Tennessee TECH

Environmental Health and Safety

HAZARDOUS WASTE MINIMAZATION PLAN

I. **Scope.** This Plan has been developed to meet the requirements of the Tennessee Hazardous Waste Reduction Act of 1990. The waste reduction concepts apply to all operations managed by Tennessee Technological University

II. **Objectives.** This plan provides the guidance framework to ensure that the generation of all hazardous wastes by the university is limited to the minimum amount, which is technically practicable and economically feasible. This Plan will help to maintain an awareness of the hazardous waste generated throughout the university and ensure an on-going review and analysis of applicable reduction factors.

a. An effective waste reduction program lowers liability risks, operating and research costs, as well as, hazardous waste administrative and disposal costs.

III. **Review and Analysis.** This plan, as well as new waste reduction technologies, procedures, and economic feasibility of alternatives, will be reviewed at least annually.

IV. **Hazardous Waste Legislation.** In response to growing concern that solid and hazardous waste problems needed more attention than they had previously been given, action was taken at the federal and state level to establish policies to reduce wastes. At the federal level, Congress passed the Resource Conservation and Recovery Act (RCRA) in 1976. This Act was the first comprehensive federal effort to regulate both solid and hazardous wastes.

a. At the state level, the Tennessee General Assembly established the Tennessee Hazardous Waste Reduction Act of 1990 which reads in part:

i. The General Assembly declares it to be the policy of the state that, wherever economically and technically feasible, the generation of hazardous waste is to be prevented or reduced as expeditiously as possible. Hazardous waste that is nevertheless generated should be stored, treated and disposed of so as to protect human health and the environment.

b. The Tennessee Hazardous Waste Reduction Act of 1990 requires both large and small quantity generators of hazardous waste to develop a hazardous waste reduction plan. The law encourages changes, which reduce, avoid, or eliminate the use of toxic materials and the generation of hazardous wastes.

V. **Hazardous Waste Definition.** A waste is a "characteristic" hazardous waste if it has any of the following characteristics:

- Ignitability - Liquid waste which has a flash-point of less than 140^{o}F. Further, it is a hazardous waste if it is an ignitable compressed gas or an oxidizer.
- Corrosivity - Aqueous waste with a pH less than or equal to 2 or greater than or equal to 12.5.
- Reactivity - Waste which is normally unstable and readily undergoes violent change, or if it reacts violently or creates toxic fumes when mixed with water.

- Toxicity - Waste with toxic concentrations that can be leached into water, using EPA's toxicity characteristic leaching procedure (TCLP). Toxicity standards are set for numerous compounds, including metals, pesticides, and organics.
    a. A waste can be deemed hazardous if it is a waste that is specifically listed in the RCRA regulations under 40 CFR Part 261 Subpart D as being hazardous.

VI. Current Waste Reduction Methodologies

Tennessee Tech University has implemented several waste reduction programs and technologies which have greatly reduced the volume and toxicity of chemical wastes produced. These methods, centered on the traditional techniques of waste abatement, waste minimization and reuse/recycle are described below.

a. Product Substitution. Non-hazardous or the least toxic materials possible, are used in production areas, chemical processes, and throughout academic and research laboratories. Specific examples include:
    i. For glassware, use biodegradable detergents or other nonchromium-containing cleaners.
    ii. Use biodegradable detergents such as Alconox in place of ethanol-base baths.
    iii. Use non-mercury based preservatives.
    iv. Use red liquid (alcohol), metal, or digital thermometers.
    v. Substitute sodium hypochlorite for sodium dichromate.
    vi. Substitute alcohols for benzene.
    vii. Substitute cyclohexane for carbon tetrachloride.
    viii. Substitute ethanol for formaldehyde in biological specimen preservation.
    ix. Use water-based paints instead of oil-based paints.
    x. Eliminate the use of pigments containing heavy metals in art practices.
    xi. In photography labs, eliminate silver from waste streams through recovery.
    xii. In teaching labs, eliminate experiments using heavy metals.
    xiii. Replace with iron, cobalt, copper, etc.
    xiv. Substitute biodegradable liquid scintillation cocktails for xylene- or toluene-based cocktails.
    xv. Try to substitute nonchlorinated solvents for chlorinated solvents.

b. Procedural changes

Wastes can be minimized by implementing procedural changes such as:
    i. Use microscale procedures or simply scale down the magnitude of experiments.
    ii. Distill spent solvents for reuse.
    iii. Segregate halogenated waste from nonhalogenated wastes.
    iv. Segