quantity Generator (Electronic Code of Federal Regulations, 2016):
    - Hazardous waste accumulation onsite time
    - Wastes containers must have secondary containment
    - Waste removal procedure outline
    - Recordkeeping requirements
    - Labeling requirements
    - Owner and/or operator requirements
    - Definition of large and small quantity generator
    - Spill control measures
    - Waste handling procedures
    - Emergency control measures (fire, explosion, etc.)

- Conditionally Exempt Small Quantity Generator (Code of Federal Regulations, 2012):
    - Definition of conditionally exempt small quantity generator
    - Waste quantity determinations
    - Treatment or disposal requirements

Waste Disposal Methods

There are many different types of disposal methods for wastes. The disposal method depends on the waste type and also the cost associated with the disposal method. Some methods include waste that is treated before being disposed of at another site. These methods include, but are not limited to:

Incineration

This waste management process consists of burning waste. Some negative impacts from burning wastes include, but is not limited to, toxic chemical production (dioxins), toxic byproducts (ash), contributions to global climate change (Global Alliance for Incinerator Alternatives, n.d.). The researched facility frequently uses Clean Harbors Environmental Services to incinerate wastes. Clean Harbors utilizes thermal treatment technologies (incineration) to treat liquid, solid, and gaseous hazardous wastes. Two train units are utilized in the incineration process. Train 1 has a permitted thermal capacity of 180 MMBTU/hr and includes a 3.6 meter diameter kiln as shown in Figure 16 (Whitaker, 2015).

Figure 16 Train 1 with 3.6 Meter Diameter Kiln

(Photo taken by the author)

Chemical reduction

This waste management process changes the chemical's characteristics. A hazardous contaminant will be converted to nonhazardous compounds (Remediation Technologies Screening Matrix and Reference Guide, Version 4.0, n.d.).

Cyanide destruction

The idea of this waste management process is to use oxidation to decrease the cyanide toxicity. Cyanide has 3 classifications. The cyanide classes include total cyanides, weak acid dissociable cyanide (WAD), and free cyanide. It is important to determine the treatment system required to address toxicity needs based on operations (Botz, 1999).

Chemical oxidation

The idea of this waste management process is to produce a chemical reaction that involves electron transfer. The oxidized substance loses the electron (Vancleave, 2011).

Wet air oxidation

This waste management process is typically used to treat hazardous, toxic, and nonbiodegradable waste streams. Wet air oxidation occurs at high temperatures (125 – 320 degrees Celsius) and also high pressures (0.5 – 20 MPa) (Vedprakash, Vijaykumar, & Jyeshtharaj, 1995).

Other waste management methods include disposal and offsite waste transfers that are land base associated. These waste management types include, but are not limited to:

Land Disposal

This waste management method consists of placing waste on or in land that is designed to prevent harmful or toxic pollutants from being released into the environment. Examples of land treatment includes landfills, surface impoundments, waste piles, or injection wells.

Landfills

Solid/Hazardous waste can be deposited into these areas and covered. EPA sets certain design standards for land based units in 40 CFR Parts 264/265, Subpart N.

Surface Impoundments

These are natural depressions or low lying areas, man-made or diked areas used for liquid hazardous wastes. Examples of surface impounds include aeration pits, ponds, and/or lagoons. EPA sets certain standards for surface impounds designs in 40 CFR Parts 264/265, Subpart.

Waste piles

These waste management units are used only for temporary storage of non-liquid wastes. These piles are open to the atmosphere and uncontained but must be placed on a double liner to prevent groundwater or other surface contamination. EPA sets certain standards for waste piles in 40 CFR Parts 254/265, Subpart L.

Injection wells

There are several types of injection wells that include Class 1 – industrial and municipal waste disposal wells, Class II-Oil and gas related wells, Class IV – Shallow Hazardous and Radioactive Injection Wells, Class V – Shallow Non-hazardous injection wells, and Class VI – Geological Sequestration wells. EPA sets standards for injection wells in 40 CFR Part 261 Subpart X – Miscellaneous Units (United States Environmental Protection Agency, 2005).

Sewer discharge

This waste management unit collects sanitary wastes and conveys the discharge to a treatment facility before it is discharged into surface water or reused (United States Environmental Protection Agency, 2016).

Recycling

Recycling wastes can help to save money, energy, and resources. Benefits realized from recycling paper include new paper production, saving trees, and saving many other natural resources. In total, paper wastes results in over half of the recycled materials collected in the United States. Papermaking materials in the United States comes from three sources that include 33 % recycled paper, 33 % trees and plants, and 33% wood chips and sawmill scraps. Over 5,000 products can be made from recycled paper, that include but are not limited to, masking tape, money, globes, bandages, dust masks, hospital gowns, coffee filters, lamp shades, car insulation, animal bedding, planting post for seedlings, and egg cartons. Some of the items that are recycled in the chemical plant researched include paper, plastic, glass, used oil, metals, and batteries.

Plastics play an important role in our daily activities. Because plastics play such a huge role in almost every aspect of human daily activities, it is imperative that disposal is managed properly. For this facility, plastics are found in soft drink bottles, lids, trash bags, cups, plates, utensils, onsite maintenance activity items or products, and medical supplies to name a few. Although all plastic is recyclable, only no 1. and no.2 plastics are allowed for recycling at the chemical plant of interest. This is because the servicing company used, Republic, only accepted this type from chemical plants. The recycling process for plastics at Republic consists of sorting by plastic type, baling, and transportation to a reclamation site where the plastic is washed and ground into small flakes. Once the small flakes are dried, they can then be transformed into new products.

Glass can be recycled to form many different products that range from bottles to kitchen tiles, counter tops, wall insulation, and more. Glass is made of sand, soda ash, limestone, and recycled glass. Although glass is recyclable, the facility did not recycle glass as part of the existing recycling program.

Batteries are another item recycled at the chemical plant investigated and are used as a portable and versatile power sources to make daily needs more convenient. Batteries are made up of mercury, lead, cadmium, and nickel. These components can easily contaminate the environmental if not properly managed. The United States Environmental Protection Agency (EPA) has established batteries as Universal Wastes. Universal wastes are wastes that are commonly generated in everyday activities. The Universal Waste program was created to streamline the hazardous waste management program. Most of the lead acid batteries, which contain sixty to eighty percent recycled lead and plastic, are recycled by a manufacturer of lead acid batteries. For the chemical plant studied, lead acid batteries used to power industrial equipment, emergency lighting, and alarm systems were sent for recycling at Clean Harbors. However, dry-cell batteries (rechargeable batteries) were mailed for recycling through the "Green Box" program. The dry cell batteries include alkaline, carbon zinc, mercuric oxide, silver oxide, zinc in air, and lithium batteries. For the chemical plant used in this research, a large amount of batteries were generated in the office setting as well as in operations. Boxes (Figure 17) were placed throughout the plant to store drycell batteries until the box becomes full and then they were mailed to the recycler.

Figure 17 Green Box

(Photo taken by author)

There were two options for placing batteries into the boxes that included placing individual batteries into a fully enclosed, nonconductive, clear plastic bag or placing tape over the ends of the batteries. These options (Figure 18) prevent the occurrence of fires, production of flammable gases on contact with water, ignition on contact with water or moist air, and the production of runoff that may create fire or explosion hazards (United States Environmental Protection Agency, 2016). For the chemical plant of interest, an optimized environmental system can track the weight of recycled batteries so that the information can be used for reports such as the Pollution Prevention Report.

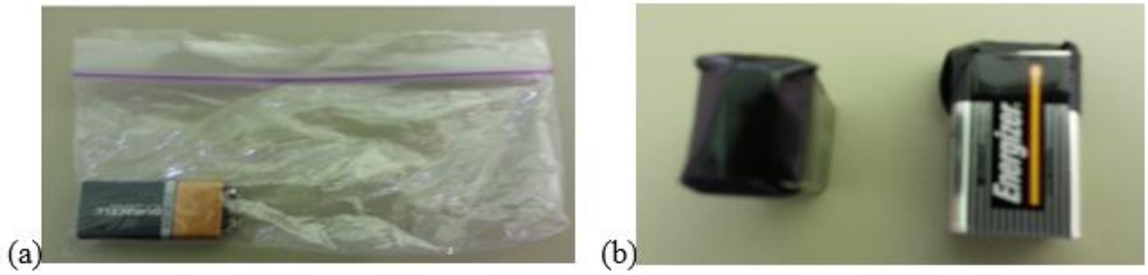

Figure 18 Recycled Battery Options for the "Green Box" Program

(Photos taken by the author)
(a) Battery Enclosed in Ziplock Bag
(b) Battery with Taped Ends

Metals have many useful properties, some of which include, providing a structure for buildings, rails for train chassis for automobiles, and containers for liquids. Metals also have chemical properties that include catalysts for chemical reactions, glass additives, battery electrodes, etc. Scrap metal occurs in the chemical industry due to onsite activities. These metals are recycled constantly. Industries and scrap metal dealers work together to recycle these metals (Wernick & Themelis, 1998). For the chemical plant investigated, the scrap metal was separated by type and transported to the Derichebourg Recycling Center in Houston, Texas.

Many waste servicing companies exist in the United States that provide recycling services for used oil. EPA believes that oil that has become contaminated with hazardous waste requires disposal and cannot be recycled (Federal Register, 1992). EPA also has three criteria for defining oil as used oil which include origin, use, and contamination. The origin of used oil must be from crude oil or made from synthetic materials. For use, oils used as lubricants, hydraulic fluid, and heat transfer fluid are all considered used oil. For contamination, for oil to be considered used oil, it must be contaminated as a result of being used (Legal Information Institute, 1998). However, at the facility used as a basis for this research, used oil that was assumed to have become contaminated with dirt, metal scrapings. It was also assumed that it was not mixed with any hazardous substance. Still, it was collected, stored properly, and tested onsite by Intergulf to make a final determination on hazardous or non-hazardous classification. If the oil resulted in a non-hazardous classification, it was accepted and transported by Intergulf to their recycling center. Intergulf is a registered used oil recycler with the Texas Commission on Environmental Quality and provides a way to recycle used oil that includes recycling used oils, oil filters, antifreeze, and absorbents (Intergulf Corporation, 2014).

It is important to manage used oil properly because just one quart can pollute gallons of water. It is also a major source of contamination of waterways and results in pollution of drinking water exposure pathways. This is why EPA has strict guidelines set for managing and storing used oil. Used oil is required to be stored in specific containers and the containers must be in good condition with no severe rusting, apparent structural defects or deterioration, and no leaking (Legal Information Institute, 1998). An optimized environmental system can insure that these requirements are met.

CHAPTER IV

PORTABLE BULK CONTAINERS

Portable bulk tanks are used in the chemical industrial setting to transport or store hazardous waste, non-hazardous waste, and recycled wastes streams. Wastes are temporarily stored in portable containers before it goes to treatment or disposal. Portable bulk containers are common in industrial settings and are also inexpensive and easy to manage, with appropriate attention to details. Portable container management allows for usage as storage, transportation, and disposal. Portable containers are regulated under the Resource Conservation and Recovery Act (RCRA).

Container management

The Resource Conservation and Recovery Act (RCRA) requires that the waste containers are closed and stored properly. A property line buffer zone of at least fifteen feet is required for waste that exhibit the ignitability reactive characteristics.

Inspections

The Resource Conservation and Recovery Act (RCRA) requires that container storage areas are inspected weekly for leaks and container deterioration. Certain information is required for maintaining proper recordkeeping of the weekly inspections and these records must be kept on file for at least three years. Some of the information includes, but is not limited to, the following:

- Date of the inspection
- Time of the inspection
- Name of the inspector
- Observations made
- Container condition
    - Waste type contained in the container
    - Container label condition
    - Container placement

Container design requirements

The waste contained in the portable container must be compatible with the container and the container is required by the Resource and Recovery Act to be placed in a containment area to safeguard against spills leaching into the ground. The container condition must be such that it is considered to be in good condition. Good condition represents a container that is not cracked, rusted, or leaking. Compatibility of a waste in a portable container means that the waste is suitable for the container in that it will not cause corrosion and decay or will not cause heat, pressure, fire, explosions, reactions, toxic dusts, mists, fumes, etc. when commingled.

Portable container secondary containment

Portable bulk container secondary containment is defined as a system that prevents wastes from releasing into the ground due to failure of primary containment. Instead, if a release occurs, the stream is drained into a sump, tank, or other container. Some examples of secondary containment include poured concrete pads or impervious bases. Some requirements of secondary containment include (United States Environmental Protection Agency, 2005):

- Sloped base so that releases are easily drained or removed
- Must be able to hold 10 percent of container volume
- Must not permit any storm water

Container Types and Specifications

Many different types of bulk containers are needed across an industrial site to store, contain, and transport wastes. The type of wastes dictates the type of container that can be used. Also the amount of waste is also a factor. One will need to determine the amount of waste that needs to be disposed or transported in order to determine the waste container size and or type. Some types of bulk containers for waste include roll-off containers, vacuum boxes, and "frac" tanks.

Roll-off containers are transported by trucks. Many different roll-off container sizes are available. These sizes include 20 yard, 25 yard, 30 yard, and 40 yard. These containers can have different types of covers including canvas tarps and hard types. Roll-off containers were primarily used for non-hazardous (class 1 and class 2) as well as hazardous wastes at the facility used as a basis for this research. An example of the non-hazardous waste in the roll-off container is construction debris. An example of hazardous waste in the roll-off container is contaminated dirt. This container type is not used for liquids and requires weekly inspections.

Vacuum box containers are designed to be transported by trucks. A size frequently used by industrial sites is the 25 yard box. These boxes are used for transporting liquids and sludge from industrial sites. Vacuum boxes can be used for non-hazardous (class 1 and class 2) as well as hazardous wastes at the facility of interest. However, this box was primarily used for semisolids such as sludge (hazardous and non-hazardous) from tank cleanout activities at this study area. This box requires weekly inspections.

Frac tanks are frequently used at chemical sites to hold water or other liquids such as sludge. It is frequently used for waste disposal in industrial chemical plant settings. This container is not designed to be transported by a truck. It is designed to be transported by a tractor that has the appropriate attachments such as a fifth wheel. Frac tanks can be used for non-hazardous (class 1 and class 2) as well as hazardous liquids. However, in conformance with internal policy, this box was primarily used for non-hazardous liquids at the facility studied. It is unknown if certain events caused this internal policy. An example of the non-hazardous liquid that was used is water used for tank hydrotesting. This box requires weekly inspections.

CHAPTER V

TRANSPORTATION/SHIPPING DOCUMENTATION

Manifests

The United States Environmental Protection Agency (USEPA), United States Department of Transportation (USDOT), along with state agencies regulate waste transportation and shipment.

The United States Environmental Protection Agency waste transportation, handling, and management regulations are found under 40 Code of Federal Regulations Part 263. The regulations govern the manner of how to protect the environment as well as human health when wastes are transported. The United States Environmental Protection Agency adopted the waste transportation regulations, and it was established by the United States Department of Transportation. Manifests are shipping documents that make up a major part of waste transportation. The manifest is a document that identifies all wastes contained in a shipment along with other important pieces of information associated with a waste shipment. Compliance with waste transportation regulations includes, but is not limited to, the following (Electronic Code of Federal Regulations, 2016):

- Generator must get an identification number that is obtained from the Environmental Protection Agency.
- Generator must have properly completed manifests for every shipment.

- Generator manifest must bear the signature of a Department of Transportation Certificate.
- Generator must maintain copies of manifests for a minimum period of three years onsite.

At the researched facility, the manifests are kept in a filing cabinet. These documents are not contained in any type of environmental management system. There have been a few occasions where a manifest has been lost. In these instances, the waste transporting company was contacted for a copy of the lost manifest. Since these documents are required to be maintained for a period of three years onsite, the paper documents become overwhelming to sort and verify. If these documents were contained in an optimized environmental system, the potential for non-compliance issues would be greatly reduced.

CHAPTER VI

PROBLEM STATEMENT AND HYPOTHESIS

Problem Statement

An environmental engineer frequently uses environmental management systems to store environmental data that is important to the operational and regulatory functions of industries as well as governmental agencies. In order to reach optimal performance for sustainable environmental compliance, it is important to have environmental management systems that have the capability to automatically and systematically produce efficient environmental information or data summaries that are properly analyzed. An optimized system has short-term and long-term benefits. Arguments for optimizing the environmental system include the benefit of maintaining adequate recording keeping and regulatory compliance, decreasing the possibility of contamination and improper waste disposal, and decreasing manpower and costs associated with environmental compliance.

An optimized environmental system can serve as a tool to produce internal daily and monthly reports as well as annual reports. In the chemical industry, reports commonly needed include: Toxic Release Inventory Reports, Pollution Prevention Reports, Annual Waste Summaries, Weekly Waste Inspections, and Manifests. The Toxic Release inventory reports are submitted to the government to provide information on environmental pollution sources onsite that emit chemicals that may be a threat to human health and the environment. This report also contains the amount of specific chemicals that are emitted, stored, recycled, or transported offsite (United States Environmental Protection Agency, 2016). The Pollution Prevention Reports are also electronically submitted to the government. These reports are required to indicate waste minimization processes or activities onsite. Recycling in the chemical industry plays a huge role in minimizing pollution and is often highlighted in these reports. Similarly, the Annual Waste Summary is submitted to the government's regulatory agency. It provides information on the amount of hazardous and Class 1 waste managed each year along with the generation source (Texas Commission on Environmental Quality, 2016).

Weekly Waste Inspections are required under the Resource Conservation and Recovery Act (RCRA) guidelines. These data provide a record of facility inspections and ensure compliance with facility supervision and integrity requirements. This proof of inspections must be maintained onsite for at least three years in accordance to Code of Federal Regulations, Title 40, Chapter I, Subchapter D Recordkeeping and Reporting, Part 262.40(a) (Institute of Legal Information, 1980). These inspections are necessary to monitor and record all solid waste generated onsite, the conditions of waste containers, and the type of waste contained or stored. These inspection reports also monitor the timeline for waste generation and storage onsite. For example, RCRA guidelines state that a large quantity generator can only store hazardous waste for up to 90 days without interim status (McCoy, 2013). Manifests are another type of document that is important to waste management. This document is required under RCRA guidelines, CFR 262.20. These regulations insure the proper transport, disposal, and treatment of solid wastes (McCoy, 2013).

Unauthorized dumping of solid waste can be dangerous to the environment and thus human health. Regulations (RCRA) prevent contamination through exposure pathways. For example, many industrial or chemicals sites are located near populated areas. If a release occurs at these sites, there is a possibility for the nearby population to be exposed to contaminates. The release can cause air, soil, or groundwater contamination. Improper waste management can cause leaching, that results from leaking containers, which eventually reaches the groundwater. This contaminated groundwater can make its way into homes or businesses. The surrounding population can be exposed through ingestion or inhalation. Additionally, the contaminants could reach recreational, agricultural, and fishing areas (LaGrega, Buckingham, & Evans, 2010).

Noncompliance penalties are enforced by the United States Environmental Protection Agency along with state environmental regulatory agencies. These governmental entities provide strict guidelines for compliance with environmental regulations and noncompliance can result in penalties and fines. For example, Subtitle C of RCRA established guidelines to manage Solid and Hazardous wastes from "cradle to grave" and mandates annual compliance inspections, civil and criminal enforcement actions for noncompliance, and assists entities with establishing waste management programs. The compliance inspections involve the review of records and inspection reports which give incite to how wastes are managed at a particular site. RCRA Subtitle C also gives the United States Environmental Protection Agency the authority to copy records at any given date or time. If a violation is found, the United States Environmental Agency has the authority to issue a warning, criminal investigation, or civil penalty. Civil penalties are applicable to any person or entity that has violated RCRA Subtitle C and the penalty amount can reach up to $37,500 per violation and can be assessed for each day the violation occurs (United States Environmental Protection Agency, 2016).

Based on knowledge of regulatory requirements as well as experience as an environmental engineer, it was evident to the author that the environmental system at the facility used as a basis for this research must be optimized to a capacity that allows for maximum recordkeeping, tracking, and compliance. The chemical plant researched had recently been substantially downsized. Also, the environmental system in place was not adequate to maintain environmental compliance. Some of the issues that occurred as a result of an inadequate environmental system included misplaced or lost waste containers, storage time exceedances, improper recordkeeping, omitted inspections, unidentified onsite material, and overall inadequate waste management. .

In order to get and maintain the environmental management system, a license must be maintained at an annual cost of $8,500.00 per year. Other costs associated with operating the system at this facility studied included three Panasonic Toughpads® for $3,700.00 each, a laptop at $500.00, and an internet service plan for $35.00 per month. The total cost to operate the system for the first year is $20,520.00, however, subsequent annual operating costs is only the cost of the annual license fee of $8,500.00 plus the Toughpads® internet service for conducting weekly inspections at $35.00 per month or $420.00 per year.

Since the penalty amount can reach up to $37,500 for each violation and can be accessed each day the violation occurs, the benefit of paying the cost of the system heavily outweighs the costs associated with noncompliance of regulatory requirements. Specifically, when considering the initial cost of obtaining and using the system, the cost is only $20,520.00 or 55% less than just a one day violation for only one violation of improper waste management. During the research period, the inadequate recordkeeping and container tracking resulted in 14 lost or misplaced containers that exceeded storage accumulation times. This also caused omitted inspections required by the state and federal agencies. At an accessed penalty of $37,500 per day, the penalty amount for these containers could have reached $525,000 per day for each violation. In this case there were multiple violations that included storage time exceedances and omitted inspections.

Thousands of pounds of waste were being generated and transported each year, and the system was not able to track the data. This issue also made it impossible to comply with internal procedures and policies. The cost associated with these rented lost containers is approximately $100.00 per week. However, this figure does not include transportation costs, liner costs, disposal costs, and initial delivery costs which total a minimum of $500 for each container (R. Lira, personal communication, July 27, 2016).

Other issues resulted when management could not easily determine the amount of wastes that were generated and transported offsite. Weekly inspections posed another issue because they were being conducted using paper checklists. These inspections have to be completed within seven days in order to meet regulatory requirements. However, it was difficult to determine exactly when these were completed because they were usually submitted at a later date than the actual inspection date. In many instances, these documents were lost or misplaced causing noncompliance issues with recordkeeping along with improper waste management.

The chemical industry researched contained three waste management units. These waste management units were locations for wastes generated onsite. Two of the units are located near waterways that eventually lead to the Galveston Bay. Improper waste management in these areas could lead to contamination of the waterway leading to the Galveston Bay.

Another area of concern for the researched chemical industry was the offsite laboratory. In instances where lost or unidentifiable solid waste material was found, it could take days to obtain results needed to make a determination on the waste type. Without a determination on the waste type, the storage time is unknown as well. Some additional specific problems encountered included inadequate sample turnaround times, inadequate sample pick-up times, inadequate onsite sample training, and inadequate communication.

This research will show how an optimized, automated environmental management system called RegAction, can maintain compliance, decrease manpower, decrease costs, and also decrease the possibility of contamination and improper waste disposal.

The facility site initially included a chemical plant and a refinery located in Texas City, Texas. The environmental department was located at the refinery and was composed of about 40 environmental employees. These employees were responsible for insuring that the refinery as well as the chemical plant maintained compliance with state and federal environmental regulations. In March 2015, an explosion occurred and killed fifteen people and injured 180 others. The company was fined $84.6 million for violations that caused the explosion. In addition, the company paid $50 million to the

United States Justice Department for federal environmental law violations. Two billion dollars was also paid to settle law suits.

In February 2015, the refinery part of the site was sold to another company. Later the new owner filed a lawsuit because it was determined that the 460,000 barrel-per-day refinery had numerous environmental problems and was found to be in noncompliance with environmental laws and regulations (Reuters, 2016).

The remaining chemical plant area eventually established its own environmental department to include only four employees. Three of these employees were brought over from the refinery. The culture of the site was not environmentally friendly. Compliance was important but not being achieved and failing to comply was due to the culture. Environmental records were not easily found and in many cases were non-existent. A high employee turnover rate due to a bad culture and unsafe working conditions led to a failing environmental system that needed a complete overhaul. Inefficiencies resulted throughout the environmental department; however the author focused on waste management.

The author wanted to improve data collection in order to remain in compliance with state and federal regulations. The existing system did not have interface, and was extremely paper driven with enough paper to fill two 40 foot long waste containers. The author's goal was to insure that data was input properly into the system and to make environmental processes systematic and efficient. This was important because in addition to cultural problems, the site generated a large amount of waste onsite at over 2200 pounds per month. During the period of research, it was normal for the site to generate hundreds of containers of wastes. Since the author was single handedly charged with waste management as one responsibility, it was necessary to make environmental processes systematic and efficient in order to comply with state and federal regulations. The author realized a need to create a compliance based system as an automated management tool to provide monitoring opportunities.

Hypothesis

Waste management issues were evident from the authors experience working as an environmental engineer at the chemical plant researched. In addition, the author reviewed published documents by the USEPA that provided explanations on the definition of an environmental system. The document explained the potential benefits of an environmental system that consist of improved compliance, environmental performance, and pollution prevention (United States Environmental Protection Agency, 2016).

Another published document by the United states Protection Agency was a study on the effects of implementing and optimizing environmental management systems. The study was focused on the effects of implementing and optimizing an environmental management system. The expected results were decreased pollution, reduced energy consumption and costs, and also decreased waste generation ((United States Environmental Protection Agency, 2016). The Texas Commission on Environmental Quality produced another publication on the benefits of an effective environmental system. Some of the benefits include pollution prevention, continuous improvement of environmental performance, streamlining operations, improving internal communications, enhancing employee morale, using material more efficiently, improving environmental compliance, and reducing costs (Texas Commission on Environmental Quality, 2011).

During the period of research, fourteen containers where lost and untracked. This led to exceedances of accumulation or storage times and omitted weekly inspections, which resulted in inadequate recordkeeping. Based on regulations stated in the Resource Conservation and Recovery Act, the penalties assessed for these violations could reach $525,000 per day for each violation. These onsite violations made it clear that in order to maintain adequate recordkeeping and environmental compliance decrease the possibility of facility and environmental contamination reduce the potential for improper waste disposal, but still decrease manpower required for waste management and the costs associated with environmental compliance, the environmental system needed to be optimized. When examining the proximity of the chemical plant to residential areas (Figure 19), it was evident that waste should be properly managed to prevent the nearby population from contamination exposure caused by releases or spills.

Figure 19 A Residential Area Less Than 1 Mile for the Chemical Plant Area
(Photo taken by author)

The facility this research is based on had experienced downsizing and the environmental system that was in place was not adequate to maintain environmental compliance. This resulted in violations of RCRA Subtitle C and also made it impossible to comply with internal procedures and policies. Other issues resulted when it became difficult to determine the amount of wastes that were generated and transported. The use of paper checklist to conduct weekly inspections posed additional problems. These inspections are required to be completed within seven days in order to meet regulatory requirements but it was difficult to determine the completion dates. This resulted primarily because the operations personnel submitted the paper checklists at a later date than the actual inspection date. In some cases, these documents were lost or misplaced causing noncompliance issues with recordkeeping along with improper waste management.

The chemical plant of interest used an offsite laboratory that was another area of concern. There were some instances that occurred where it took many days to obtain analytical results needed to make a waste determination. Other laboratory problems included inadequate sample turnaround times, inadequate sample pick-up times, inadequate onsite sample training, and inadequate communication.

It was hypothesized that an optimized environmental management system can mitigate the noncompliance issues associated with waste management. This system should provide:

- Accurate recording of data about the nature of the waste
- Access to allow monitoring of storage time
- A decrease in communication time
- A decrease in container arrival times
- A decrease in waste management costs
- Allow for improved environmental compliance

It was also decided that an enhancement for this environmental management system would be to make it accessible to the internet. This would help to optimize the management process by expediting data input, improving access to the data from all locations of the facility rather than just the compliance office, allow utilization of the waste data to depict compliance and problems, and facilitate anticipation of problems.

The hypothesis will be tested by evaluating the system's ability to order and track container onsite arrival times, record storage, RCRA compliance and its capacity to graphically facilitate decisions by the management team. Feedback from operations personnel will be considered in the improvement and effectiveness of the system. This type of feedback is also important to determine if there will be continued use of the system once it is deployed as the foundation of an effective system by the operations personnel who will have to use it on a daily basis. Final validation of the management system will focus on an evaluation of violations and penalties that occur for noncompliance of regulatory requirements associated with waste management.

Since the criteria used for determining optimization included regulatory compliance and noncompliance penalties, internal communication time, onsite storage accumulation time exceedances, recordkeeping efficiency, number of lost waste containers, and time needed to make waste classifications, the project activity took over one year. The initial phase of the scope of work included the determination of the project budget, affected personnel, meeting with RegAction and Panasonic representatives, and making modifications to the system. The second phase included training personnel to use the system, meeting with affected personnel such as operations, security, safety, and environmental. The last phase of the project included evaluating the results to determine if the systems would allow for optimal environmental compliance.

CHAPTER VII

RESULTS

Waste Module

The environmental management system was optimized by modifying and expanding the waste module within the company's data management system, called RegAction©. The results of optimizing the system were quantified and documented based on the author's experiences, feedback from management and operations personnel, and reviewing response times included noting the actual arrival times of the containers against the requested arrival times. Other optimized results were documented by assessing the occurrences of lost inspection reports and containers storage time exceedances resulting in noncompliance with TCEQ regulations and penalties resulting from state and federal audits.

Waste inspection forms, process knowledge documents, and waste container forms were created to optimize the environmental system. The waste inspections forms were created to maintain compliance with state and federal environmental regulations by eliminating a paper driven system for automating recordkeeping and preventing the occurrence of contamination through pathway exposure. The waste container forms were created to prevent lost containers, increase container tracking, decrease container ordering time, and to further prevent the risk of contamination through pathway exposure. These forms also included uploading capabilities to show container locations.

The forms were accessed by operations through a Panasonic Toughpad® tablet. Computer programs were written to create the waste inspection forms in a digital format supported by the tablet. This allowed written inputs for data (e.g., waste generation times, accumulation times, and container condition, etc.) to be digitally input quickly. This increased accuracy of reports and allowed immediate data sharing. It also allowed the forms to interface in a way to coordinate data management.

For the inspection and waste container forms, meetings were held with RegAction representatives and onsite employees. The first meeting was held to discuss the goals and benefits of the environmental system modification and to get feedback. The reviews on the system were mixed. Some employees were hesitant, some were excited, and some were not interested in using the system at all. Upper management seemed to have a wait and see attitude because it had never been done before. The employees that were hesitant thought that it would just add more work to their already busy schedule. However, interested employees were trained over a period of approximately one month and the program was implemented.

After about six months, more employees from operations wanted to use the system because they saw its efficiency. These employees were also able to see how it saved them money because of container tracking, so they were willing to learn more about the system. Management saw the benefits and became more supportive of the program being implemented and further motivated operations staff to use the new system.

A learning curve was taken into consideration when developing the system and operations employees were given access to only a certain part of the system, depending on the designated use. In addition, many employees that needed to use the system had been working at the site for over twenty years and did not feel comfortable using new technology or changing the traditional way of doing things. However, even though they initially said they would not use the system, when they saw the benefits and embraced the system fully, occasionally asked other employees for help using the system to ensure they were doing things correctly.

Operations personnel were instructed to log into the environmental management system and complete a form within the waste module for ordering waste containers (Figure 20). Once completed, this form arrived as an instant notification in the environmental engineer's email box.

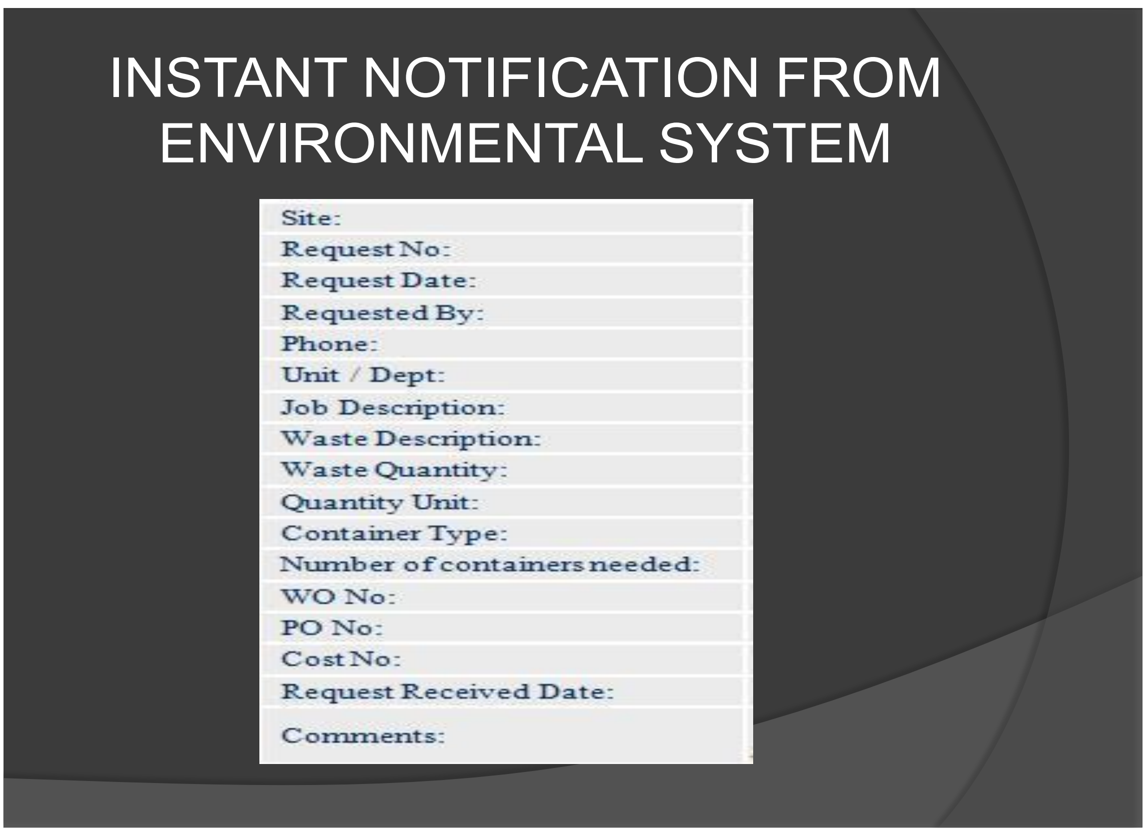

Figure 20 Environmental Management System Waste Instant Notification (RegAction Inc., 2014)

The waste module was modified and implemented and there were several positive responses. As a result of optimizing the environmental system, bulk waste containers are arriving onsite on time and the communication between personnel has drastically improved by fifty percent. Additionally, the engineer can make an early determination on the type of manifests that may be needed. This allows the engineer to prepare manifests/shipping documents in advance.

Research was conducted to determine the impact of developing and optimizing the system by analyzing box arrival times, communicating with operations personnel, and reviewing data within the environmental system. Before the system modification, the arrival times reached up to two (2) weeks and the requests were not easily tracked which resulted in lost containers. Communication with operations personnel occurred on a daily basis, several times per day. The usual conversation consisted of placing orders for new waste containers, asking about containers that had not arrived yet, and if the containers had arrived onsite then there was a conversation about the location of the container. Inadequate recordkeeping resulted in confusion and several other calls to servicing companies to track containers that were thought to have been ordered. Even though waste container orders had been placed through phone calls, since there was not a record stating this, often times the servicing companies would not have a record either. This resulted in reordering waste containers and delays in waste shipments. Figure 21 provides a snapshot of the results obtained from modifying, implementing, and optimizing the environmental system. With the new system, arrival times occurred on the requested date and containers were easily tracked. This promoted compliance because the containers were never lost.

Response Time

Container Request Date From Environmental Management System	Request Date Accepted by the Environmental Engineer	Request Delivery Notification Sent to Servicing Company	Initial Date of Container Request (Arrival Time Request)	Container Onsite Delivery Date
6/19/2013	6/19/2013	6/19/2013	6/20/2013	6/20/2013
6/28/2013	6/28/2013	6/28/2013	7/1/2013	7/1/2013
6/28/2013	6/28/2013	6/28/2013	7/1/2013	7/1/2013
6/28/2013	6/28/2013	6/28/2013	7/15/2013	7/15/2013
7/8/2013	7/8/2013	7/8/2013	7/9/2013	7/9/2013
7/31/2013	7/31/2013	7/31/2013	8/2/2013	8/2/2013
9/5/2013	9/5/2013	9/5/2013	9/9/2013	9/9/2013
9/10/2013	9/10/2013	9/10/2013	9/12/2013	9/12/2013
10/28/2013	10/28/2013	10/28/2013	10/30/2013	10/30/2013
12/20/2013	12/20/2013	12/20/2013	12/24/2013	12/24/2013
1/15/2014	1/15/2014	1/15/2014	1/15/2014	1/15/2014

Figure 21 Container Response Time

(Created by the author)

The response times were examined during the research period. The container orders were reviewed by the engineer on the same date that operations made the waste container request. In addition, the delivery times reached 100 percent efficiency by arriving at the site at all requested times.

Several other positive effects resulted from optimizing the waste module of the environmental system. These results included, but where not limited to, the following:

- The system was easy for personnel to use and this resulted in continued onsite usage.
- The containers arrived on time providing for an increased response time.
- Communication time decreased by over 50%.
- Improved efficiency and policy conformance.
- Promoted environmental compliance.
- Improved recordkeeping for container tracking.
- Resulted in cost decreases associated with waste containers.

Graphing

The environmental management system was optimized by developing and implementing graphing capabilities as shown in Figures 22 and 23. Several meetings were held with environmental management and RegAction representatives to determine the type of graphs that would be most beneficial. After the graph types were selected, information technologist from RegAction worked with the author to create a computer program to produce the graphs. The initial design of the graphing programs had to be modified because the initial output did not have the structural desired. Modifications to improve display of waste codes were made. The system was expanded to produce yearly graphs that allowed efficiency comparisons.

After a process of design and testing, the author and the software design team achieved the desired outcome and the graphs could be produced instantly with only the selection of waste type, waste codes, or year. The system also had the capability to produce yearly comparison graphs instantly. Upper management could therefore view graphs quickly to get information on waste shipments for a specified time period and observe costs and saving information.

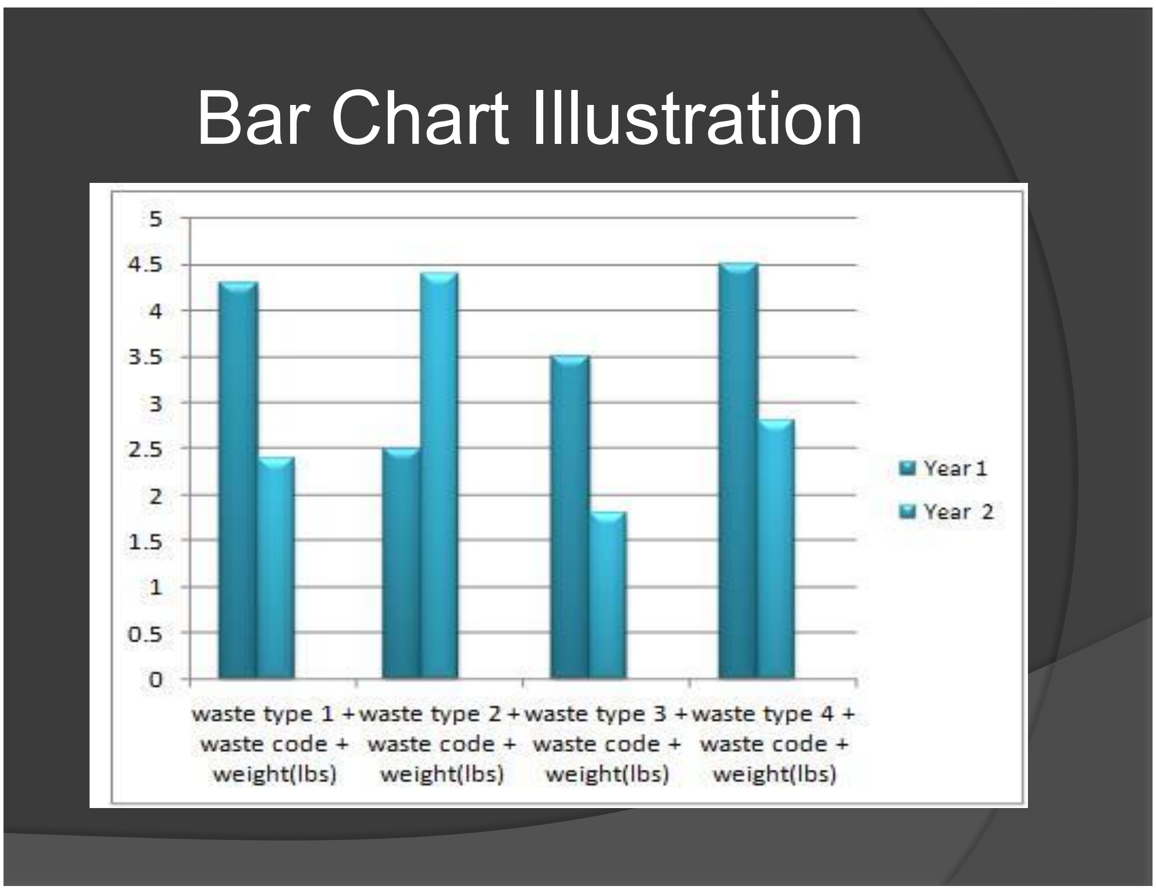

Figure 22 Illustration of Bar Chart Produced by Optimizing the Environmental System (RegAction, Inc., 2014)

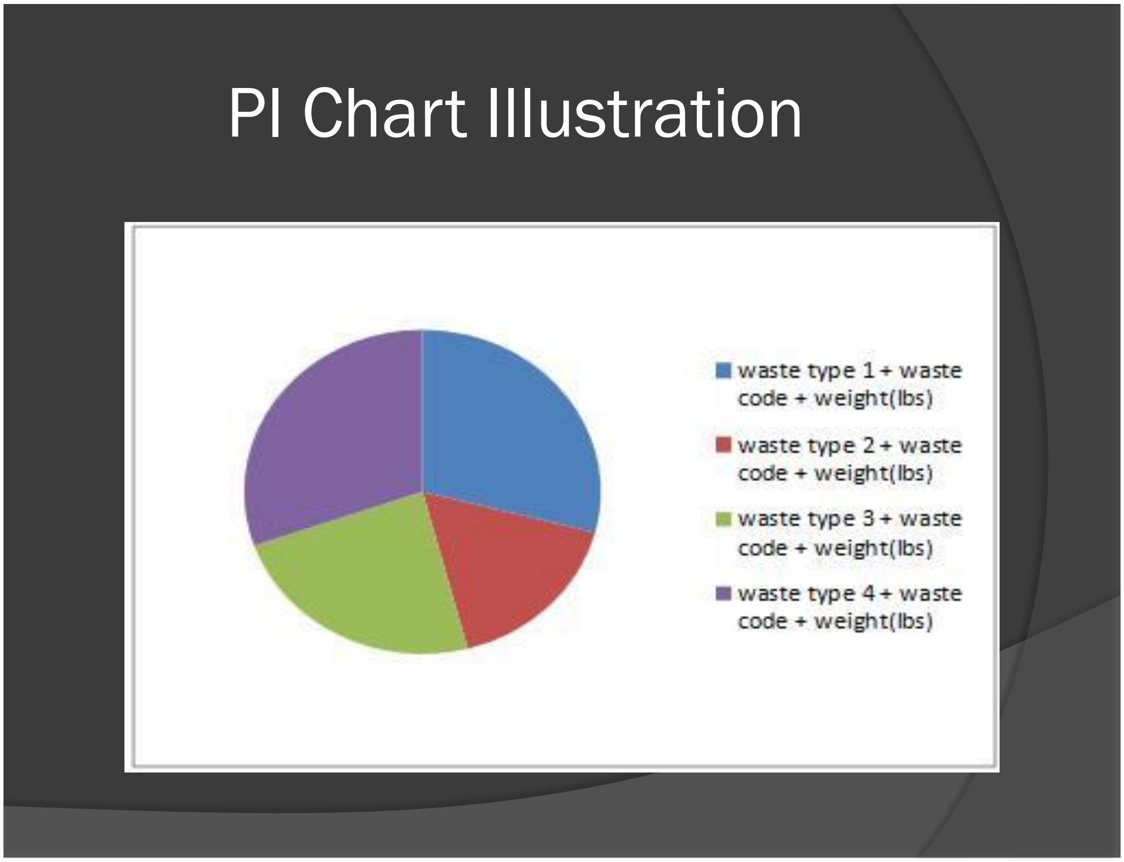

Figure 23 Illustration of Pie Chart Produced by Optimizing the Environmental System (RegAction, Inc., 2014)

Another result of the system as designed by the author and software design team was the facility environmental engineer does not need to spend very much time extracting data to put into excel spreadsheets to produce graphs. Rather, this can be done quickly by make a few selections in the graphing chart section within the environmental system to produce graphs instantly. This process is overall more efficient because it also decreases the chance of errors when putting data into the excel spreadsheet. To optimize the graphing section, the system was optimized to include modifications such as (RegAction, Inc., 2014):

- **Year:** The engineer will need to select/input the year that the chart is to depict.
- **Waste stream/waste code:** The engineer will need to select/input the waste code(s) that needs to be charted.
- **Generating department:** The engineer will need to select/input the area where the waste was generated onsite.
- **Chart type:** The engineer will need to select the type of chart needed, such as a bar graph, pie chart, chart comparisons, etc.
- **Chart criteria:** The engineer will need to select chart grouping characteristics such as waste streams, departments, transporter, etc.

Weekly Inspections

Research was conducted to determine the type of notepad acceptable to the site. To design and implement the use of a tablet-based data recording system, meetings were held between the author, RegAction representatives and onsite personnel that initially focused on the environmental, health and safety protocol required to facility operations and regulatory compliance. However, as time went on, the asbestos coordinator, plant security personnel, and onsite contractors were added to discuss the system and any requirements that may not have been considered. During these meetings, it was determined that the device needed to meet Class 1 Division 2 safety standards for onsite usage.

Things that were considered included notepad capabilities and safety. The notepad needed to be intrinsically safe (explosion proof) for use onsite. A decision was made to use Panasonic handheld computerized notepads (Figure 24) to conduct weekly inspections. Several problems occurred with the Panasonic device because production had to meet the safety standards and the device was requested to have radio frequency identification capability. It was initially stated the device would be tested and ready for use in about six months. However, after the first six months, another six months came and passed due to product testing.

After the device was received, onsite training and testing was initiated. However, it was quickly determined that the device could not be used as needed when on the facility because there was no available wifi connection inside operations. After several attempts to gain a wifi connection, it was determined that an internet plan had to be purchased. This took several more months because internet providers were not familiar with the tablet device.

Once the internet service was established for the operations areas in the facility, the team started again to test the device for conducting waste management. Once shown viable, site personnel were trained to log into the system to conduct the required inspections and manage the receipt and discharge of container. It was found that the learning curve was not as steep as originally feared. This was due, in part, to full engagement with the system by a large segment of the management team. Also, site personnel that conducted waste inspections were only given access to that part of the system, so they were not subjected to having to learn components of the system which were not relevant to their activities. Further, the willingness of younger, more "technology savvy" operations staff to help older staff, and the willingness of this older workforce to ask for, and accept, help from the newer staff had a very positive impact on training times, system implementation, and ultimately the program's successes.

Figure 24 Panasonic Toughpad®

(Group Mobile, 2016)

The results of using the Toughpad® onsite made record keeping more efficient. Operations personnel no longer needed to waste time getting and supplying information to the engineer on a weekly basis. The engineer had the capability to log into the environmental management system to view weekly waste inspections. This also increased recording keeping efficiency because a paper checklist was no longer necessary. The engineer also had the ability to determine the accumulation start dates for each waste container from viewing the data in the system. These actions promoted compliance with state and federal environmental regulations.

Offsite Laboratory

Research was conducted to determine the laboratory services needed in the chemical industry. This research was based on problems identified while managing wastes at the studied chemical site. Problems found included lost analytical reports, analytical reports that took large amounts of time to read, and noncompliance issues.

A decision was made to get a new laboratory service and link the laboratory data to the environmental system to provide a more optimized environmental system. More specifically, once the laboratory completes analysis of a sample, the analytical report is immediately loaded into the system by laboratory personnel using appropriate login credentials. Once this information is loaded into the system, an instant notification is immediately sent to the environmental engineer as well as other selected site personnel. This is necessary because if a parameter exceeds a permit limit, the Texas Commission on Environmental Quality may need to be notified within a specified time period. This specified time period is identified within environmental permits.

For the facility serving as the basis for this research, an instant notification was necessary when samples were taken during a demolition project. The project was delayed because an unknown liquid substance was seeping from the ground. This incident needed to be reported to the Texas Commission on Environmental Quality, however, the substance needed to be identified. In order to identify and report this substance, analytical results from the sample were needed promptly. During this incident, the environmental system had not been optimized and the reports were received after an extended time period of one week. This delay, promoted pathway exposure risks associated with contaminated groundwater.

As an additional means to promote environmental compliance, the laboratory was also instructed to prepare a more efficient document for environmental systems optimization. This consisted of a Process Knowledge document that immediately identified the classification (hazardous or nonhazardous) of a substance by color coding. Red indicates a parameter that exceeds the hazardous limit, green indicates nonhazardous class 1, and yellow indicates nonhazardous class 2. Site personnel that were unfamiliar with the waste classification process or analytical reports could quickly review the short document to determine a waste classification.

Computer programs were written by RegAction in collaboration with the author. Their laboratory information technology representatives help to form the process knowledge documents and data storage protocols. After the program was initially completed, the document management system could not distinguish between Class 1 from Class 2 wastes. This required additional changes in the data management hierarchy and form generation network. For the Process Knowledge document, several in-house meetings and conference calls were held with the laboratory representatives, RegAction representatives, and onsite employees to test the document. This was followed by a long testing period which resulted in additional meetings to discuss how to better link documents to the environmental management system. This process took over a year because there were several issues with the computer programs and the facility information technology (IT) professionals needed time to establish a way to link the laboratory system with the onsite environmental system.

Once finalized, the Process Knowledge documents promoted efficient recordkeeping or analytical reports. Recordkeeping of analytical reports are especially useful and are necessary to make and verify waste determinations. The Texas Commission on Environmental Quality frequently conducts unannounced waste classification audits. During these audits, a facility has to prove how a waste classification was determined for a specified waste code identified on the Notice of Registration. For example, the TCEQ could contact a facility to conduct an audit on the contaminated soil waste code. During this audit, a facility has to provide justification on the waste code used. Analytical reports or Process Knowledge documents were used at the facility to show waste code justification.

Since these types of audits are frequently conducted, it was necessary that the environmental management system was optimized in this area. Once the Process Knowledge document was created, recordkeeping for analytical reports was more efficient and resulted in zero findings during waste code audits conducted by the Texas Commission on Environmental Quality. This action promoted environmental compliance with the Texas Commission on Environmental Quality and 100 percent efficiency.

A measurable instance that identifies the efficiency of the Process Knowledge document is the time factor in reading analytical lab reports to determine waste classifications. The average analytical report received from a laboratory contained about sixty pages. Reading this document to make a waste classification is very time consuming and can take four to eight hours to evaluate. After the Process knowledge document was created, the waste classification time was reduced to less than five minutes.

In conclusion, a host of criteria were used to develop and refine the environmental management system. These included: eliminating regulatory compliance and noncompliance penalties, minimizing internal communication time, eliminating onsite storage and accumulation time exceedances, increasing recordkeeping efficiency, eliminating the number of lost containers, and minimizing the time needed to make waste classifications. By optimizing the environmental management system to balance the criteria, the expectation was to achieve overall efficiency in managing wastes generated at the facility as characterized by compliance with state and federal requirements. This could only be achieved by improving engagement of the facility staff and minimizing the time and resources needed to achieving this objective.

When considering the results from evaluating the container arrival times, staff response time, compliance with storage and tracking requirements, waste characterization, and overall cost savings, it was concluded that the system was 100% efficiency if for no other reason that TCEQ inspections started resulting in "zero findings" reports. All containers arrived at the facility on the requested dates and all containers were recorded in the system. All containers that arrived onsite were easily tracked, location identified, and were never lost during their residence on site. During the final period of evaluation at this facility, fines were non-existent and staff cooperation was at a peak. The graphing and data presentation capabilities of the new system were quickly embraced by the management team as it now took less than five minutes to produce reports and illustrations of waste management successes. Further, waste classification time was reduced to less than ten minutes by using the Process Knowledge Document.

As part of a forensic evaluation of the newly design and implemented system designed from this effort, interviews were conducted with operations personnel. From these interviews it was determined that the system was extremely user friendly and was readily accepted by all. This resulted in continued usage which was integral to achieving compliance. Operations personnel also reported at least a 50% decrease in communication time and that the ability to track container cost was simplified.

During the assessment phase of this project, there were three regulatory compliance audits at the researched chemical manufacturing facility after the environmental system was optimized. All three regulatory audits resulted in zero findings and total compliance with state and federal regulations.

Unfortunately, while these successes were being confirmed during the later stages of this research, the study had to be cut short due to a change in corporate structure. This further limited the author's ability to access the system, document key components of the design, and provide more comprehensive illustrations of the work performed and the successes achieved. However, it was clear that the benefit of optimizing the environmental system easily outweighed the risk of noncompliance with state and federal regulations and the cost of penalties faced if compliance could not be achieved.

CHAPTER VIII

RECOMMENDATIONS FOR FUTURE PROJECTS

As noted previously, the project was terminated prematurely due to a change in corporate philosophy and support for the study. However, if work had continued, the next step would have been to expand the use of the Toughpad® data recording platform to include container tracking via Global Positioning System or Radio-Frequency Identification (RFID). The RFID tags transfer data electromagnetically and can easily track bulk waste containers onsite. The RFID tags have the ability to read data and also send out data, resulting in more efficient technology than barcodes (Bonsor & Fenlon, 2007). RFID tags can be identified for future use for environmental systems optimization. In a chemical industrial setting, containers frequently move around within the site. If an RFID tag is placed on each waste container, the environmental management system can be modified to include a map indicating where the containers are located onsite, waste type, accumulation start dates, and cost centers. Therefore, it is recommended that integration of such a container tagging and data recording system should be fully investigated.

For handling samples, a future recommendation is to electronically sign the chain of custodies associated with waste samples, and transfer it to the laboratory via the Panasonic Toughpad® through the environmental management system. This could result in instant notifications from a chemical industry to an offsite laboratory. The laboratory could instantly know information such as the sample type, container number, and the turnaround time for the results. This also decreases the chances of contamination from several individuals handling samples as well as the paper Chain of Custodies.

CHAPTER IX

IMPLEMENTATION STRATEGIES

Initial research was conducted on an existing environmental system. An evaluation consisted of an examination of the waste section of the system. A determination was made on the recordkeeping and activities required to meet environmental compliance based on state and federal regulations. Upon completion of the evaluation, it was noted that some areas of the environmental management system could be optimized to meet compliance requirements. Implementation and modification phases were determined based on regular activities associated with chemical industries. These regular activities included, but where not limited to, demolition, hydro testing, tank cleaning, remediation efforts, and waste management.

To make the necessary modifications needed to optimize the environmental system, the author collaborated with IT professionals and onsite employees. A timeline for completion was also noted. Site personnel also used the system to insure optimization and feedback was noted.

REFERENCES

American Fuel & Petroleum Manufacturers. (2015). *Petrochemicals*. Retrieved from https://www.afpm.org/petrochemicals/

Bonsor, K. & Fenlon, W. (2007, November 5). *How RFID works*. Retrieved from http://electronics.howstuffworks.com/gadgets/high-tech-gadgets/rfid5.htm

Botz, M. (1999).*Overview of cyanide treatment methods*. Retrieved from http://www.infomine.com/library/publications/docs/Botz1999.pdf

Code of Federal Regulations. (2012). *Special requirements for hazardous waste generated by conditionally exempt small quantity generators*. Washington, DC: Government Publishing Office.

Code of Federal Regulations. (2012). *Title 40-protection of environment: Part 261-identification and listing of hazardous waste*. Washington, DC: Government Publishing Office.

Department of State Health Services. (2013). *Characterization of potential adverse health effects associated with consuming fish from the San Jacinto River-Houston ship channel, Harris County, Texas*. Retrieved from http://dshs.texas.gov/epitox/reports/SJR_Risk_Characterization.doc

Electronic Code of Federal Regulations. (2016). *Title 40: Part 262-standards applicable to generators of hazardous waste*. Washington, DC: Government Publishing Office.

Electronic Code of Federal Regulations. (2016). *Title 40: Part 263-standards applicable to transporters of hazardous waste*. Retrieved from http://www.ecfr.gov/cgi-bin/text-idx?mc=true&node=pt40.26.263&rgn=div5#sp40.28.263.b

Federal Register. (1992). *Rules and regulations: 40 CFR parts 260, 261, 266, 271, and 279*. Washington, DC: Environmental Protection Agency

Global Alliance for Incinerator Alternatives. (n.d.). *Incinerators*. Retrieved from http://www.no-burn.org/section.php?id=84

Group Mobile [Advanced Mobile Technology]. (2016). Retrieved from https://groupmobile.com/panasonic-toughpad-fz-m1-1.html

Intergulf Corporation. (2014). *Hazardous waste transportation*. Retrieved from http://www.intergulfcorp.com/transportation.php

LaGrega, M. D., Buckingham, P. L., & Evans, J. C. (2010). *Hazardous waste management* (2nd ed.). Long Grove, IL: Waveland Press, Inc.

Legal Information Institute. (1980). *40 CFR-262.40–standards applicable to genderators of hazardous waste*. Retrieved from https://www.law.cornell.edu/cfr/text/40/279.22

Legal Information Institute. (1998). *40 CFR 279.22–used oil storage*. Retrieved from https://www.law.cornell.edu/cfr/text/40/279.22

McCoy's RCRA Reference. (2013). *Title 40-accumulation time*. Lakewood, CO: McCoy and Associates

McCoy's RCRA Reference. (2013). *Title 40- compliance with the manifest system and recordkeeping*. Lakewood, CO: McCoy and Associates

McCoy's RCRA Reference. (2013). *Title 40-record keeping and reporting*. Lakewood, CO: McCoy and Associates

National Pollutant Discharge Elimination System (NPDES). (2015). *Sanitary sewer overflows (SSOs)*. Washington, DC: Environmental Protection Agency

National Pollutant Discharge Elimination System (NPDES). (2016). *Municipal wastewater*. Washington, DC: Environmental Protection Agency

Port of Houston Authority of Harris County. (2016). *About the port*. Retrieved from http://www.portofhouston.com/about-us

Remediation Technologies Screening Matrix and Reference Guide, Version 4.0. (n.d.). *4.16 chemical reduction/oxidation*. Retrieved from http://www.frtr.gov/matrix2/section4/4-16.html

RegAction, Inc. (2014). *webWMS (waste management)*. Retrieved from https://www.regaction.com/en/products/environmental-management-suite/waste/webwms/

Reuters. Global Energy News. (2016). Retrieved from: http://uk.reuters.com/article/uk-marathon-bp-refinery-lawsuit-idUKKCN12B0BK

Ryan, R. H. (2010, June 12). *Chemical industries*. Retrieved from http://www.tshaonline.org/handbook/online/articles/dmc01

Solid Waste and Emergency Response. (2015). *Introduction to land disposal units*. Washington, DC: Environmental Protection Agency

Sibley, M. M. (2010, June 15). *Houston ship channel*. Retrieved from http://www.tshaonline.org/handbook/online/articles/rhh11

Texas Commission on Environmental Quality. (2006). *Texas administrative code: Municipal solid waste*. Retrieved from http://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=330&rl=331

Texas Commission on Environmental Quality. (2009). *Industrial and hazardous waste: Rules and regulations for small quantity generators*. Retrieved from https://www.tceq.texas.gov/publications/rg/rg-234.html

Texas Commission on Environmental Quality. (2011). *A Guide to Developing an Environmental Management System for a Small Business*. Retrieved from https://www.tetc-env.net/pdfs/guidetodevelopinganemsforsmallbusiness.pdf

Texas Commission on Environmental Quality. (2015). *Guidelines for the classification and coding of industrial and hazardous waste*. Retrieved from file:///C:/Users/EE%20-%20DT13/Downloads/RG-022.pdf

Texas Commission on Environmental Quality. (2015).*Texas administrative code: Industrial solid waste and municipal hazardous waste*. Retrieved from http://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=335&rl=503

Texas Commission on Environmental Quality. (2016). *Industrial and hazardous waste registration and reporting: Am I regulated?* Retrieved from https://www.tceq.texas.gov/permitting/registration/ihw

Texas Commission on Environmental Quality. (2016). *Industrial and hazardous waste reporting: Registered generators*. Retrieved from https://www.tceq.texas.gov/p2/recycle/renew/renew.html/permitting/registration/ihw/waste_reporting.html

Texas Economic Development Corporation, Texas Wide Open for Business. (2016). *Petroleum refining and chemical products*. Retrieved from https://texaswideopenforbusiness.com/industries/petroleum-refining-chemical-products

Texas Parks and Wildlife Foundation. (2008). *Spotted seatrout and catfish consumption advisory in Galveston Bay*. Retrieved from http://tpwd.texas.gov/faq/fishboat/fish/pcbfaq.phtml

Texas Welcomes Friends. (2016). *Port of Texas City*. Retrieved from http://www.texaswelcomesfriends.com/texas-Ports/port-of-Texas-City_Galveston-County/port-Of-Texas-City_Galveston-County.html

The Wall Street Journal. (2013). *Waste lands: America's forgotten nuclear legacy, Texas City Chemicals, Inc.* Retrieved from http://projects.wsj.com/waste-lands/site/457-texas-city-chemicals-inc/

United States Environmental Protection Agency. (2005). *Introduction to containers*. Retrieved from https://www.epa.gov/sites/production/files/2015-07/documents/cont05.pdf

United States Environmental Protection Agency. (2016) *Environmental Management Systems: Informing Organizational Decisions*. Retrieved from https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractdetail/abstract/1758/report/0

United States Environmental Protection Agency. (2016). *Learn about environmental management systems*. Retrieved from https://www.epa.gov/ems/learn-about-environmental-management-systems#costs

United States Environmental Protection Agency. (2016). *Learn about the toxics release inventory*. Retrieved from https://www.epa.gov/toxics-release-inventory-tri-program/learn-about-toxics-release-inventory

United States Environmental Protection Agency. (2016). *Wastes–resource conservation–common wastes and materials–paper recycling*. Retrieved from https://archive.epa.gov/wastes/conserve/materials/paper/web/html/faqs.html

Vancleave, Janice. (2011). *Aerobic oxidation*. Retrieved from http://scienceprojectideasforkids.com/2011/aerobic-oxidation/

Vedprakash, S. M., Vijaykumar, V. M., Jyeshtharaj, B. J. (1995). Wet air oxidation. *Industrial & Engineering Chemistry Research*, *34*(1), 2–48. http://dx.doi.org/10.1021/ie00040a001

Wernick, I., & Themelis, N. J. (1998). Recycling metals for the environment. *Annual Reviews Energy and Environment*, *23*, 465–497. Retrieved from http://www.seas.columbia.edu/earth/papers/aree98.pdf

Whitaker, G. (2015, March 11). *Clean Harbors Site Tour*. Tour conducted at Clean Harbors Environmental Services in LaPorte, Texas.

APPENDIX A

PROCESS KNOWLEDGE DOCUMENT

Analysis	Hazardous Criteria	Class 1 Criteria
ICR		
Ignitability 1010	Liquids (other than aqueous waste containing <24% alcohol by volume) that have a flash point <140oF, or	Liquids that have a flash point >140oF and <150oF, or
	Non-liquids that, under std T & P, are capable of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, burn so vigorously and persistently that they create a hazard, or	Solid/semisolid, that under normal transportation/storage/disposal conditions if liable to cause fire through friction, retained heat from manufacturing or processing, or
	Ignitable compressed gases (49 CFR 173.300), or	Can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard
	Oxidizers (49 CFR 173.151)	
Corrosivity 9040/9045	aqueous, pH <2 or >12.5, or	Solid/semisolid that when mixed with equivalent weight of water, produces a solution with a pH <2 or >12.5
	is a liquid and corrodes steel at rate >0.25 inch/year at 55oC	
	Is capable of detonation or explosive decomposition or reaction at STP, if subjected to a strong ignition source, or if heated under confinement	
Reactivity (R)	When mixed with water it is potentially explosive, reacts violently, or generates toxic gas	
	Is normally unstable and readily undergoes violent change without detonating	
	Is a forbidden explosive (49 CFR173.51 or a Class A explosive (49CFR173.53)	

Is a Class B explosive (49 CFR 173.88

Is a cyanide or sulfide bearing waste that when exposed to pH conditions between 2 and 12.5 it can generate enough toxic gases, vapors or fumes to present a danger to human health or the environment (see cyanide/sulfide guidelines below)

Sulfide 9030 — 500 mg/kg generated from waste

Cyanide 9020 — 250 mg/kg generated from waste

Toxicity (T)			
	Hazardous TCLP >mg/l	Class 1 TCLP >mg/l	Class 2 TCLP <mg/l
Analyte			
Volatiles 8260/8240			
Acetone	-	400	400
Acetonitrile	-	20	20
Acrylamide	-	0.08	0.08
Acrylonitrile	-	0.6	0.6
Benzene	0.5	0.5	0.5
Bromodichloromethane	-	0.3	0.3
Bromomethane	-	5	5
Carbon disulfide	-	400	400
Carbon tetrachloride	0.5	0.5	0.5
Chlorobenzene	100	70	70
Chloroform	6	6	6
Dichlorodifluoromethane	-	700	700
1,2-Dichloroethane	0.5	0.5	0.5
1,1-Dichloroethylene	0.7	0.6	0.6
1,3-Dichloropropene	-	1	1
1,4-dioxane	-	30	30
Ethylbenzene	-	400	400
Ethylene dibromide	-	0.004	0.004
Methacrylonitrile	-	0.4	0.4
Methylene chloride	-	50	50
Methyl ethyl ketone (2-butanone)	200	200	200
Methyl isobutyl ketone (4-methyl-2-pentanone)	-	200	200

Styrene	-	700	700
1,1,1,2-tetrachloroethane	-	10	10
1,1,2,2-tetrachloroethane	-	2	2
Tetrachloroethylene	0.7	0.7	0.7
Toluene	-	1000	1000
Trans-1,3-dichloropropene	-	1	1
Tribromomethane (bromoform)	-	70	70
1,1,1-Trichloroethane	-	300	300
1,1,2-Trichloroethane	-	6	6
Trichloroethylene	0.5	0.5	0.5
Trichlorofluoromethane	-	1000	1000
1,2,3-Trichloropropane	-	20	20
Vinyl Chloride	0.2	0.2	0.2
Xylenes	-	7000	7000
Semi-Volatiles 8270			
Acenapthene	-	210	210
Acetophenone	-	400	400
Aniline	-	60	60
Anthracene	-	1050	1050
Benzidine	-	0.002	0.002
Bis(2-chloroethyl)ether	-	0.3	0.3
Bis(2-ethylhexyl)phthalate	-	30	30
Butylbenzyl phthalate	-	700	700
Chloro-m-cresol,p	-	7000	7000
2-chlorophenol	-	20	20
o-Cresol (2-methylphenol)	200	200	200
p-cresol	200	200	200
m-cresol	200	200	200
Cresols*	200	200*	200*
Dibutyl phthalate	-	400	400
1,4-Dichlorobenzene	7.5	7.5	7.5
3,3-dichlorobenzidine	-	0.8	0.8
2,4-Dichlorophenol	-	10	10
Diethyl phthalate	-	3000	3000
2,4-Dimethylphenol	-	70	70
2,6-Dimethylphenol	-	21	21
m-dinitrobenzene	-	0.4	0.4
2,4-dinitrophenol	-	7	7
2,4-Dinitrotoluene	0.13	0.13	0.13
2,4-& 2,6-dinitrotoluene (mix)	-	0.13	0.13
1,2-Diphenylhydrazine	-	0.4	0.4

2-ethoxyethanol	-	1400	1400
Fluoranthene	-	140	140
Fluorene	-	140	140
Hexachlorobenzene	0.13	0.13	0.13
Hexachloro-1,3-butadiene	0.5	0.4	0.4
Hexachlorocyclopentadiene	-	20	20
Hexachloroethane	3	3	3
Hexachlorophene	-	1	1
Isophorone	-	90	90
2-methoxyethanol	-	14	14
Nitrobenzene	2	2	2
Pentachlorobenzene	-	3	3
Pentachloronitrobenzene	-	10	10
Pentachlorophenol	100	100	100
Phenol	-	2000	2000
Pyrene	-	5.9	5.9
Pyridine	5	4	4
2,3,4,6-tetrachlorophenol	-	100	100
1,2,4-Trichlorobenzene	-	70	70
2,4,5-Trichlorophenol	400	400	400
2,4,6-trichlorophenol	2	2	2
Direct Injection 8000/8270			
Isobutyl alcohol	-	1000	1000
Diphenylamine	-	90	90
Ethylene glycol	-	7000	7000
N-Nitroso-di-n-butylamine	-	0.06	0.06
N-nitrosodiphenylamine	-	70	70
N-nitrosomethylethylamine	-	0.02	0.02
N-nitroso-n-propylamine	-	0.05	0.05
N-nitrosopyrrolidine	-	0.2	0.2
p-Phenylene diamine	-	20	20
Metals 6010/7470/7421			
Antimony	-	1	1
Arsenic	5	1.8	1.8
Barium	100	100	100
Beryllium	-	0.08	0.08
Cadmium	1	0.5	0.5
Chromium	5	5	5
Lead	5	1.5	1.5
Mercury	0.2	0.2	0.2
Nickel	-	70	70
Selenium	1	1	1

Silver	5	5	5
Vanadium Pentoxide	-	30	30
Other - Pesticides/Dioxins/Furans			
Chlordane	0.03	0.03	0.03
DDD	-	1	1
DDE	-	1	1
DDT	-	1	1
2,4-D (2,4-Dichlorophenoxy-acetic acid)	10	10	10
Dieldrin	-	0.02	0.02
Dimethoate	-	70	70
Dinoseb	-	3.5	3.5
Dioxins (Polychlorinated dibenzo-p-dioxins)	-	below	below
2,3,7,8-TCDD	-	0.005	0.005
1,2,3,7,8-PeCDD	-	0.01	0.01
1,2,3,4,7,8-HxCDD	-	0.05	0.05
1,2,3,6,7,8-HxCDD	-	0.05	0.05
1,2,3,7,8,9-HxCDD	-	0.05	0.05
Disulfoton	-	0.1	0.1
Endrin	0.02	0.02	0.02
Furans	-	below	below
2,3,7,8-TCDF	-	0.05	0.05
1,2,3,7,8-PeCDF	-	0.1	0.1
2,3,4,7,8-PeCDF	-	0.01	0.01
1,2,3,4,7,8-HxCDF	-	0.05	0.05
1,2,3,6,7,8-HxCDF	-	0.05	0.05
1,2,3,7,8,9-HxCDF	-	0.05	0.05
Heptachlor	0.008	0.008	0.008
Heptachlor epoxide	-	0.04	0.04
Lindane	0.4	0.3	0.3
Methomyl	-	90	90
Methyl Parathion	-	0.9	0.9
Methoxychlor	10	10	10
Mirex	-	0.7	0.7
Parathion	-	20	20
Pronamide	-	300	300
Toxaphene	0.5	0.3	0.3
2,4,5-TP (silvex or 2,4,5-Trichlorophenoxy-propionic acid)	1	1	1

APPENDIX B

LISTED WASTES CONSTITUENTS

Table 1 Listed Wastes Constituents

Constituent	Maximum for any single composite sample—TCLP (mg/l)
Generic exclusion levels for K061 and K062 non-wastewater residues	
Antimony	0.1
Arsenic	0.5
Barium	7.6
Beryllium	0.01
Cadmium	0.05
Chromium (total)	0.33
Lead	0.15
Mercury	0.009
Nickel	1
Selenium	0.16
Silver	0.3
Thallium	0.02
Zinc	70
Generic exclusion levels for F006 nonwastewater residues	
Antimony	0.1
Arsenic	0.5
Barium	7.6
Beryllium	0.01
Cadmium	0.05
Chromium (total)	0.33
Cyanide (total) (mg/kg)	1.8
Lead	0.15
Mercury	0.009
Nickel	1
Selenium	0.16
Silver	0.3
Thallium	0.02
Zinc	70

Table 2 Listed Wastes F Codes

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
Generic:		
F001	The following spent halogenated solvents used in degreasing: Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(T)
F002	The following spent halogenated solvents: Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2-trichloroethane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004, or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(T)
F003	The following spent non-halogenated solvents: Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, before use, only the above spent non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and, a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(I)*

Table 2 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
F004	The following spent non-halogenated solvents: Cresols and cresylic acid, and nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(T)
F005	The following spent non-halogenated solvents: Toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2-nitropropane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(I,T)
F006	Wastewater treatment sludges from electroplating operations except from the following processes: (1) Sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum	(T)
F007	Spent cyanide plating bath solutions from electroplating operations	(R, T)
F008	Plating bath residues from the bottom of plating baths from electroplating operations where cyanides are used in the process	(R, T)
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process	(R, T)
F010	Quenching bath residues from oil baths from metal heat treating operations where cyanides are used in the process	(R, T)
F011	Spent cyanide solutions from salt bath pot cleaning from metal heat treating operations	(R, T)
F012	Quenching waste water treatment sludges from metal heat treating operations where cyanides are used in the process	(T)

Table 2 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
F019	Wastewater treatment sludges from the chemical conversion coating of aluminum except from zirconium phosphating in aluminum can washing when such phosphating is an exclusive conversion coating process. Wastewater treatment sludges from the manufacturing of motor vehicles using a zinc phosphating process will not be subject to this listing at the point of generation if the wastes are not placed outside on the land prior to shipment to a landfill for disposal and are either: disposed in a Subtitle D municipal or industrial landfill unit that is equipped with a single clay liner and is permitted, licensed or otherwise authorized by the state; or disposed in a landfill unit subject to, or otherwise meeting, the landfill requirements in § 258.40, § 264.301 or § 265.301. For the purposes of this listing, motor vehicle manufacturing is defined in paragraph (b)(4)(i) of this section and (b)(4)(ii) of this section describes the recordkeeping requirements for motor vehicle manufacturing facilities	(T)
F020	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri- or tetrachlorophenol, or of intermediates used to produce their pesticide derivatives. (This listing does not include wastes from the production of Hexachlorophene from highly purified 2,4,5-trichlorophenol.)	(H)
F021	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of pentachlorophenol, or of intermediates used to produce its derivatives	(H)
F022	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta-, or hexachlorobenzenes under alkaline conditions	(H)

Table 2 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
F023	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri- and tetrachlorophenols. (This listing does not include wastes from equipment used only for the production or use of Hexachlorophene from highly purified 2,4,5-trichlorophenol.)	(H)
F024	Process wastes, including but not limited to, distillation residues, heavy ends, tars, and reactor clean-out wastes, from the production of certain chlorinated aliphatic hydrocarbons by free radical catalyzed processes. These chlorinated aliphatic hydrocarbons are those having carbon chain lengths ranging from one to and including five, with varying amounts and positions of chlorine substitution. (This listing does not include wastewaters, wastewater treatment sludges, spent catalysts, and wastes listed in § 261.31 or § 261.32.)	(T)
F025	Condensed light ends, spent filters and filter aids, and spent desiccant wastes from the production of certain chlorinated aliphatic hydrocarbons, by free radical catalyzed processes. These chlorinated aliphatic hydrocarbons are those having carbon chain lengths ranging from one to and including five, with varying amounts and positions of chlorine substitution	(T)
F026	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta-, or hexachlorobenzene under alkaline conditions	(H)
F027	Discarded unused formulations containing tri-, tetra-, or pentachlorophenol or discarded unused formulations containing compounds derived from these chlorophenols. (This listing does not include formulations containing Hexachlorophene sythesized from prepurified 2,4,5-trichlorophenol as the sole component.)	(H)

Table 2 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
F028	Residues resulting from the incineration or thermal treatment of soil contaminated with EPA Hazardous Waste Nos. F020, F021, F022, F023, F026, and F027	(T)
F032	Wastewaters (except those that have not come into contact with process contaminants), process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that currently use or have previously used chlorophenolic formulations (except potentially cross-contaminated wastes that have had the F032 waste code deleted in accordance with § 261.35 of this chapter or potentially cross-contaminated wastes that are otherwise currently regulated as hazardous wastes (i.e., F034 or F035), and where the generator does not resume or initiate use of chlorophenolic formulations). This listing does not include K001 bottom sediment sludge from the treatment of wastewater from wood preserving processes that use creosote and/or pentachlorophenol	(T)
F034	Wastewaters (except those that have not come into contact with process contaminants), process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that use creosote formulations. This listing does not include K001 bottom sediment sludge from the treatment of wastewater from wood preserving processes that use creosote and/or pentachlorophenol	(T)
F035	Wastewaters (except those that have not come into contact with process contaminants), process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that use inorganic preservatives containing arsenic or chromium. This listing does not include K001 bottom sediment sludge from the treatment of wastewater from wood preserving processes that use creosote and/or pentachlorophenol	(T)

Table 2 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
F037	Petroleum refinery primary oil/water/solids separation sludge—Any sludge generated from the gravitational separation of oil/water/solids during the storage or treatment of process wastewaters and oily cooling wastewaters from petroleum refineries. Such sludges include, but are not limited to, those generated in oil/water/solids separators; tanks and impoundments; ditches and other conveyances; sumps; and stormwater units receiving dry weather flow. Sludge generated in stormwater units that do not receive dry weather flow, sludges generated from non-contact once-through cooling waters segregated for treatment from other process or oily cooling waters, sludges generated in aggressive biological treatment units as defined in § 261.31(b)(2) (including sludges generated in one or more additional units after wastewaters have been treated in aggressive biological treatment units) and K051 wastes are not included in this listing. This listing does include residuals generated from processing or recycling oil-bearing hazardous secondary materials excluded under § 261.4(a)(12)(i), if those residuals are to be disposed of	(T)
F038	Petroleum refinery secondary (emulsified) oil/water/solids separation sludge—Any sludge and/or float generated from the physical and/or chemical separation of oil/water/solids in process wastewaters and oily cooling wastewaters from petroleum refineries. Such wastes include, but are not limited to, all sludges and floats generated in: induced air flotation (IAF) units, tanks and impoundments, and all sludges generated in DAF units. Sludges generated in stormwater units that do not receive dry weather flow, sludges generated from non-contact once-through cooling waters segregated for treatment from other process or oily cooling waters, sludges and floats generated in aggressive biological treatment units as defined in § 261.31(b)(2) (including sludges and floats generated in one or more additional units after wastewaters have been treated in aggressive biological treatment units) and F037, K048, and K051 wastes are not included in this listing	(T)
F039	Leachate (liquids that have percolated through land disposed wastes) resulting from the disposal of more than one restricted waste classified as hazardous under subpart D of this part. (Leachate resulting from the disposal of one or more of the following EPA Hazardous Wastes and no other Hazardous Wastes retains its EPA Hazardous Waste Number(s): F020, F021, F022, F026, F027, and/or F028.)	(T)

Table 3 Listed Wastes K Codes

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
Wood preservation		
K001	Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol	(T)
Inorganic pigments:		
K002	Wastewater treatment sludge from the production of chrome yellow and orange pigments	(T)
K003	Wastewater treatment sludge from the production of molybdate orange pigments	(T)
K004	Wastewater treatment sludge from the production of zinc yellow pigments	(T)
K005	Wastewater treatment sludge from the production of chrome green pigments	(T)
K006	Wastewater treatment sludge from the production of chrome oxide green pigments (anhydrous and hydrated)	(T)
K007	Wastewater treatment sludge from the production of iron blue pigments	(T)
K008	Oven residue from the production of chrome oxide green pigments	(T)
Organic chemicals:		
K009	Distillation bottoms from the production of acetaldehyde from ethylene	(T)
K010	Distillation side cuts from the production of acetaldehyde from ethylene	(T)
K011	Bottom stream from the wastewater stripper in the production of acrylonitrile	(R, T)
K013	Bottom stream from the acetonitrile column in the production of acrylonitrile	(R, T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
K014	Bottoms from the acetonitrile purification column in the production of acrylonitrile	(T)
K015	Still bottoms from the distillation of benzyl chloride	(T)
K016	Heavy ends or distillation residues from the production of carbon tetrachloride	(T)
K017	Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin	(T)
K018	Heavy ends from the fractionation column in ethyl chloride production	(T)
K019	Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production	(T)
K020	Heavy ends from the distillation of vinyl chloride in vinyl chloride monomer production	(T)
K021	Aqueous spent antimony catalyst waste from fluoromethanes production	(T)
K022	Distillation bottom tars from the production of phenol/acetone from cumene	(T)
K023	Distillation light ends from the production of phthalic anhydride from naphthalene	(T)
K024	Distillation bottoms from the production of phthalic anhydride from naphthalene	(T)
K025	Distillation bottoms from the production of nitrobenzene by the nitration of benzene	(T)
K026	Stripping still tails from the production of methy ethyl pyridines	(T)
K027	Centrifuge and distillation residues from toluene diisocyanate production	(R, T)
K028	Spent catalyst from the hydrochlorinator reactor in the production of 1,1,1-trichloroethane	(T)
K029	Waste from the product steam stripper in the production of 1,1,1-trichloroethane	(T)
K030	Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene	(T)
K083	Distillation bottoms from aniline production	(T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
K085	Distillation or fractionation column bottoms from the production of chlorobenzenes	(T)
K093	Distillation light ends from the production of phthalic anhydride from ortho-xylene	(T)
K094	Distillation bottoms from the production of phthalic anhydride from ortho-xylene	(T)
K095	Distillation bottoms from the production of 1,1,1-trichloroethane	(T)
K096	Heavy ends from the heavy ends column from the production of 1,1,1-trichloroethane	(T)
K103	Process residues from aniline extraction from the production of aniline	(T)
K104	Combined wastewater streams generated from nitrobenzene/aniline production	(T)
K105	Separated aqueous stream from the reactor product washing step in the production of chlorobenzenes	(T)
K107	Column bottoms from product separation from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazides	(C,T)
K108	Condensed column overheads from product separation and condensed reactor vent gases from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazides	(I,T)
K109	Spent filter cartridges from product purification from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazides	(T)
K110	Condensed column overheads from intermediate separation from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazides	(T)
K111	Product washwaters from the production of dinitrotoluene via nitration of toluene	(C,T)
K112	Reaction by-product water from the drying column in the production of toluenediamine via hydrogenation of dinitrotoluene	(T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
K113	Condensed liquid light ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene	(T)
K114	Vicinals from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene	(T)
K115	Heavy ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene	(T)
K116	Organic condensate from the solvent recovery column in the production of toluene diisocyanate via phosgenation of toluenediamine	(T)
K117	Wastewater from the reactor vent gas scrubber in the production of ethylene dibromide via bromination of ethene	(T)
K118	Spent adsorbent solids from purification of ethylene dibromide in the production of ethylene dibromide via bromination of ethene	(T)
K136	Still bottoms from the purification of ethylene dibromide in the production of ethylene dibromide via bromination of ethene	(T)
K149	Distillation bottoms from the production of alpha- (or methyl-) chlorinated toluenes, ring-chlorinated toluenes, benzoyl chlorides, and compounds with mixtures of these functional groups, (This waste does not include still bottoms from the distillation of benzyl chloride.)	(T)
K150	Organic residuals, excluding spent carbon adsorbent, from the spent chlorine gas and hydrochloric acid recovery processes associated with the production of alpha- (or methyl-) chlorinated toluenes, ring-chlorinated toluenes, benzoyl chlorides, and compounds with mixtures of these functional groups	(T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
K151	Wastewater treatment sludges, excluding neutralization and biological sludges, generated during the treatment of wastewaters from the production of alpha- (or methyl-) chlorinated toluenes, ring-chlorinated toluenes, benzoyl chlorides, and compounds with mixtures of these functional groups	(T)
K156	Organic waste (including heavy ends, still bottoms, light ends, spent solvents, filtrates, and decantates) from the production of carbamates and carbamoyl oximes. (This listing does not apply to wastes generated from the manufacture of 3-iodo-2-propynyl n-butylcarbamate.)	(T)
K157	Wastewaters (including scrubber waters, condenser waters, washwaters, and separation waters) from the production of carbamates and carbamoyl oximes. (This listing does not apply to wastes generated from the manufacture of 3-iodo-2-propynyl n-butylcarbamate.)	(T)
K158	Bag house dusts and filter/separation solids from the production of carbamates and carbamoyl oximes. (This listing does not apply to wastes generated from the manufacture of 3-iodo-2-propynyl n-butylcarbamate.)	(T)
K159	Organics from the treatment of thiocarbamate wastes	(T)
K161	Purification solids (including filtration, evaporation, and centrifugation solids), bag house dust and floor sweepings from the production of dithiocarbamate acids and their salts. (This listing does not include K125 or K126.)	(R,T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
K174	Wastewater treatment sludges from the production of ethylene dichloride or vinyl chloride monomer (including sludges that result from commingled ethylene dichloride or vinyl chloride monomer wastewater and other wastewater), unless the sludges meet the following conditions: (i) they are disposed of in a subtitle C or non-hazardous landfill licensed or permitted by the state or federal government; (ii) they are not otherwise placed on the land prior to final disposal; and (iii) the generator maintains documentation demonstrating that the waste was either disposed of in an on-site landfill or consigned to a transporter or disposal facility that provided a written commitment to dispose of the waste in an off-site landfill. Respondents in any action brought to enforce the requirements of subtitle C must, upon a showing by the government that the respondent managed wastewater treatment sludges from the production of vinyl chloride monomer or ethylene dichloride, demonstrate that they meet the terms of the exclusion set forth above. In doing so, they must provide appropriate documentation (e.g., contracts between the generator and the landfill owner/operator, invoices documenting delivery of waste to landfill, etc.) that the terms of the exclusion were met	(T)
K175	Wastewater treatment sludges from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process	(T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
K181	Nonwastewaters from the production of dyes and/or pigments (including nonwastewaters commingled at the point of generation with nonwastewaters from other processes) that, at the point of generation, contain mass loadings of any of the constituents identified in paragraph (c) of this section that are equal to or greater than the corresponding paragraph (c) levels, as determined on a calendar year basis. These wastes will not be hazardous if the nonwastewaters are: (i) disposed in a Subtitle D landfill unit subject to the design criteria in § 258.40, (ii) disposed in a Subtitle C landfill unit subject to either § 264.301 or § 265.301, (iii) disposed in other Subtitle D landfill units that meet the design criteria in § 258.40, § 264.301, or § 265.301, or (iv) treated in a combustion unit that is permitted under Subtitle C, or an onsite combustion unit that is permitted under the Clean Air Act. For the purposes of this listing, dyes and/or pigments production is defined in paragraph (b)(1) of this section. Paragraph (d) of this section describes the process for demonstrating that a facility's nonwastewaters are not K181. This listing does not apply to wastes that are otherwise identified as hazardous under §§ 261.21-261.24 and 261.31-261.33 at the point of generation. Also, the listing does not apply to wastes generated before any annual mass loading limit is met	(T)
Inorganic chemicals:		
K071	Brine purification muds from the mercury cell process in chlorine production, where separately prepurified brine is not used	(T)
K073	Chlorinated hydrocarbon waste from the purification step of the diaphragm cell process using graphite anodes in chlorine production	(T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
K106	Wastewater treatment sludge from the mercury cell process in chlorine production	(T)
K176	Baghouse filters from the production of antimony oxide, including filters from the production of intermediates (e.g., antimony metal or crude antimony oxide)	(E)
K177	Slag from the production of antimony oxide that is speculatively accumulated or disposed, including slag from the production of intermediates (e.g., antimony metal or crude antimony oxide)	(T)
K178	Residues from manufacturing and manufacturing-site storage of ferric chloride from acids formed during the production of titanium dioxide using the chloride-ilmenite process	(T)
Pesticides:		
K031	By-product salts generated in the production of MSMA and cacodylic acid	(T)
K032	Wastewater treatment sludge from the production of chlordane	(T)
K033	Wastewater and scrub water from the chlorination of cyclopentadiene in the production of chlordane	(T)
K034	Filter solids from the filtration of hexachlorocyclopentadiene in the production of chlordane	(T)
K035	Wastewater treatment sludges generated in the production of creosote	(T)
K036	Still bottoms from toluene reclamation distillation in the production of disulfoton	(T)
K037	Wastewater treatment sludges from the production of disulfoton	(T)
K038	Wastewater from the washing and stripping of phorate production	(T)
K039	Filter cake from the filtration of diethylphosphorodithioic acid in the production of phorate	(T)
K040	Wastewater treatment sludge from the production of phorate	(T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
K041	Wastewater treatment sludge from the production of toxaphene	(T)
K042	Heavy ends or distillation residues from the distillation of tetrachlorobenzene in the production of 2,4,5-T	(T)
K043	2,6-Dichlorophenol waste from the production of 2,4-D	(T)
K097	Vacuum stripper discharge from the chlordane chlorinator in the production of chlordane	(T)
K098	Untreated process wastewater from the production of toxaphene	(T)
K099	Untreated wastewater from the production of 2,4-D	(T)
K123	Process wastewater (including supernates, filtrates, and washwaters) from the production of ethylenebisdithiocarbamic acid and its salt	(T)
K124	Reactor vent scrubber water from the production of ethylenebisdithiocarbamic acid and its salts	(C, T)
K125	Filtration, evaporation, and centrifugation solids from the production of ethylenebisdithiocarbamic acid and its salts	(T)
K126	Baghouse dust and floor sweepings in milling and packaging operations from the production or formulation of ethylenebisdithiocarbamic acid and its salts	(T)
K131	Wastewater from the reactor and spent sulfuric acid from the acid dryer from the production of methyl bromide	(C, T)
K132	Spent absorbent and wastewater separator solids from the production of methyl bromide	(T)
Explosives:		
K044	Wastewater treatment sludges from the manufacturing and processing of explosives	(R)
K045	Spent carbon from the treatment of wastewater containing explosives	(R)
K046	Wastewater treatment sludges from the manufacturing, formulation and loading of lead-based initiating compounds	(T)
K047	Pink/red water from TNT operations	(R)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
Petroleum refining:		
K048	Dissolved air flotation (DAF) float from the petroleum refining industry	(T)
K049	Slop oil emulsion solids from the petroleum refining industry	(T)
K050	Heat exchanger bundle cleaning sludge from the petroleum refining industry	(T)
K051	API separator sludge from the petroleum refining industry	(T)
K052	Tank bottoms (leaded) from the petroleum refining industry	(T)
K169	Crude oil storage tank sediment from petroleum refining operations	(T)
K170	Clarified slurry oil tank sediment and/or in-line filter/separation solids from petroleum refining operations	(T)
K171	Spent Hydrotreating catalyst from petroleum refining operations, including guard beds used to desulfurize feeds to other catalytic reactors (this listing does not include inert support media)	(I,T)
K172	Spent Hydrorefining catalyst from petroleum refining operations, including guard beds used to desulfurize feeds to other catalytic reactors (this listing does not include inert support media)	(I,T)
Iron and steel:		
K061	Emission control dust/sludge from the primary production of steel in electric furnaces	(T)
K062	Spent pickle liquor generated by steel finishing operations of facilities within the iron and steel industry (SIC Codes 331 and 332)	(C,T)
Primary aluminum:		
K088	Spent potliners from primary aluminum reduction	(T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
Secondary lead:		
K069	Emission control dust/sludge from secondary lead smelting. (Note: This listing is stayed administratively for sludge generated from secondary acid scrubber systems. The stay will remain in effect until further administrative action is taken. If EPA takes further action effecting this stay, EPA will publish a notice of the action in the Federal Register)	(T)
K100	Waste leaching solution from acid leaching of emission control dust/sludge from secondary lead smelting	(T)
Veterinary pharmaceuticals:		
K084	Wastewater treatment sludges generated during the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds	(T)
K101	Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds	(T)
K102	Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds	(T)
Ink formulation:		
K086	Solvent washes and sludges, caustic washes and sludges, or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead	(T)

Table 3 (continued)

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
Coking:		
K060	Ammonia still lime sludge from coking operations	(T)
K087	Decanter tank tar sludge from coking operations	(T)
K141	Process residues from the recovery of coal tar, including, but not limited to, collecting sump residues from the production of coke from coal or the recovery of coke by-products produced from coal. This listing does not include K087 (decanter tank tar sludges from coking operations)	(T)
K142	Tar storage tank residues from the production of coke from coal or from the recovery of coke by-products produced from coal	(T)
K143	Process residues from the recovery of light oil, including, but not limited to, those generated in stills, decanters, and wash oil recovery units from the recovery of coke by-products produced from coal	(T)
K144	Wastewater sump residues from light oil refining, including, but not limited to, intercepting or contamination sump sludges from the recovery of coke by-products produced from coal	(T)
K145	Residues from naphthalene collection and recovery operations from the recovery of coke by-products produced from coal	(T)
K147	Tar storage tank residues from coal tar refining	(T)
K148	Residues from coal tar distillation, including but not limited to, still bottoms	(T)

Table 4 Listed Wastes P Codes

Hazardous waste No.	Chemical abstracts No.	Substance
P023	107-20-0	Acetaldehyde, chloro-
P002	591-08-2	Acetamide, N-(aminothioxomethyl)-
P057	640-19-7	Acetamide, 2-fluoro-
P058	62-74-8	Acetic acid, fluoro-, sodium salt
P002	591-08-2	1-Acetyl-2-thiourea
P003	107-02-8	Acrolein
P070	116-06-3	Aldicarb
P203	1646-88-4	Aldicarb sulfone.
P004	309-00-2	Aldrin
P005	107-18-6	Allyl alcohol
P006	20859-73-8	Aluminum phosphide (R,T)
P007	2763-96-4	5-(Aminomethyl)-3-isoxazolol
P008	504-24-5	4-Aminopyridine
P009	131-74-8	Ammonium picrate (R)
P119	7803-55-6	Ammonium vanadate
P099	506-61-6	Argentate(1-), bis(cyano-C)-, potassium
P010	7778-39-4	Arsenic acid H3 AsO4
P012	1327-53-3	Arsenic oxide As2 O3
P011	1303-28-2	Arsenic oxide As2 O5
P011	1303-28-2	Arsenic pentoxide
P012	1327-53-3	Arsenic trioxide
P038	692-42-2	Arsine, diethyl-
P036	696-28-6	Arsonous dichloride, phenyl-
P054	151-56-4	Aziridine
P067	75-55-8	Aziridine, 2-methyl-
P013	542-62-1	Barium cyanide
P024	106-47-8	Benzenamine, 4-chloro-
P077	100-01-6	Benzenamine, 4-nitro-
P028	100-44-7	Benzene, (chloromethyl)-
P042	51-43-4	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-, (R)-
P046	122-09-8	Benzeneethanamine, alpha,alpha-dimethyl-

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P014	108-98-5	Benzenethiol
P127	1563-66-2	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate.
P188	57-64-7	Benzoic acid, 2-hydroxy-, compd. with (3aS-cis)-1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethylpyrrolo[2,3-b]indol-5-yl methylcarbamate ester (1:1).
P001	1 81-81-2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%
P028	100-44-7	Benzyl chloride
P015	7440-41-7	Beryllium powder
P017	598-31-2	Bromoacetone
P018	357-57-3	Brucine
P045	39196-18-4	2-Butanone, 3,3-dimethyl-1-(methylthio)-,O-[(methylamino)carbonyl] oxime
P021	592-01-8	Calcium cyanide
P021	592-01-8	Calcium cyanide Ca(CN)2
P189	55285-14-8	Carbamic acid, [(dibutylamino)-thio]methyl-, 2,3-dihydro-2,2-dimethyl- 7-benzofuranyl ester.
P191	644-64-4	Carbamic acid, dimethyl-, 1-[(dimethyl-amino)carbonyl]- 5-methyl-1H- pyrazol-3-yl ester.
P192	119-38-0	Carbamic acid, dimethyl-, 3-methyl-1-(1-methylethyl)-1H- pyrazol-5-yl ester.
P190	1129-41-5	Carbamic acid, methyl-, 3-methylphenyl ester.
P127	1563-66-2	Carbofuran.
P022	75-15-0	Carbon disulfide
P095	75-44-5	Carbonic dichloride

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P189	55285-14-8	Carbosulfan.
P023	107-20-0	Chloroacetaldehyde
P024	106-47-8	p-Chloroaniline
P026	5344-82-1	1-(o-Chlorophenyl)thiourea
P027	542-76-7	3-Chloropropionitrile
P029	544-92-3	Copper cyanide
P029	544-92-3	Copper cyanide Cu(CN)
P202	64-00-6	m-Cumenyl methylcarbamate.
P030		Cyanides (soluble cyanide salts), not otherwise specified
P031	460-19-5	Cyanogen
P033	506-77-4	Cyanogen chloride
P033	506-77-4	Cyanogen chloride (CN)Cl
P034	131-89-5	2-Cyclohexyl-4,6-dinitrophenol
P016	542-88-1	Dichloromethyl ether
P036	696-28-6	Dichlorophenylarsine
P037	60-57-1	Dieldrin
P038	692-42-2	Diethylarsine
P041	311-45-5	Diethyl-p-nitrophenyl phosphate
P040	297-97-2	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	55-91-4	Diisopropylfluorophosphate (DFP)
P004	309-00-2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro- 1,4,4a,5,8,8a,-hexahydro-, (1alpha,4alpha,4abeta,5alpha,8alpha,8abeta)-
P060	465-73-6	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro- 1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abeta,5beta,8beta,8abeta)-

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P037	60-57-1	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta,6a alpha,7beta, 7aalpha)-
P051	1 72-20-8	2,7:3,6-Dimethanonaphth [2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2abeta,3alpha,6alpha,6 abeta,7beta, 7aalpha)-, & metabolites
P044	60-51-5	Dimethoate
P046	122-09-8	alpha,alpha-Dimethylphenethylamine
P191	644-64-4	Dimetilan.
P047	1 534-52-1	4,6-Dinitro-o-cresol, & salts
P048	51-28-5	2,4-Dinitrophenol
P020	88-85-7	Dinoseb
P085	152-16-9	Diphosphoramide, octamethyl-
P111	107-49-3	Diphosphoric acid, tetraethyl ester
P039	298-04-4	Disulfoton
P049	541-53-7	Dithiobiuret
P185	26419-73-8	1,3-Dithiolane-2-carboxaldehyde, 2,4-dimethyl-, O- [(methylamino)-carbonyl]oxime.
P050	115-29-7	Endosulfan
P088	145-73-3	Endothall
P051	72-20-8	Endrin
P051	72-20-8	Endrin, & metabolites
P042	51-43-4	Epinephrine
P031	460-19-5	Ethanedinitrile
P194	23135-22-0	Ethanimidothioic acid, 2-(dimethylamino)-N-[[(methylamino) carbonyl]oxy]-2-oxo-, methyl ester.
P066	16752-77-5	Ethanimidothioic acid,N-[[(methylamino)carbonyl]oxy]-, methyl ester
P101	107-12-0	Ethyl cyanide

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P054	151-56-4	Ethyleneimine
P097	52-85-7	Famphur
P056	7782-41-4	Fluorine
P057	640-19-7	Fluoroacetamide
P058	62-74-8	Fluoroacetic acid, sodium salt
P198	23422-53-9	Formetanate hydrochloride.
P197	17702-57-7	Formparanate.
P065	628-86-4	Fulminic acid, mercury(2+) salt (R,T)
P059	76-44-8	Heptachlor
P062	757-58-4	Hexaethyl tetraphosphate
P116	79-19-6	Hydrazinecarbothioamide
P068	60-34-4	Hydrazine, methyl-
P063	74-90-8	Hydrocyanic acid
P063	74-90-8	Hydrogen cyanide
P096	7803-51-2	Hydrogen phosphide
P060	465-73-6	Isodrin
P192	119-38-0	Isolan.
P202	64-00-6	3-Isopropylphenyl N-methylcarbamate.
P007	2763-96-4	3(2H)-Isoxazolone, 5-(aminomethyl)-
P196	15339-36-3	Manganese, bis(dimethylcarbamodithioato-S,S′)-,
P196	15339-36-3	Manganese dimethyldithiocarbamate.
P092	62-38-4	Mercury, (acetato-O)phenyl-
P065	628-86-4	Mercury fulminate (R,T)
P082	62-75-9	Methanamine, N-methyl-N-nitroso-
P064	624-83-9	Methane, isocyanato-
P016	542-88-1	Methane, oxybis[chloro-
P112	509-14-8	Methane, tetranitro- (R)
P118	75-70-7	Methanethiol, trichloro-
P198	23422-53-9	Methanimidamide, N,N-dimethyl-N′-[3-[[(methylamino)-carbonyl]oxy]phenyl]-, monohydrochloride.

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P197	17702-57-7	Methanimidamide, N,N-dimethyl-N′-[2-methyl-4-[[(methylamino)carbonyl]oxy]phenyl]-
P050	115-29-7	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
P059	76-44-8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P199	2032-65-7	Methiocarb.
P066	16752-77-5	Methomyl
P068	60-34-4	Methyl hydrazine
P064	624-83-9	Methyl isocyanate
P069	75-86-5	2-Methyllactonitrile
P071	298-00-0	Methyl parathion
P190	1129-41-5	Metolcarb.
P128	315-8-4	Mexacarbate.
P072	86-88-4	alpha-Naphthylthiourea
P073	13463-39-3	Nickel carbonyl
P073	13463-39-3	Nickel carbonyl $Ni(CO)_4$, (T-4)-
P074	557-19-7	Nickel cyanide
P074	557-19-7	Nickel cyanide $Ni(CN)_2$
P075	1 54-11-5	Nicotine, & salts
P076	10102-43-9	Nitric oxide
P077	100-01-6	p-Nitroaniline
P078	10102-44-0	Nitrogen dioxide
P076	10102-43-9	Nitrogen oxide NO
P078	10102-44-0	Nitrogen oxide NO_2
P081	55-63-0	Nitroglycerine (R)
P082	62-75-9	N-Nitrosodimethylamine
P084	4549-40-0	N-Nitrosomethylvinylamine
P085	152-16-9	Octamethylpyrophosphoramide
P087	20816-12-0	Osmium oxide OsO_4, (T-4)-

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P087	20816-12-0	Osmium tetroxide
P088	145-73-3	7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
P194	23135-22-0	Oxamyl.
P089	56-38-2	Parathion
P034	131-89-5	Phenol, 2-cyclohexyl-4,6-dinitro-
P048	51-28-5	Phenol, 2,4-dinitro-
P047	1 534-52-1	Phenol, 2-methyl-4,6-dinitro-, & salts
P020	88-85-7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
P009	131-74-8	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P128	315-18-4	Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester).
P199	2032-65-7	Phenol, (3,5-dimethyl-4-(methylthio)-, methylcarbamate
P202	64-00-6	Phenol, 3-(1-methylethyl)-, methyl carbamate.
P201	2631-37-0	Phenol, 3-methyl-5-(1-methylethyl)-, methyl carbamate.
P092	62-38-4	Phenylmercury acetate
P093	103-85-5	Phenylthiourea
P094	298-02-2	Phorate
P095	75-44-5	Phosgene
P096	7803-51-2	Phosphine
P041	311-45-5	Phosphoric acid, diethyl 4-nitrophenyl ester
P039	298-04-4	Phosphorodithioic acid, O,O-diethylS-[2-(ethylthio)ethyl] ester
P094	298-02-2	Phosphorodithioic acid, O,O-diethylS-[(ethylthio)methyl] ester
P044	60-51-5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methyl-amino)-2-oxoethyl] ester

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P043	55-91-4	Phosphorofluoridic acid, bis(1-methylethyl) ester
P089	56-38-2	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
P040	297-97-2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
P097	52-85-7	Phosphorothioic acid,O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester
P071	298-00-0	Phosphorothioic acid, O,O,-dimethyl O-(4-nitrophenyl) ester
P204	57-47-6	Physostigmine.
P188	57-64-7	Physostigmine salicylate.
P110	78-00-2	Plumbane, tetraethyl-
P098	151-50-8	Potassium cyanide
P098	151-50-8	Potassium cyanide K(CN)
P099	506-61-6	Potassium silver cyanide
P201	2631-37-0	Promecarb
P070	116-06-3	Propanal, 2-methyl-2-(methylthio)-,O-[(methylamino)carbonyl]oxime
P203	1646-88-4	Propanal, 2-methyl-2-(methyl-sulfonyl)-, O-[(methylamino)carbonyl] oxime.
P101	107-12-0	Propanenitrile
P027	542-76-7	Propanenitrile, 3-chloro-
P069	75-86-5	Propanenitrile, 2-hydroxy-2-methyl-
P081	55-63-0	1,2,3-Propanetriol, trinitrate (R)
P017	598-31-2	2-Propanone, 1-bromo-
P102	107-19-7	Propargyl alcohol
P003	107-02-8	2-Propenal
P005	107-18-6	2-Propen-1-ol
P067	75-55-8	1,2-Propylenimine
P102	107-19-7	2-Propyn-1-ol
P008	504-24-5	4-Pyridinamine

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P075	1 54-11-5	Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts
P204	57-47-6	Pyrrolo[2,3-b]indol-5-ol, 1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethyl- ,methylcarbamate (ester), (3aS-cis)-.
P114	12039-52-0	Selenious acid, dithallium(1+) salt
P103	630-10-4	Selenourea
P104	506-64-9	Silver cyanide
P104	506-64-9	Silver cyanide Ag(CN)
P105	26628-22-8	Sodium azide
P106	143-33-9	Sodium cyanide
P106	143-33-9	Sodium cyanide Na(CN)
P108	1 57-24-9	Strychnidin-10-one, & salts
P018	357-57-3	Strychnidin-10-one, 2,3-dimethoxy-
P108	1 57-24-9	Strychnine, & salts
P115	7446-18-6	Sulfuric acid, dithallium(1+) salt
P109	3689-24-5	Tetraethyldithiopyrophosphate
P110	78-00-2	Tetraethyl lead
P111	107-49-3	Tetraethyl pyrophosphate
P112	509-14-8	Tetranitromethane (R)
P062	757-58-4	Tetraphosphoric acid, hexaethyl ester
P113	1314-32-5	Thallic oxide
P113	1314-32-5	Thallium oxide Tl2 O3
P114	12039-52-0	Thallium(I) selenite
P115	7446-18-6	Thallium(I) sulfate
P109	3689-24-5	Thiodiphosphoric acid, tetraethyl ester
P045	39196-18-4	Thiofanox
P049	541-53-7	Thioimidodicarbonic diamide [(H2 N)C(S)]2 NH
P014	108-98-5	Thiophenol
P116	79-19-6	Thiosemicarbazide
P026	5344-82-1	Thiourea, (2-chlorophenyl)-
P072	86-88-4	Thiourea, 1-naphthalenyl-

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P093	103-85-5	Thiourea, phenyl-
P185	26419-73-8	Tirpate.
P123	8001-35-2	Toxaphene
P118	75-70-7	Trichloromethanethiol
P119	7803-55-6	Vanadic acid, ammonium salt
P120	1314-62-1	Vanadium oxide V2 O5
P120	1314-62-1	Vanadium pentoxide
P084	4549-40-0	Vinylamine, N-methyl-N-nitroso-
P001	1 81-81-2	Warfarin, & salts, when present at concentrations greater than 0.3%
P205	137-30-4	Zinc, bis(dimethylcarbamodithioato-S,S′)-,
P121	557-21-1	Zinc cyanide
P121	557-21-1	Zinc cyanide Zn(CN)2
P122	1314-84-7	Zinc phosphide Zn3 P2, when present at concentrations greater than 10% (R,T)
P205	137-30-4	Ziram.
P001	1 81-81-2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%
P001	1 81-81-2	Warfarin, & salts, when present at concentrations greater than 0.3%
P002	591-08-2	Acetamide, -(aminothioxomethyl)-
P002	591-08-2	1-Acetyl-2-thiourea
P003	107-02-8	Acrolein
P003	107-02-8	2-Propenal
P004	309-00-2	Aldrin
P004	309-00-2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a,-hexahydro-, (1alpha,4alpha,4abeta,5alpha,8alpha,8abeta)-
P005	107-18-6	Allyl alcohol
P005	107-18-6	2-Propen-1-ol

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P006	20859-73-8	Aluminum phosphide (R,T)
P007	2763-96-4	5-(Aminomethyl)-3-isoxazolol
P007	2763-96-4	3(2H)-Isoxazolone, 5-(aminomethyl)-
P008	504-24-5	4-Aminopyridine
P008	504-24-5	4-Pyridinamine
P009	131-74-8	Ammonium picrate (R)
P009	131-74-8	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P010	7778-39-4	Arsenic acid H3 AsO4
P011	1303-28-2	Arsenic oxide As2 O5
P011	1303-28-2	Arsenic pentoxide
P012	1327-53-3	Arsenic oxide As2 O3
P012	1327-53-3	Arsenic trioxide
P013	542-62-1	Barium cyanide
P014	108-98-5	Benzenethiol
P014	108-98-5	Thiophenol
P015	7440-41-7	Beryllium powder
P016	542-88-1	Dichloromethyl ether
P016	542-88-1	Methane, oxybis[chloro-
P017	598-31-2	Bromoacetone
P017	598-31-2	2-Propanone, 1-bromo-
P018	357-57-3	Brucine
P018	357-57-3	Strychnidin-10-one, 2,3-dimethoxy-
P020	88-85-7	Dinoseb
P020	88-85-7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
P021	592-01-8	Calcium cyanide
P021	592-01-8	Calcium cyanide Ca(CN)2
P022	75-15-0	Carbon disulfide
P023	107-20-0	Acetaldehyde, chloro-
P023	107-20-0	Chloroacetaldehyde
P024	106-47-8	Benzenamine, 4-chloro-
P024	106-47-8	p-Chloroaniline
P026	5344-82-1	1-(o-Chlorophenyl)thiourea
P026	5344-82-1	Thiourea, (2-chlorophenyl)-

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P027	542-76-7	3-Chloropropionitrile
P027	542-76-7	Propanenitrile, 3-chloro-
P028	100-44-7	Benzene, (chloromethyl)-
P028	100-44-7	Benzyl chloride
P029	544-92-3	Copper cyanide
P029	544-92-3	Copper cyanide Cu(CN)
P030		Cyanides (soluble cyanide salts), not otherwise specified
P031	460-19-5	Cyanogen
P031	460-19-5	Ethanedinitrile
P033	506-77-4	Cyanogen chloride
P033	506-77-4	Cyanogen chloride (CN)Cl
P034	131-89-5	2-Cyclohexyl-4,6-dinitrophenol
P034	131-89-5	Phenol, 2-cyclohexyl-4,6-dinitro-
P036	696-28-6	Arsonous dichloride, phenyl-
P036	696-28-6	Dichlorophenylarsine
P037	60-57-1	Dieldrin
P037	60-57-1	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta,6aalpha,7beta, 7aalpha)-
P038	692-42-2	Arsine, diethyl-
P038	692-42-2	Diethylarsine
P039	298-04-4	Disulfoton
P039	298-04-4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
P040	297-97-2	O,O-Diethyl O-pyrazinyl phosphorothioate
P040	297-97-2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
P041	311-45-5	Diethyl-p-nitrophenyl phosphate
P041	311-45-5	Phosphoric acid, diethyl 4-nitrophenyl ester
P042	51-43-4	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-, (R)-

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P042	51-43-4	Epinephrine
P043	55-91-4	Diisopropylfluorophosphate (DFP)
P043	55-91-4	Phosphorofluoridic acid, bis(1-methylethyl) ester
P044	60-51-5	Dimethoate
P044	60-51-5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methyl amino)-2-oxoethyl] ester
P045	39196-18-4	2-Butanone, 3,3-dimethyl-1-(methylthio)-, O-[(methylamino)carbonyl] oxime
P045	39196-18-4	Thiofanox
P046	122-09-8	Benzeneethanamine, alpha,alpha-dimethyl-
P046	122-09-8	alpha,alpha-Dimethylphenethylamine
P047	1 534-52-1	4,6-Dinitro-o-cresol, & salts
P047	1 534-52-1	Phenol, 2-methyl-4,6-dinitro-, & salts
P048	51-28-5	2,4-Dinitrophenol
P048	51-28-5	Phenol, 2,4-dinitro-
P049	541-53-7	Dithiobiuret
P049	541-53-7	Thioimidodicarbonic diamide [(H2 N)C(S)]2 NH
P050	115-29-7	Endosulfan
P050	115-29-7	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
P051	1 72-20-8	2,7:3,6-Dimethanonaphth [2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta, 7aalpha)-, & metabolites
P051	72-20-8	Endrin
P051	72-20-8	Endrin, & metabolites
P054	151-56-4	Aziridine
P054	151-56-4	Ethyleneimine

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P056	7782-41-4	Fluorine
P057	640-19-7	Acetamide, 2-fluoro-
P057	640-19-7	Fluoroacetamide
P058	62-74-8	Acetic acid, fluoro-, sodium salt
P058	62-74-8	Fluoroacetic acid, sodium salt
P059	76-44-8	Heptachlor
P059	76-44-8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P060	465-73-6	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abeta,5beta,8beta,8a beta)-
P060	465-73-6	Isodrin
P062	757-58-4	Hexaethyl tetraphosphate
P062	757-58-4	Tetraphosphoric acid, hexaethyl ester
P063	74-90-8	Hydrocyanic acid
P063	74-90-8	Hydrogen cyanide
P064	624-83-9	Methane, isocyanato-
P064	624-83-9	Methyl isocyanate
P065	628-86-4	Fulminic acid, mercury(2+) salt (R,T)
P065	628-86-4	Mercury fulminate (R,T)
P066	16752-77-5	Ethanimidothioic acid, N-[[(methylamino)carbonyl]oxy]-, methyl ester
P066	16752-77-5	Methomyl
P067	75-55-8	Aziridine, 2-methyl-
P067	75-55-8	1,2-Propylenimine
P068	60-34-4	Hydrazine, methyl-
P068	60-34-4	Methyl hydrazine
P069	75-86-5	2-Methyllactonitrile
P069	75-86-5	Propanenitrile, 2-hydroxy-2-methyl-
P070	116-06-3	Aldicarb

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P070	116-06-3	Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime
P071	298-00-0	Methyl parathion
P071	298-00-0	Phosphorothioic acid, O,O,-dimethyl O-(4-nitrophenyl) ester
P072	86-88-4	alpha-Naphthylthiourea
P072	86-88-4	Thiourea, 1-naphthalenyl-
P073	13463-39-3	Nickel carbonyl
P073	13463-39-3	Nickel carbonyl Ni(CO)4, (T-4)-
P074	557-19-7	Nickel cyanide
P074	557-19-7	Nickel cyanide Ni(CN)2
P075	1 54-11-5	Nicotine, & salts
P075	1 54-11-5	Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts
P076	10102-43-9	Nitric oxide
P076	10102-43-9	Nitrogen oxide NO
P077	100-01-6	Benzenamine, 4-nitro-
P077	100-01-6	p-Nitroaniline
P078	10102-44-0	Nitrogen dioxide
P078	10102-44-0	Nitrogen oxide NO2
P081	55-63-0	Nitroglycerine (R)
P081	55-63-0	1,2,3-Propanetriol, trinitrate (R)
P082	62-75-9	Methanamine, -methyl-N-nitroso-
P082	62-75-9	N-Nitrosodimethylamine
P084	4549-40-0	N-Nitrosomethylvinylamine
P084	4549-40-0	Vinylamine, -methyl-N-nitroso-
P085	152-16-9	Diphosphoramide, octamethyl-
P085	152-16-9	Octamethylpyrophosphoramide
P087	20816-12-0	Osmium oxide OsO4, (T-4)-
P087	20816-12-0	Osmium tetroxide
P088	145-73-3	Endothall
P088	145-73-3	7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
P089	56-38-2	Parathion

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P089	56-38-2	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
P092	62-38-4	Mercury, (acetato-O)phenyl-
P092	62-38-4	Phenylmercury acetate
P093	103-85-5	Phenylthiourea
P093	103-85-5	Thiourea, phenyl-
P094	298-02-2	Phorate
P094	298-02-2	Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester
P095	75-44-5	Carbonic dichloride
P095	75-44-5	Phosgene
P096	7803-51-2	Hydrogen phosphide
P096	7803-51-2	Phosphine
P097	52-85-7	Famphur
P097	52-85-7	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester
P098	151-50-8	Potassium cyanide
P098	151-50-8	Potassium cyanide K(CN)
P099	506-61-6	Argentate(1-), bis(cyano-C)-, potassium
P099	506-61-6	Potassium silver cyanide
P101	107-12-0	Ethyl cyanide
P101	107-12-0	Propanenitrile
P102	107-19-7	Propargyl alcohol
P102	107-19-7	2-Propyn-1-ol
P103	630-10-4	Selenourea
P104	506-64-9	Silver cyanide
P104	506-64-9	Silver cyanide Ag(CN)
P105	26628-22-8	Sodium azide
P106	143-33-9	Sodium cyanide
P106	143-33-9	Sodium cyanide Na(CN)
P108	1 157-24-9	Strychnidin-10-one, & salts
P108	1 157-24-9	Strychnine, & salts

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P109	3689-24-5	Tetraethyldithiopyrophosphate
P109	3689-24-5	Thiodiphosphoric acid, tetraethyl ester
P110	78-00-2	Plumbane, tetraethyl-
P110	78-00-2	Tetraethyl lead
P111	107-49-3	Diphosphoric acid, tetraethyl ester
P111	107-49-3	Tetraethyl pyrophosphate
P112	509-14-8	Methane, tetranitro-(R)
P112	509-14-8	Tetranitromethane (R)
P113	1314-32-5	Thallic oxide
P113	1314-32-5	Thallium oxide Tl2 O3
P114	12039-52-0	Selenious acid, dithallium(1+) salt
P114	12039-52-0	Tetraethyldithiopyrophosphate
P115	7446-18-6	Thiodiphosphoric acid, tetraethyl ester
P115	7446-18-6	Plumbane, tetraethyl-
P116	79-19-6	Tetraethyl lead
P116	79-19-6	Thiosemicarbazide
P118	75-70-7	Methanethiol, trichloro-
P118	75-70-7	Trichloromethanethiol
P119	7803-55-6	Ammonium vanadate
P119	7803-55-6	Vanadic acid, ammonium salt
P120	1314-62-1	Vanadium oxide V2O5
P120	1314-62-1	Vanadium pentoxide
P121	557-21-1	Zinc cyanide
P121	557-21-1	Zinc cyanide Zn(CN)2
P122	1314-84-7	Zinc phosphide Zn3 P2, when present at concentrations greater than 10% (R,T)
P123	8001-35-2	Toxaphene
P127	1563-66-2	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate.
P127	1563-66-2	Carbofuran
P128	315-8-4	Mexacarbate

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P128	315-18-4	Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester)
P185	26419-73-8	1,3-Dithiolane-2-carboxaldehyde, 2,4-dimethyl-, O-[(methylamino)-carbonyl]oxime.
P185	26419-73-8	Tirpate
P188	57-64-7	Benzoic acid, 2-hydroxy-, compd. with (3aS-cis)-1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethylpyrrolo[2,3-b]indol-5-yl methylcarbamate ester (1:1)
P188	57-64-7	Physostigmine salicylate
P189	55285-14-8	Carbamic acid, [(dibutylamino)-thio]methyl-, 2,3-dihydro-2,2-dimethyl-7-benzofuranyl ester
P189	55285-14-8	Carbosulfan
P190	1129-41-5	Carbamic acid, methyl-, 3-methylphenyl ester
P190	1129-41-5	Metolcarb
P191	644-64-4	Carbamic acid, dimethyl-, 1-[(dimethyl-amino)carbonyl]-5-methyl-1H-pyrazol-3-yl ester
P191	644-64-4	Dimetilan
P192	119-38-0	Carbamic acid, dimethyl-, 3-methyl-1-(1-methylethyl)-1H-pyrazol-5-yl ester
P192	119-38-0	Isolan
P194	23135-22-0	Ethanimidthioic acid, 2-(dimethylamino)-N-[[(methylamino) carbonyl]oxy]-2-oxo-, methyl ester
P194	23135-22-0	Oxamyl
P196	15339-36-3	Manganese, bis(dimethylcarbamodithioato-S,S′)-,
P196	15339-36-3	Manganese dimethyldithiocarbamate
P197	17702-57-7	Formparanate

Table 4 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
P197	17702-57-7	Methanimidamide, N,N-dimethyl-N′-[2-methyl-4-[[(methylamino)carbonyl]oxy]phenyl]-
P198	23422-53-9	Formetanate hydrochloride
P198	23422-53-9	Methanimidamide, N,N-dimethyl-N′-[3-[[(methylamino)-carbonyl]oxy]phenyl]-monohydrochloride
P199	2032-65-7	Methiocarb
P199	2032-65-7	Phenol, (3,5-dimethyl-4-(methylthio)-, methylcarbamate
P201	2631-37-0	Phenol, 3-methyl-5-(1-methylethyl)-, methyl carbamate
P201	2631-37-0	Promecarb
P202	64-00-6	m-Cumenyl methylcarbamate
P202	64-00-6	3-Isopropylphenyl N-methylcarbamate
P202	64-00-6	Phenol, 3-(1-methylethyl)-, methyl carbamate
P203	1646-88-4	Aldicarb sulfone
P203	1646-88-4	Propanal, 2-methyl-2-(methyl-sulfonyl)-, O-[(methylamino)carbonyl] oxime
P204	57-47-6	Physostigmine
P204	57-47-6	Pyrrolo[2,3-b]indol-5-ol, 1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethyl-, methylcarbamate (ester), (3aS-cis)-
P205	137-30-4	Zinc, bis(dimethylcarbamodithioato-S,S′)-,
P205	137-30-4	Ziram

Table 5 Listed Wastes U Codes

Hazardous waste No.	Chemical abstracts No.	Substance
U394	30558-43-1	A2213.
U001	75-07-0	Acetaldehyde (I)
U034	75-87-6	Acetaldehyde, trichloro-
U187	62-44-2	Acetamide, N-(4-ethoxyphenyl)-
U005	53-96-3	Acetamide, N-9H-fluoren-2-yl-
U240	1 94-75-7	Acetic acid, (2,4-dichlorophenoxy)-, salts & esters
U112	141-78-6	Acetic acid ethyl ester (I)
U144	301-04-2	Acetic acid, lead(2+) salt
U214	563-68-8	Acetic acid, thallium(1+) salt
see F027	93-76-5	Acetic acid, (2,4,5-trichlorophenoxy)-
U002	67-64-1	Acetone (I)
U003	75-05-8	Acetonitrile (I,T)
U004	98-86-2	Acetophenone
U005	53-96-3	2-Acetylaminofluorene
U006	75-36-5	Acetyl chloride (C,R,T)
U007	79-06-1	Acrylamide
U008	79-10-7	Acrylic acid (I)
U009	107-13-1	Acrylonitrile
U011	61-82-5	Amitrole
U012	62-53-3	Aniline (I,T)
U136	75-60-5	Arsinic acid, dimethyl-
U014	492-80-8	Auramine
U015	115-02-6	Azaserine
U010	50-07-7	Azirino[2′,3′:3,4]pyrrolo[1,2-a]indole-4,7-dione, 6-amino-8-[[(aminocarbonyl)oxy]methyl]-1,1a,2,8,8a,8b-hexahydro-8a-methoxy-5-methyl-, [1aS-(1aalpha, 8beta,8aalpha,8balpha)]-
U280	101-27-9	Barban.
U278	22781-23-3	Bendiocarb.
U364	22961-82-6	Bendiocarb phenol.
U271	17804-35-2	Benomyl.
U157	56-49-5	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U016	225-51-4	Benz[c]acridine
U017	98-87-3	Benzal chloride
U192	23950-58-5	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-
U018	56-55-3	Benz[a]anthracene
U094	57-97-6	Benz[a]anthracene, 7,12-dimethyl-
U012	62-53-3	Benzenamine (I,T)
U014	492-80-8	Benzenamine, 4,4′-carbonimidoylbis[N,N-dimethyl-
U049	3165-93-3	Benzenamine, 4-chloro-2-methyl-, hydrochloride
U093	60-11-7	Benzenamine, N,N-dimethyl-4-(phenylazo)-
U328	95-53-4	Benzenamine, 2-methyl-
U353	106-49-0	Benzenamine, 4-methyl-
U158	101-14-4	Benzenamine, 4,4′-methylenebis[2-chloro-
U222	636-21-5	Benzenamine, 2-methyl-, hydrochloride
U181	99-55-8	Benzenamine, 2-methyl-5-nitro-
U019	71-43-2	Benzene (I,T)
U038	510-15-6	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethylester
U030	101-55-3	Benzene, 1-bromo-4-phenoxy-
U035	305-03-3	Benzenebutanoic acid, 4-[bis(2-chloroethyl)amino]-
U037	108-90-7	Benzene, chloro-
U221	25376-45-8	Benzenediamine, ar-methyl-
U028	117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U069	84-74-2	1,2-Benzenedicarboxylic acid, dibutylester
U088	84-66-2	1,2-Benzenedicarboxylic acid, diethylester
U102	131-11-3	1,2-Benzenedicarboxylic acid, dimethylester
U107	117-84-0	1,2-Benzenedicarboxylic acid, dioctylester

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U070	95-50-1	Benzene, 1,2-dichloro-
U071	541-73-1	Benzene, 1,3-dichloro-
U072	106-46-7	Benzene, 1,4-dichloro-
U060	72-54-8	Benzene, 1,1′-(2,2-dichloroethylidene)bis[4-chloro-
U017	98-87-3	Benzene, (dichloromethyl)-
U223	26471-62-5	Benzene, 1,3-diisocyanatomethyl- (R,T)
U239	1330-20-7	Benzene, dimethyl- (I)
U201	108-46-3	1,3-Benzenediol
U127	118-74-1	Benzene, hexachloro-
U056	110-82-7	Benzene, hexahydro- (I)
U220	108-88-3	Benzene, methyl-
U105	121-14-2	Benzene, 1-methyl-2,4-dinitro-
U106	606-20-2	Benzene, 2-methyl-1,3-dinitro-
U055	98-82-8	Benzene, (1-methylethyl)- (I)
U169	98-95-3	Benzene, nitro-
U183	608-93-5	Benzene, pentachloro-
U185	82-68-8	Benzene, pentachloronitro-
U020	98-09-9	Benzenesulfonic acid chloride (C,R)
U020	98-09-9	Benzenesulfonyl chloride (C,R)
U207	95-94-3	Benzene, 1,2,4,5-tetrachloro-
U061	50-29-3	Benzene, 1,1′-(2,2,2-trichloroethylidene)bis[4-chloro-
U247	72-43-5	Benzene, 1,1′-(2,2,2-trichloroethylidene)bis[4- methoxy-
U023	98-07-7	Benzene, (trichloromethyl)-
U234	99-35-4	Benzene, 1,3,5-trinitro-
U021	92-87-5	Benzidine
U278	22781-23-3	1,3-Benzodioxol-4-ol, 2,2-dimethyl-, methyl carbamate.
U364	22961-82-6	1,3-Benzodioxol-4-ol, 2,2-dimethyl-,
U203	94-59-7	1,3-Benzodioxole, 5-(2-propenyl)-
U141	120-58-1	1,3-Benzodioxole, 5-(1-propenyl)-
U367	1563-38-8	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-
U090	94-58-6	1,3-Benzodioxole, 5-propyl-

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U064	189-55-9	Benzo[rst]pentaphene
U248	181-81-2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations of 0.3% or less
U022	50-32-8	Benzo[a]pyrene
U197	106-51-4	p-Benzoquinone
U023	98-07-7	Benzotrichloride (C,R,T)
U085	1464-53-5	2,2′-Bioxirane
U021	92-87-5	[1,1′-Biphenyl]-4,4′-diamine
U073	91-94-1	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dichloro-
U091	119-90-4	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dimethoxy-
U095	119-93-7	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dimethyl-
U225	75-25-2	Bromoform
U030	101-55-3	4-Bromophenyl phenyl ether
U128	87-68-3	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
U172	924-16-3	1-Butanamine, N-butyl-N-nitroso-
U031	71-36-3	1-Butanol (I)
U159	78-93-3	2-Butanone (I,T)
U160	1338-23-4	2-Butanone, peroxide (R,T)
U053	4170-30-3	2-Butenal
U074	764-41-0	2-Butene, 1,4-dichloro- (I,T)
U143	303-34-4	2-Butenoic acid, 2-methyl-, 7-[[2,3-dihydroxy-2-(1-methoxyethyl)-3-methyl-1-oxobutoxy]methyl]- 2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester, [1S-[1alpha(Z),7(2S*,3R*),7aalpha]]-
U031	71-36-3	n-Butyl alcohol (I)
U136	75-60-5	Cacodylic acid
U032	13765-19-0	Calcium chromate
U372	10605-21-7	Carbamic acid, 1H-benzimidazol-2-yl, methyl ester.

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U271	17804-35-2	Carbamic acid, [1-[(butylamino)carbonyl]-1H-benzimidazol-2-yl]-, methyl ester.
U280	101-27-9	Carbamic acid, (3-chlorophenyl)-, 4-chloro-2-butynyl ester.
U238	51-79-6	Carbamic acid, ethyl ester
U178	615-53-2	Carbamic acid, methylnitroso-, ethyl ester
U373	122-42-9	Carbamic acid, phenyl-, 1-methylethyl ester.
U409	23564-05-8	Carbamic acid, [1,2-phenylenebis (iminocarbonothioyl)]bis-, dimethyl ester.
U097	79-44-7	Carbamic chloride, dimethyl-
U389	2303-17-5	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3,3-trichloro-2-propenyl) ester.
U387	52888-80-9	Carbamothioic acid, dipropyl-, S-(phenylmethyl) ester.
U114	1 111-54-6	Carbamodithioic acid, 1,2-ethanediylbis- ,salts & esters
U062	2303-16-4	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-di-chloro-2-propenyl) ester
U279	63-25-2	Carbaryl.
U372	10605-21-7	Carbendazim.
U367	1563-38-8	Carbofuran phenol.
U215	6533-73-9	Carbonic acid, dithallium(1+) salt
U033	353-50-4	Carbonic difluoride
U156	79-22-1	Carbonochloridic acid, methyl ester (I,T)
U033	353-50-4	Carbon oxyfluoride (R,T)
U211	56-23-5	Carbon tetrachloride
U034	75-87-6	Chloral
U035	305-03-3	Chlorambucil
U036	57-74-9	Chlordane, alpha & gamma isomers
U026	494-03-1	Chlornaphazin
U037	108-90-7	Chlorobenzene
U038	510-15-6	Chlorobenzilate
U039	59-50-7	p-Chloro-m-cresol

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U042	110-75-8	2-Chloroethyl vinyl ether
U044	67-66-3	Chloroform
U046	107-30-2	Chloromethyl methyl ether
U047	91-58-7	beta-Chloronaphthalene
U048	95-57-8	o-Chlorophenol
U049	3165-93-3	4-Chloro-o-toluidine, hydrochloride
U032	13765-19-0	Chromic acid H2 CrO4, calcium salt
U050	218-01-9	Chrysene
U051		Creosote
U052	1319-77-3	Cresol (Cresylic acid)
U053	4170-30-3	Crotonaldehyde
U055	98-82-8	Cumene (I)
U246	506-68-3	Cyanogen bromide (CN)Br
U197	106-51-4	2,5-Cyclohexadiene-1,4-dione
U056	110-82-7	Cyclohexane (I)
U129	58-89-9	Cyclohexane, 1,2,3,4,5,6-hexachloro- ,(1alpha,2alpha,3beta,4alpha,5alpha,6beta)-
U057	108-94-1	Cyclohexanone (I)
U130	77-47-4	1,3-Cyclopentadiene, 1,2,3,4,5,5- hexachloro-
U058	50-18-0	Cyclophosphamide
U240	1 94-75-7	2,4-D, salts & esters
U059	20830-81-3	Daunomycin
U060	72-54-8	DDD
U061	50-29-3	DDT
U062	2303-16-4	Diallate
U063	53-70-3	Dibenz[a,h]anthracene
U064	189-55-9	Dibenzo[a,i]pyrene
U066	96-12-8	1,2-Dibromo-3-chloropropane
U069	84-74-2	Dibutyl phthalate
U070	95-50-1	o-Dichlorobenzene
U071	541-73-1	m-Dichlorobenzene
U072	106-46-7	p-Dichlorobenzene
U073	91-94-1	3,3′-Dichlorobenzidine

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U074	764-41-0	1,4-Dichloro-2-butene (I,T)
U075	75-71-8	Dichlorodifluoromethane
U078	75-35-4	1,1-Dichloroethylene
U079	156-60-5	1,2-Dichloroethylene
U025	111-44-4	Dichloroethyl ether
U027	108-60-1	Dichloroisopropyl ether
U024	111-91-1	Dichloromethoxy ethane
U081	120-83-2	2,4-Dichlorophenol
U082	87-65-0	2,6-Dichlorophenol
U084	542-75-6	1,3-Dichloropropene
U085	1464-53-5	1,2:3,4-Diepoxybutane (I,T)
U108	123-91-1	1,4-Diethyleneoxide
U028	117-81-7	Diethylhexyl phthalate
U395	5952-26-1	Diethylene glycol, dicarbamate.
U086	1615-80-1	N,N′-Diethylhydrazine
U087	3288-58-2	O,O-Diethyl S-methyl dithiophosphate
U088	84-66-2	Diethyl phthalate
U089	56-53-1	Diethylstilbesterol
U090	94-58-6	Dihydrosafrole
U091	119-90-4	3,3′-Dimethoxybenzidine
U092	124-40-3	Dimethylamine (I)
U093	60-11-7	p-Dimethylaminoazobenzene
U094	57-97-6	7,12-Dimethylbenz[a]anthracene
U095	119-93-7	3,3′-Dimethylbenzidine
U096	80-15-9	alpha,alpha-Dimethylbenzylhydroperoxide (R)
U097	79-44-7	Dimethylcarbamoyl chloride
U098	57-14-7	1,1-Dimethylhydrazine
U099	540-73-8	1,2-Dimethylhydrazine
U101	105-67-9	2,4-Dimethylphenol
U102	131-11-3	Dimethyl phthalate
U103	77-78-1	Dimethyl sulfate
U105	121-14-2	2,4-Dinitrotoluene
U106	606-20-2	2,6-Dinitrotoluene
U107	117-84-0	Di-n-octyl phthalate

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U108	123-91-1	1,4-Dioxane
U109	122-66-7	1,2-Diphenylhydrazine
U110	142-84-7	Dipropylamine (I)
U111	621-64-7	Di-n-propylnitrosamine
U041	106-89-8	Epichlorohydrin
U001	75-07-0	Ethanal (I)
U404	121-44-8	Ethanamine, N,N-diethyl-
U174	55-18-5	Ethanamine, N-ethyl-N-nitroso-
U155	91-80-5	1,2-Ethanediamine, N,N-dimethyl-N′-2-pyridinyl-N′-(2-thienylmethyl)-
U067	106-93-4	Ethane, 1,2-dibromo-
U076	75-34-3	Ethane, 1,1-dichloro-
U077	107-06-2	Ethane, 1,2-dichloro-
U131	67-72-1	Ethane, hexachloro-
U024	111-91-1	Ethane, 1,1′-[methylenebis(oxy)]bis[2-chloro-
U117	60-29-7	Ethane, 1,1′-oxybis-(I)
U025	111-44-4	Ethane, 1,1′-oxybis[2-chloro-
U184	76-01-7	Ethane, pentachloro-
U208	630-20-6	Ethane, 1,1,1,2-tetrachloro-
U209	79-34-5	Ethane, 1,1,2,2-tetrachloro-
U218	62-55-5	Ethanethioamide
U226	71-55-6	Ethane, 1,1,1-trichloro-
U227	79-00-5	Ethane, 1,1,2-trichloro-
U410	59669-26-0	Ethanimidothioic acid, N,N′-[thiobis[(methylimino)carbonyloxy]]bis-, dimethyl ester
U394	30558-43-1	Ethanimidothioic acid, 2-(dimethylamino)-N-hydroxy-2-oxo-, methyl ester.
U359	110-80-5	Ethanol, 2-ethoxy-
U173	1116-54-7	Ethanol, 2,2′-(nitrosoimino)bis-
U395	5952-26-1	Ethanol, 2,2′-oxybis-, dicarbamate.
U004	98-86-2	Ethanone, 1-phenyl-
U043	75-01-4	Ethene, chloro-
U042	110-75-8	Ethene, (2-chloroethoxy)-

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U078	75-35-4	Ethene, 1,1-dichloro-
U079	156-60-5	Ethene, 1,2-dichloro-, (E)-
U210	127-18-4	Ethene, tetrachloro-
U228	79-01-6	Ethene, trichloro-
U112	141-78-6	Ethyl acetate (I)
U113	140-88-5	Ethyl acrylate (I)
U238	51-79-6	Ethyl carbamate (urethane)
U117	60-29-7	Ethyl ether (I)
U114	1 111-54-6	Ethylenebisdithiocarbamic acid, salts & esters
U067	106-93-4	Ethylene dibromide
U077	107-06-2	Ethylene dichloride
U359	110-80-5	Ethylene glycol monoethyl ether
U115	75-21-8	Ethylene oxide (I,T)
U116	96-45-7	Ethylenethiourea
U076	75-34-3	Ethylidene dichloride
U118	97-63-2	Ethyl methacrylate
U119	62-50-0	Ethyl methanesulfonate
U120	206-44-0	Fluoranthene
U122	50-00-0	Formaldehyde
U123	64-18-6	Formic acid (C,T)
U124	110-00-9	Furan (I)
U125	98-01-1	2-Furancarboxaldehyde (I)
U147	108-31-6	2,5-Furandione
U213	109-99-9	Furan, tetrahydro-(I)
U125	98-01-1	Furfural (I)
U124	110-00-9	Furfuran (I)
U206	18883-66-4	Glucopyranose, 2-deoxy-2-(3-methyl-3-nitrosoureido)-, D-
U206	18883-66-4	D-Glucose, 2-deoxy-2-[[(methylnitrosoamino)-carbonyl]amino]-
U126	765-34-4	Glycidylaldehyde
U163	70-25-7	Guanidine, N-methyl-N′-nitro-N-nitroso-
U127	118-74-1	Hexachlorobenzene
U128	87-68-3	Hexachlorobutadiene

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U130	77-47-4	Hexachlorocyclopentadiene
U131	67-72-1	Hexachloroethane
U132	70-30-4	Hexachlorophene
U243	1888-71-7	Hexachloropropene
U133	302-01-2	Hydrazine (R,T)
U086	1615-80-1	Hydrazine, 1,2-diethyl-
U098	57-14-7	Hydrazine, 1,1-dimethyl-
U099	540-73-8	Hydrazine, 1,2-dimethyl-
U109	122-66-7	Hydrazine, 1,2-diphenyl-
U134	7664-39-3	Hydrofluoric acid (C,T)
U134	7664-39-3	Hydrogen fluoride (C,T)
U135	6-4-7783	Hydrogen sulfide
U135	6-4-7783	Hydrogen sulfide H2 S
U096	80-15-9	Hydroperoxide, 1-methyl-1-phenylethyl- (R)
U116	96-45-7	2-Imidazolidinethione
U137	193-39-5	Indeno[1,2,3-cd]pyrene
U190	85-44-9	1,3-Isobenzofurandione
U140	78-83-1	Isobutyl alcohol (I,T)
U141	120-58-1	Isosafrole
U142	143-50-0	Kepone
U143	303-34-4	Lasiocarpine
U144	301-04-2	Lead acetate
U146	1335-32-6	Lead, bis(acetato-O)tetrahydroxytri-
U145	7446-27-7	Lead phosphate
U146	1335-32-6	Lead subacetate
U129	58-89-9	Lindane
U163	70-25-7	MNNG
U147	108-31-6	Maleic anhydride
U148	123-33-1	Maleic hydrazide
U149	109-77-3	Malononitrile
U150	148-82-3	Melphalan
U151	7439-97-6	Mercury
U152	126-98-7	Methacrylonitrile (I, T)
U092	124-40-3	Methanamine, N-methyl- (I)

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U029	74-83-9	Methane, bromo-
U045	74-87-3	Methane, chloro- (I, T)
U046	107-30-2	Methane, chloromethoxy-
U068	74-95-3	Methane, dibromo-
U080	75-09-2	Methane, dichloro-
U075	75-71-8	Methane, dichlorodifluoro-
U138	74-88-4	Methane, iodo-
U119	62-50-0	Methanesulfonic acid, ethyl ester
U211	56-23-5	Methane, tetrachloro-
U153	74-93-1	Methanethiol (I, T)
U225	75-25-2	Methane, tribromo-
U044	67-66-3	Methane, trichloro-
U121	75-69-4	Methane, trichlorofluoro-
U036	57-74-9	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-
U154	67-56-1	Methanol (I)
U155	91-80-5	Methapyrilene
U142	143-50-0	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-
U247	72-43-5	Methoxychlor
U154	67-56-1	Methyl alcohol (I)
U029	74-83-9	Methyl bromide
U186	504-60-9	1-Methylbutadiene (I)
U045	74-87-3	Methyl chloride (I,T)
U156	79-22-1	Methyl chlorocarbonate (I,T)
U226	71-55-6	Methyl chloroform
U157	56-49-5	3-Methylcholanthrene
U158	101-14-4	4,4′-Methylenebis(2-chloroaniline)
U068	74-95-3	Methylene bromide
U080	75-09-2	Methylene chloride
U159	78-93-3	Methyl ethyl ketone (MEK) (I,T)
U160	1338-23-4	Methyl ethyl ketone peroxide (R,T)
U138	74-88-4	Methyl iodide
U161	108-10-1	Methyl isobutyl ketone (I)

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U162	80-62-6	Methyl methacrylate (I,T)
U161	108-10-1	4-Methyl-2-pentanone (I)
U164	56-04-2	Methylthiouracil
U010	50-07-7	Mitomycin C
U059	20830-81-3	5,12-Naphthacenedione, 8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-, (8S-cis)-
U167	134-32-7	1-Naphthalenamine
U168	91-59-8	2-Naphthalenamine
U026	494-03-1	Naphthalenamine, N,N′-bis(2-chloroethyl)-
U165	91-20-3	Naphthalene
U047	91-58-7	Naphthalene, 2-chloro-
U166	130-15-4	1,4-Naphthalenedione
U236	72-57-1	2,7-Naphthalenedisulfonic acid, 3,3′-[(3,3′-dimethyl[1,1′-biphenyl]-4,4′-diyl)bis(azo)bis[5-amino-4-hydroxy]-, tetrasodium salt
U279	63-25-2	1-Naphthalenol, methylcarbamate.
U166	130-15-4	1,4-Naphthoquinone
U167	134-32-7	alpha-Naphthylamine
U168	91-59-8	beta-Naphthylamine
U217	10102-45-1	Nitric acid, thallium(1+) salt
U169	98-95-3	Nitrobenzene (I,T)
U170	100-02-7	p-Nitrophenol
U171	79-46-9	2-Nitropropane (I,T)
U172	924-16-3	N-Nitrosodi-n-butylamine
U173	1116-54-7	N-Nitrosodiethanolamine
U174	55-18-5	N-Nitrosodiethylamine
U176	759-73-9	N-Nitroso-N-ethylurea
U177	684-93-5	N-Nitroso-N-methylurea
U178	615-53-2	N-Nitroso-N-methylurethane
U179	100-75-4	N-Nitrosopiperidine
U180	930-55-2	N-Nitrosopyrrolidine
U181	99-55-8	5-Nitro-o-toluidine

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U193	1120-71-4	1,2-Oxathiolane, 2,2-dioxide
U058	50-18-0	2H-1,3,2-Oxazaphosphorin-2-amine,N,N-bis(2-chloroethyl)tetrahydro-, 2-oxide
U115	75-21-8	Oxirane (I,T)
U126	765-34-4	Oxiranecarboxyaldehyde
U041	106-89-8	Oxirane, (chloromethyl)-
U182	123-63-7	Paraldehyde
U183	608-93-5	Pentachlorobenzene
U184	76-01-7	Pentachloroethane
U185	82-68-8	Pentachloronitrobenzene (PCNB)
See F027	87-86-5	Pentachlorophenol
U161	108-10-1	Pentanol, 4-methyl-
U186	504-60-9	1,3-Pentadiene (I)
U187	62-44-2	Phenacetin
U188	108-95-2	Phenol
U048	95-57-8	Phenol, 2-chloro-
U039	59-50-7	Phenol, 4-chloro-3-methyl-
U081	120-83-2	Phenol, 2,4-dichloro-
U082	87-65-0	Phenol, 2,6-dichloro-
U089	56-53-1	Phenol, 4,4′-(1,2-diethyl-1,2-ethenediyl)bis-, (E)-
U101	105-67-9	Phenol, 2,4-dimethyl-
U052	1319-77-3	Phenol, methyl-
U132	70-30-4	Phenol, 2,2′-methylenebis[3,4,6-trichloro-
U411	114-26-1	Phenol, 2-(1-methylethoxy)-, methylcarbamate.
U170	100-02-7	Phenol, 4-nitro-
See F027	87-86-5	Phenol, pentachloro-
See F027	58-90-2	Phenol, 2,3,4,6-tetrachloro-
See F027	95-95-4	Phenol, 2,4,5-trichloro-
See F027	88-06-2	Phenol, 2,4,6-trichloro-
U150	148-82-3	L-Phenylalanine, 4-[bis(2-chloroethyl)amino]-

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U145	7446-27-7	Phosphoric acid, lead(2+) salt (2:3)
U087	3288-58-2	Phosphorodithioic acid, O,O-diethyl S-methyl ester
U189	1314-80-3	Phosphorus sulfide (R)
U190	85-44-9	Phthalic anhydride
U191	109-06-8	2-Picoline
U179	100-75-4	Piperidine, 1-nitroso-
U192	23950-58-5	Pronamide
U194	107-10-8	1-Propanamine (I,T)
U111	621-64-7	1-Propanamine, N-nitroso-N-propyl-
U110	142-84-7	1-Propanamine, N-propyl- (I)
U066	96-12-8	Propane, 1,2-dibromo-3-chloro-
U083	78-87-5	Propane, 1,2-dichloro-
U149	109-77-3	Propanedinitrile
U171	79-46-9	Propane, 2-nitro- (I,T)
U027	108-60-1	Propane, 2,2′-oxybis[2-chloro-
U193	1120-71-4	1,3-Propane sultone
See F027	93-72-1	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-
U235	126-72-7	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U140	78-83-1	1-Propanol, 2-methyl- (I,T)
U002	67-64-1	2-Propanone (I)
U007	79-06-1	2-Propenamide
U084	542-75-6	1-Propene, 1,3-dichloro-
U243	1888-71-7	1-Propene, 1,1,2,3,3,3-hexachloro-
U009	107-13-1	2-Propenenitrile
U152	126-98-7	2-Propenenitrile, 2-methyl- (I,T)
U008	79-10-7	2-Propenoic acid (I)
U113	140-88-5	2-Propenoic acid, ethyl ester (I)
U118	97-63-2	2-Propenoic acid, 2-methyl-, ethyl ester
U162	80-62-6	2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U373	122-42-9	Propham.
U411	114-26-1	Propoxur.
U387	52888-80-9	Prosulfocarb.

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U194	107-10-8	n-Propylamine (I,T)
U083	78-87-5	Propylene dichloride
U148	123-33-1	3,6-Pyridazinedione, 1,2-dihydro-
U196	110-86-1	Pyridine
U191	109-06-8	Pyridine, 2-methyl-
U237	66-75-1	2,4-(1H,3H)-Pyrimidinedione, 5-[bis(2-chloroethyl)amino]-
U164	56-04-2	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-
U180	930-55-2	Pyrrolidine, 1-nitroso-
U200	50-55-5	Reserpine
U201	108-46-3	Resorcinol
U203	94-59-7	Safrole
U204	7783-00-8	Selenious acid
U204	7783-00-8	Selenium dioxide
U205	7488-56-4	Selenium sulfide
U205	7488-56-4	Selenium sulfide SeS2 (R,T)
U015	115-02-6	L-Serine, diazoacetate (ester)
See F027	93-72-1	Silvex (2,4,5-TP)
U206	18883-66-4	Streptozotocin
U103	77-78-1	Sulfuric acid, dimethyl ester
U189	1314-80-3	Sulfur phosphide (R)
See F027	93-76-5	2,4,5-T
U207	95-94-3	1,2,4,5-Tetrachlorobenzene
U208	630-20-6	1,1,1,2-Tetrachloroethane
U209	79-34-5	1,1,2,2-Tetrachloroethane
U210	127-18-4	Tetrachloroethylene
See F027	58-90-2	2,3,4,6-Tetrachlorophenol
U213	109-99-9	Tetrahydrofuran (I)
U214	563-68-8	Thallium(I) acetate
U215	6533-73-9	Thallium(I) carbonate
U216	7791-12-0	Thallium(I) chloride
U216	7791-12-0	thallium chloride TlCl
U217	10102-45-1	Thallium(I) nitrate
U218	62-55-5	Thioacetamide

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U410	59669-26-0	Thiodicarb.
U153	74-93-1	Thiomethanol (I,T)
U244	137-26-8	Thioperoxydicarbonic diamide [(H2 N)C(S)]2 S2, tetramethyl-
U409	23564-05-8	Thiophanate-methyl.
U219	62-56-6	Thiourea
U244	137-26-8	Thiram
U220	108-88-3	Toluene
U221	25376-45-8	Toluenediamine
U223	26471-62-5	Toluene diisocyanate (R,T)
U328	95-53-4	o-Toluidine
U353	106-49-0	p-Toluidine
U222	636-21-5	o-Toluidine hydrochloride
U389	2303-17-5	Triallate.
U011	61-82-5	1H-1,2,4-Triazol-3-amine
U226	71-55-6	1,1,1-Trichloroethane
U227	79-00-5	1,1,2-Trichloroethane
U228	79-01-6	Trichloroethylene
U121	75-69-4	Trichloromonofluoromethane
See F027	95-95-4	2,4,5-Trichlorophenol
See F027	88-06-2	2,4,6-Trichlorophenol
U404	121-44-8	Triethylamine.
U234	99-35-4	1,3,5-Trinitrobenzene (R,T)
U182	123-63-7	1,3,5-Trioxane, 2,4,6-trimethyl-
U235	126-72-7	Tris(2,3-dibromopropyl) phosphate
U236	72-57-1	Trypan blue
U237	66-75-1	Uracil mustard
U176	759-73-9	Urea, N-ethyl-N-nitroso-
U177	684-93-5	Urea, N-methyl-N-nitroso-
U043	75-01-4	Vinyl chloride
U248	1 81-81-2	Warfarin, & salts, when present at concentrations of 0.3% or less
U239	1330-20-7	Xylene (I)

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U200	50-55-5	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methyl ester, (3beta,16beta,17alpha,18beta,20alpha)-
U249	1314-84-7	Zinc phosphide Zn3 P2, when present at concentrations of 10% or less
U001	75-07-0	Acetaldehyde (I)
U001	75-07-0	Ethanal (I)
U002	67-64-1	Acetone (I)
U002	67-64-1	2-Propanone (I)
U003	75-05-8	Acetonitrile (I,T)
U004	98-86-2	Acetophenone
U004	98-86-2	Ethanone, 1-phenyl-
U005	53-96-3	Acetamide, -9H-fluoren-2-yl-
U005	53-96-3	2-Acetylaminofluorene
U006	75-36-5	Acetyl chloride (C,R,T)
U007	79-06-1	Acrylamide
U007	79-06-1	2-Propenamide
U008	79-10-7	Acrylic acid (I)
U008	79-10-7	2-Propenoic acid (I)
U009	107-13-1	Acrylonitrile
U009	107-13-1	2-Propenenitrile
U010	50-07-7	Azirino[2′,3′:3,4]pyrrolo[1,2-a]indole-4,7-dione, 6-amino-8-[[(aminocarbonyl)oxy]methyl]-1,1a,2,8,8a,8b-hexahydro-8a-methoxy-5-methyl-, [1aS-(1aalpha, 8beta,8aalpha,8balpha)]-
U010	50-07-7	Mitomycin C
U011	61-82-5	Amitrole
U011	61-82-5	1H-1,2,4-Triazol-3-amine
U012	62-53-3	Aniline (I,T)
U012	62-53-3	Benzenamine (I,T)
U014	492-80-8	Auramine
U014	492-80-8	Benzenamine, 4,4′-carbonimidoylbis[N,N-dimethyl-

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U015	115-02-6	Azaserine
U015	115-02-6	L-Serine, diazoacetate (ester)
U016	225-51-4	Benz[c]acridine
U017	98-87-3	Benzal chloride
U017	98-87-3	Benzene, (dichloromethyl)-
U018	56-55-3	Benz[a]anthracene
U019	71-43-2	Benzene (I,T)
U020	98-09-9	Benzenesulfonic acid chloride (C,R)
U020	98-09-9	Benzenesulfonyl chloride (C,R)
U021	92-87-5	Benzidine
U021	92-87-5	[1,1′-Biphenyl]-4,4′-diamine
U022	50-32-8	Benzo[a]pyrene
U023	98-07-7	Benzene, (trichloromethyl)-
U023	98-07-7	Benzotrichloride (C,R,T)
U024	111-91-1	Dichloromethoxy ethane
U024	111-91-1	Ethane, 1,1′-[methylenebis(oxy)]bis[2-chloro-
U025	111-44-4	Dichloroethyl ether
U025	111-44-4	Ethane, 1,1′-oxybis[2-chloro-
U026	494-03-1	Chlornaphazin
U026	494-03-1	Naphthalenamine, N,N′-bis(2-chloroethyl)-
U027	108-60-1	Dichloroisopropyl ether
U027	108-60-1	Propane, 2,2′-oxybis[2-chloro-
U028	117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U028	117-81-7	Diethylhexyl phthalate
U029	74-83-9	Methane, bromo-
U029	74-83-9	Methyl bromide
U030	101-55-3	Benzene, 1-bromo-4-phenoxy-
U030	101-55-3	4-Bromophenyl phenyl ether
U031	71-36-3	1-Butanol (I)
U031	71-36-3	n-Butyl alcohol (I)
U032	13765-19-0	Calcium chromate
U032	13765-19-0	Chromic acid H2 CrO4, calcium salt
U033	353-50-4	Carbonic difluoride

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U033	353-50-4	Carbon oxyfluoride (R,T)
U034	75-87-6	Acetaldehyde, trichloro-
U034	75-87-6	Chloral
U035	305-03-3	Benzenebutanoic acid, 4-[bis(2-chloroethyl)amino]-
U035	305-03-3	Chlorambucil
U036	57-74-9	Chlordane, alpha & gamma isomers
U036	57-74-9	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-
U037	108-90-7	Benzene, chloro-
U037	108-90-7	Chlorobenzene
U038	510-15-6	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester
U038	510-15-6	Chlorobenzilate
U039	59-50-7	p-Chloro-m-cresol
U039	59-50-7	Phenol, 4-chloro-3-methyl-
U041	106-89-8	Epichlorohydrin
U041	106-89-8	Oxirane, (chloromethyl)-
U042	110-75-8	2-Chloroethyl vinyl ether
U042	110-75-8	Ethene, (2-chloroethoxy)-
U043	75-01-4	Ethene, chloro-
U043	75-01-4	Vinyl chloride
U044	67-66-3	Chloroform
U044	67-66-3	Methane, trichloro-
U045	74-87-3	Methane, chloro- (I,T)
U045	74-87-3	Methyl chloride (I,T)
U046	107-30-2	Chloromethyl methyl ether
U046	107-30-2	Methane, chloromethoxy-
U047	91-58-7	beta-Chloronaphthalene
U047	91-58-7	Naphthalene, 2-chloro-
U048	95-57-8	o-Chlorophenol
U048	95-57-8	Phenol, 2-chloro-
U049	3165-93-3	Benzenamine, 4-chloro-2-methyl-, hydrochloride
U049	3165-93-3	4-Chloro-o-toluidine, hydrochloride

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U050	218-01-9	Chrysene
U051		Creosote
U052	1319-77-3	Cresol (Cresylic acid)
U052	1319-77-3	Phenol, methyl-
U053	4170-30-3	2-Butenal
U053	4170-30-3	Crotonaldehyde
U055	98-82-8	Benzene, (1-methylethyl)-(I)
U055	98-82-8	Cumene (I)
U056	110-82-7	Benzene, hexahydro-(I)
U056	110-82-7	Cyclohexane (I)
U057	108-94-1	Cyclohexanone (I)
U058	50-18-0	Cyclophosphamide
U058	50-18-0	2H-1,3,2-Oxazaphosphorin-2-amine, N,N-bis(2-chloroethyl)tetrahydro-, 2-oxide
U059	20830-81-3	Daunomycin
U059	20830-81-3	5,12-Naphthacenedione, 8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-, (8S-cis)-
U060	72-54-8	Benzene, 1,1′-(2,2-dichloroethylidene)bis[4-chloro-
U060	72-54-8	DDD
U061	50-29-3	Benzene, 1,1′-(2,2,2-trichloroethylidene)bis[4-chloro-
U061	50-29-3	DDT
U062	2303-16-4	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-di chloro-2-propenyl) ester
U062	2303-16-4	Diallate
U063	53-70-3	Dibenz[a,h]anthracene
U064	189-55-9	Benzo[rst]pentaphene
U064	189-55-9	Dibenzo[a,i]pyrene
U066	96-12-8	1,2-Dibromo-3-chloropropane
U066	96-12-8	Propane, 1,2-dibromo-3-chloro-
U067	106-93-4	Ethane, 1,2-dibromo-
U067	106-93-4	Ethylene dibromide

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U068	74-95-3	Methane, dibromo-
U068	74-95-3	Methylene bromide
U069	84-74-2	1,2-Benzenedicarboxylic acid, dibutyl ester
U069	84-74-2	Dibutyl phthalate
U070	95-50-1	Benzene, 1,2-dichloro-
U070	95-50-1	o-Dichlorobenzene
U071	541-73-1	Benzene, 1,3-dichloro-
U071	541-73-1	m-Dichlorobenzene
U072	106-46-7	Benzene, 1,4-dichloro-
U072	106-46-7	p-Dichlorobenzene
U073	91-94-1	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dichloro-
U073	91-94-1	3,3′-Dichlorobenzidine
U074	764-41-0	2-Butene, 1,4-dichloro-(I,T)
U074	764-41-0	1,4-Dichloro-2-butene (I,T)
U075	75-71-8	Dichlorodifluoromethane
U075	75-71-8	Methane, dichlorodifluoro-
U076	75-34-3	Ethane, 1,1-dichloro-
U076	75-34-3	Ethylidene dichloride
U077	107-06-2	Ethane, 1,2-dichloro-
U077	107-06-2	Ethylene dichloride
U078	75-35-4	1,1-Dichloroethylene
U078	75-35-4	Ethene, 1,1-dichloro-
U079	156-60-5	1,2-Dichloroethylene
U079	156-60-5	Ethene, 1,2-dichloro-, (E)-
U080	75-09-2	Methane, dichloro-
U080	75-09-2	Methylene chloride
U081	120-83-2	2,4-Dichlorophenol
U081	120-83-2	Phenol, 2,4-dichloro-
U082	87-65-0	2,6-Dichlorophenol
U082	87-65-0	Phenol, 2,6-dichloro-
U083	78-87-5	Propane, 1,2-dichloro-
U083	78-87-5	Propylene dichloride
U084	542-75-6	1,3-Dichloropropene

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U084	542-75-6	1-Propene, 1,3-dichloro-
U085	1464-53-5	2,2′-Bioxirane
U085	1464-53-5	1,2:3,4-Diepoxybutane (I,T)
U086	1615-80-1	N,N′-Diethylhydrazine
U086	1615-80-1	Hydrazine, 1,2-diethyl-
U087	3288-58-2	O,O-Diethyl S-methyl dithiophosphate
U087	3288-58-2	Phosphorodithioic acid, O,O-diethyl S-methyl ester
U088	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
U088	84-66-2	Diethyl phthalate
U089	56-53-1	Diethylstilbesterol
U089	56-53-1	Phenol, 4,4′-(1,2-diethyl-1,2-ethenediyl)bis-, (E)-
U090	94-58-6	1,3-Benzodioxole, 5-propyl-
U090	94-58-6	Dihydrosafrole
U091	119-90-4	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dimethoxy-
U091	119-90-4	3,3′-Dimethoxybenzidine
U092	124-40-3	Dimethylamine (I)
U092	124-40-3	Methanamine, -methyl-(I)
U093	60-11-7	Benzenamine, N,N-dimethyl-4-(phenylazo)-
U093	60-11-7	p-Dimethylaminoazobenzene
U094	57-97-6	Benz[a]anthracene, 7,12-dimethyl-
U094	57-97-6	7,12-Dimethylbenz[a]anthracene
U095	119-93-7	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dimethyl-
U095	119-93-7	3,3′-Dimethylbenzidine
U096	80-15-9	alpha,alpha-Dimethylbenzylhydroperoxide (R)
U096	80-15-9	Hydroperoxide, 1-methyl-1-phenylethyl-(R)
U097	79-44-7	Carbamic chloride, dimethyl-
U097	79-44-7	Dimethylcarbamoyl chloride
U098	57-14-7	1,1-Dimethylhydrazine

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U098	57-14-7	Hydrazine, 1,1-dimethyl-
U099	540-73-8	1,2-Dimethylhydrazine
U099	540-73-8	Hydrazine, 1,2-dimethyl-
U101	105-67-9	2,4-Dimethylphenol
U101	105-67-9	Phenol, 2,4-dimethyl-
U102	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
U102	131-11-3	Dimethyl phthalate
U103	77-78-1	Dimethyl sulfate
U103	77-78-1	Sulfuric acid, dimethyl ester
U105	121-14-2	Benzene, 1-methyl-2,4-dinitro-
U105	121-14-2	2,4-Dinitrotoluene
U106	606-20-2	Benzene, 2-methyl-1,3-dinitro-
U106	606-20-2	2,6-Dinitrotoluene
U107	117-84-0	1,2-Benzenedicarboxylic acid, dioctyl ester
U107	117-84-0	Di-n-octyl phthalate
U108	123-91-1	1,4-Diethyleneoxide
U108	123-91-1	1,4-Dioxane
U109	122-66-7	1,2-Diphenylhydrazine
U109	122-66-7	Hydrazine, 1,2-diphenyl-
U110	142-84-7	Dipropylamine (I)
U110	142-84-7	1-Propanamine, N-propyl-(I)
U111	621-64-7	Di-n-propylnitrosamine
U111	621-64-7	1-Propanamine, N-nitroso-N-propyl-
U112	141-78-6	Acetic acid ethyl ester (I)
U112	141-78-6	Ethyl acetate (I)
U113	140-88-5	Ethyl acrylate (I)
U113	140-88-5	2-Propenoic acid, ethyl ester (I)
U114	1111-54-6	Carbamodithioic acid, 1,2-ethanediylbis-, salts & esters
U114	1111-54-6	Ethylenebisdithiocarbamic acid, salts & esters
U115	75-21-8	Ethylene oxide (I,T)
U115	75-21-8	Oxirane (I,T)
U116	96-45-7	Ethylenethiourea

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U116	96-45-7	2-Imidazolidinethione
U117	60-29-7	Ethane, 1,1′-oxybis-(I)
U117	60-29-7	Ethyl ether (I)
U118	97-63-2	Ethyl methacrylate
U118	97-63-2	2-Propenoic acid, 2-methyl-, ethyl ester
U119	62-50-0	Ethyl methanesulfonate
U119	62-50-0	Methanesulfonic acid, ethyl ester
U120	206-44-0	Fluoranthene
U121	75-69-4	Methane, trichlorofluoro-
U121	75-69-4	Trichloromonofluoromethane
U122	50-00-0	Formaldehyde
U123	64-18-6	Formic acid (C,T)
U124	110-00-9	Furan (I)
U124	110-00-9	Furfuran (I)
U125	98-01-1	2-Furancarboxaldehyde (I)
U125	98-01-1	Furfural (I)
U126	765-34-4	Glycidylaldehyde
U126	765-34-4	Oxiranecarboxyaldehyde
U127	118-74-1	Benzene, hexachloro-
U127	118-74-1	Hexachlorobenzene
U128	87-68-3	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
U128	87-68-3	Hexachlorobutadiene
U129	58-89-9	Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1alpha,2alpha,3beta,4alpha,5alpha,6beta)-
U129	58-89-9	Lindane
U130	77-47-4	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
U130	77-47-4	Hexachlorocyclopentadiene
U131	67-72-1	Ethane, hexachloro-
U131	67-72-1	Hexachloroethane
U132	70-30-4	Hexachlorophene
U132	70-30-4	Phenol, 2,2′-methylenebis[3,4,6-trichloro-
U133	302-01-2	Hydrazine (R,T)
U134	7664-39-3	Hydrofluoric acid (C,T)

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U134	7664-39-3	Hydrogen fluoride (C,T)
U135	6-4-7783	Hydrogen sulfide
U135	6-4-7783	Hydrogen sulfide H2S
U136	75-60-5	Arsinic acid, dimethyl-
U136	75-60-5	Cacodylic acid
U137	193-39-5	Indeno[1,2,3-cd]pyrene
U138	74-88-4	Methane, iodo-
U138	74-88-4	Methyl iodide
U140	78-83-1	Isobutyl alcohol (I,T)
U140	78-83-1	1-Propanol, 2-methyl- (I,T)
U141	120-58-1	1,3-Benzodioxole, 5-(1-propenyl)-
U141	120-58-1	Isosafrole
U142	143-50-0	Kepone
U142	143-50-0	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-
U143	303-34-4	2-Butenoic acid, 2-methyl-, 7-[[2,3-dihydroxy-2-(1-methoxyethyl)-3-methyl-1-oxobutoxy]methyl]-2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester, [1S-[1alpha(Z),7(2S*,3R*),7aalpha]]-
U143	303-34-4	Lasiocarpine
U144	301-04-2	Acetic acid, lead(2+) salt
U144	301-04-2	Lead acetate
U145	7446-27-7	Lead phosphate
U145	7446-27-7	Phosphoric acid, lead(2+) salt (2:3)
U146	1335-32-6	Lead, bis(acetato-O)tetrahydroxytri-
U146	1335-32-6	Lead subacetate
U147	108-31-6	2,5-Furandione
U147	108-31-6	Maleic anhydride
U148	123-33-1	Maleic hydrazide
U148	123-33-1	3,6-Pyridazinedione, 1,2-dihydro-
U149	109-77-3	Malononitrile
U149	109-77-3	Propanedinitrile

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U150	148-82-3	Melphalan
U150	148-82-3	L-Phenylalanine, 4-[bis(2-chloroethyl)amino]-
U151	7439-97-6	Mercury
U152	126-98-7	Methacrylonitrile (I,T)
U152	126-98-7	2-Propenenitrile, 2-methyl- (I,T)
U153	74-93-1	Methanethiol (I,T)
U153	74-93-1	Thiomethanol (I,T)
U154	67-56-1	Methanol (I)
U154	67-56-1	Methyl alcohol (I)
U155	91-80-5	1,2-Ethanediamine, N,N-dimethyl-N′-2-pyridinyl-N′-(2-thienylmethyl)-
U155	91-80-5	Methapyrilene
U156	79-22-1	Carbonochloridic acid, methyl ester (I,T)
U156	79-22-1	Methyl chlorocarbonate (I,T)
U157	56-49-5	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-
U157	56-49-5	3-Methylcholanthrene
U158	101-14-4	Benzenamine, 4,4′-methylenebis[2-chloro-
U158	101-14-4	4,4′-Methylenebis(2-chloroaniline)
U159	78-93-3	2-Butanone (I,T)
U159	78-93-3	Methyl ethyl ketone (MEK) (I,T)
U160	1338-23-4	2-Butanone, peroxide (R,T)
U160	1338-23-4	Methyl ethyl ketone peroxide (R,T)
U161	108-10-1	Methyl isobutyl ketone (I)
U161	108-10-1	4-Methyl-2-pentanone (I)
U161	108-10-1	Pentanol, 4-methyl-
U162	80-62-6	Methyl methacrylate (I,T)
U162	80-62-6	2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U163	70-25-7	Guanidine, -methyl-N'-nitro-N-nitroso-
U163	70-25-7	MNNG
U164	56-04-2	Methylthiouracil
U164	56-04-2	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U165	91-20-3	Naphthalene
U166	130-15-4	1,4-Naphthalenedione
U166	130-15-4	1,4-Naphthoquinone
U167	134-32-7	1-Naphthalenamine
U167	134-32-7	alpha-Naphthylamine
U168	91-59-8	2-Naphthalenamine
U168	91-59-8	beta-Naphthylamine
U169	98-95-3	Benzene, nitro-
U169	98-95-3	Nitrobenzene (I,T)
U170	100-02-7	p-Nitrophenol
U170	100-02-7	Phenol, 4-nitro-
U171	79-46-9	2-Nitropropane (I,T)
U171	79-46-9	Propane, 2-nitro- (I,T)
U172	924-16-3	1-Butanamine, N-butyl-N-nitroso-
U172	924-16-3	N-Nitrosodi-n-butylamine
U173	1116-54-7	Ethanol, 2,2′-(nitrosoimino)bis-
U173	1116-54-7	N-Nitrosodiethanolamine
U174	55-18-5	Ethanamine, -ethyl-N-nitroso-
U174	55-18-5	N-Nitrosodiethylamine
U176	759-73-9	N-Nitroso-N-ethylurea
U176	759-73-9	Urea, N-ethyl-N-nitroso-
U177	684-93-5	N-Nitroso-N-methylurea
U177	684-93-5	Urea, N-methyl-N-nitroso-
U178	615-53-2	Carbamic acid, methylnitroso-, ethyl ester
U178	615-53-2	N-Nitroso-N-methylurethane
U179	100-75-4	N-Nitrosopiperidine
U179	100-75-4	Piperidine, 1-nitroso-
U180	930-55-2	N-Nitrosopyrrolidine
U180	930-55-2	Pyrrolidine, 1-nitroso-
U181	99-55-8	Benzenamine, 2-methyl-5-nitro-
U181	99-55-8	5-Nitro-o-toluidine
U182	123-63-7	1,3,5-Trioxane, 2,4,6-trimethyl-
U182	123-63-7	Paraldehyde
U183	608-93-5	Benzene, pentachloro-

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U183	608-93-5	Pentachlorobenzene
U184	76-01-7	Ethane, pentachloro-
U184	76-01-7	Pentachloroethane
U185	82-68-8	Benzene, pentachloronitro-
U185	82-68-8	Pentachloronitrobenzene (PCNB)
U186	504-60-9	1-Methylbutadiene (I)
U186	504-60-9	1,3-Pentadiene (I)
U187	62-44-2	Acetamide, -(4-ethoxyphenyl)-
U187	62-44-2	Phenacetin
U188	108-95-2	Phenol
U189	1314-80-3	Phosphorus sulfide (R)
U189	1314-80-3	Sulfur phosphide (R)
U190	85-44-9	1,3-Isobenzofurandione
U190	85-44-9	Phthalic anhydride
U191	109-06-8	2-Picoline
U191	109-06-8	Pyridine, 2-methyl-
U192	23950-58-5	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-
U192	23950-58-5	Pronamide
U193	1120-71-4	1,2-Oxathiolane, 2,2-dioxide
U193	1120-71-4	1,3-Propane sultone
U194	107-10-8	1-Propanamine (I,T)
U194	107-10-8	n-Propylamine (I,T)
U196	110-86-1	Pyridine
U197	106-51-4	p-Benzoquinone
U197	106-51-4	2,5-Cyclohexadiene-1,4-dione
U200	50-55-5	Reserpine
U200	50-55-5	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methyl ester,(3beta,16beta,17alpha,18beta,20alpha)-
U201	108-46-3	1,3-Benzenediol
U201	108-46-3	Resorcinol
U203	94-59-7	1,3-Benzodioxole, 5-(2-propenyl)-
U203	94-59-7	Safrole

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U204	7783-00-8	Selenious acid
U204	7783-00-8	Selenium dioxide
U205	7488-56-4	Selenium sulfide
U205	7488-56-4	Selenium sulfide SeS2 (R,T)
U206	18883-66-4	Glucopyranose, 2-deoxy-2-(3-methyl-3-nitrosoureido)-, D-
U206	18883-66-4	D-Glucose, 2-deoxy-2-[[(methylnitrosoamino)-carbonyl]amino]-
U206	18883-66-4	Streptozotocin
U207	95-94-3	Benzene, 1,2,4,5-tetrachloro-
U207	95-94-3	1,2,4,5-Tetrachlorobenzene
U208	630-20-6	Ethane, 1,1,1,2-tetrachloro-
U208	630-20-6	1,1,1,2-Tetrachloroethane
U209	79-34-5	Ethane, 1,1,2,2-tetrachloro-
U209	79-34-5	1,1,2,2-Tetrachloroethane
U210	127-18-4	Ethene, tetrachloro-
U210	127-18-4	Tetrachloroethylene
U211	56-23-5	Carbon tetrachloride
U211	56-23-5	Methane, tetrachloro-
U213	109-99-9	Furan, tetrahydro-(I)
U213	109-99-9	Tetrahydrofuran (I)
U214	563-68-8	Acetic acid, thallium(1+) salt
U214	563-68-8	Thallium(I) acetate
U215	6533-73-9	Carbonic acid, dithallium(1+) salt
U215	6533-73-9	Thallium(I) carbonate
U216	7791-12-0	Thallium(I) chloride
U216	7791-12-0	Thallium chloride TlCl
U217	10102-45-1	Nitric acid, thallium(1+) salt
U217	10102-45-1	Thallium(I) nitrate
U218	62-55-5	Ethanethioamide
U218	62-55-5	Thioacetamide
U219	62-56-6	Thiourea
U220	108-88-3	Benzene, methyl-
U220	108-88-3	Toluene

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U221	25376-45-8	Benzenediamine, ar-methyl-
U221	25376-45-8	Toluenediamine
U222	636-21-5	Benzenamine, 2-methyl-, hydrochloride
U222	636-21-5	o-Toluidine hydrochloride
U223	26471-62-5	Benzene, 1,3-diisocyanatomethyl- (R,T)
U223	26471-62-5	Toluene diisocyanate (R,T)
U225	75-25-2	Bromoform
U225	75-25-2	Methane, tribromo-
U226	71-55-6	Ethane, 1,1,1-trichloro-
U226	71-55-6	Methyl chloroform
U226	71-55-6	1,1,1-Trichloroethane
U227	79-00-5	Ethane, 1,1,2-trichloro-
U227	79-00-5	1,1,2-Trichloroethane
U228	79-01-6	Ethene, trichloro-
U228	79-01-6	Trichloroethylene
U234	99-35-4	Benzene, 1,3,5-trinitro-
U234	99-35-4	1,3,5-Trinitrobenzene (R,T)
U235	126-72-7	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U235	126-72-7	Tris(2,3-dibromopropyl) phosphate
U236	72-57-1	2,7-Naphthalenedisulfonic acid, 3,3′-[(3,3′-dimethyl[1,1′-biphenyl]-4,4′-diyl)bis(azo)bis[5-amino-4-hydroxy]-, tetrasodium salt
U236	72-57-1	Trypan blue
U237	66-75-1	2,4-(1H,3H)-Pyrimidinedione, 5-[bis(2-chloroethyl)amino]-
U237	66-75-1	Uracil mustard
U238	51-79-6	Carbamic acid, ethyl ester
U238	51-79-6	Ethyl carbamate (urethane)
U239	1330-20-7	Benzene, dimethyl- (I,T)
U239	1330-20-7	Xylene (I)
U240	1 94-75-7	Acetic acid, (2,4-dichlorophenoxy)-, salts & esters
U240	1 94-75-7	2,4-D, salts & esters
U243	1888-71-7	Hexachloropropene

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U243	1888-71-7	1-Propene, 1,1,2,3,3,3-hexachloro-
U244	137-26-8	Thioperoxydicarbonic diamide [(H2N)C(S)]2 S2, tetramethyl-
U244	137-26-8	Thiram
U246	506-68-3	Cyanogen bromide (CN)Br
U247	72-43-5	Benzene, 1,1′-(2,2,2-trichloroethylidene)bis[4- methoxy-
U247	72-43-5	Methoxychlor
U248	1 81-81-2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations of 0.3% or less
U248	1 81-81-2	Warfarin, & salts, when present at concentrations of 0.3% or less
U249	1314-84-7	Zinc phosphide Zn3 P2, when present at concentrations of 10% or less
U271	17804-35-2	Benomyl
U271	17804-35-2	Carbamic acid, [1-[(butylamino)carbonyl]-1H-benzimidazol-2-yl]-, methyl ester
U278	22781-23-3	Bendiocarb
U278	22781-23-3	1,3-Benzodioxol-4-ol, 2,2-dimethyl-, methyl carbamate
U279	63-25-2	Carbaryl
U279	63-25-2	1-Naphthalenol, methylcarbamate
U280	101-27-9	Barban
U280	101-27-9	Carbamic acid, (3-chlorophenyl)-, 4-chloro-2-butynyl ester
U328	95-53-4	Benzenamine, 2-methyl-
U328	95-53-4	o-Toluidine
U353	106-49-0	Benzenamine, 4-methyl-
U353	106-49-0	p-Toluidine
U359	110-80-5	Ethanol, 2-ethoxy-
U359	110-80-5	Ethylene glycol monoethyl ether
U364	22961-82-6	Bendiocarb phenol
U364	22961-82-6	1,3-Benzodioxol-4-ol, 2,2-dimethyl-,
U367	1563-38-8	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
U367	1563-38-8	Carbofuran phenol
U372	10605-21-7	Carbamic acid, 1H-benzimidazol-2-yl, methyl ester
U372	10605-21-7	Carbendazim
U373	122-42-9	Carbamic acid, phenyl-, 1-methylethyl ester
U373	122-42-9	Propham
U387	52888-80-9	Carbamothioic acid, dipropyl-, S-(phenylmethyl) ester
U387	52888-80-9	Prosulfocarb
U389	2303-17-5	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3,3-trichloro-2-propenyl) ester
U389	2303-17-5	Triallate
U394	30558-43-1	A2213
U394	30558-43-1	Ethanimidothioic acid, 2-(dimethylamino)-N-hydroxy-2-oxo-, methyl ester
U395	5952-26-1	Diethylene glycol, dicarbamate
U395	5952-26-1	Ethanol, 2,2′-oxybis-, dicarbamate
U404	121-44-8	Ethanamine, N,N-diethyl-
U404	121-44-8	Triethylamine
U409	23564-05-8	Carbamic acid, [1,2-phenylenebis (iminocarbonothioyl)]bis-, dimethyl ester
U409	23564-05-8	Thiophanate-methyl
U410	59669-26-0	Ethanimidothioic acid, N,N′-[thiobis[(methylimino)carbonyloxy]]bis-, dimethyl ester
U410	59669-26-0	Thiodicarb
U411	114-26-1	Phenol, 2-(1-methylethoxy)-, methylcarbamate
U411	114-26-1	Propoxur
See F027	93-76-5	Acetic acid, (2,4,5-trichlorophenoxy)-
See F027	87-86-5	Pentachlorophenol
See F027	87-86-5	Phenol, pentachloro-
See F027	58-90-2	Phenol, 2,3,4,6-tetrachloro-
See F027	95-95-4	Phenol, 2,4,5-trichloro-

Table 5 (continued)

Hazardous waste No.	Chemical abstracts No.	Substance
See F027	88-06-2	Phenol, 2,4,6-trichloro-
See F027	93-72-1	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-
See F027	93-72-1	Silvex (2,4,5-TP)
See F027	93-76-5	2,4,5-T
See F027	58-90-2	2,3,4,6-Tetrachlorophenol
See F027	95-95-4	2,4,5-Trichlorophenol
See F027	88-06-2	2,4,6-Trichlorophenol

Table 6 Hazardous Waste Characteristics

Characteristic	Symbol- Hazard Code
Ignitable Waste	(I)
Corrosive Waste	(C)
Reactive Waste	(R)
Acute Hazardous Waste	(H)
Toxic Waste	(T)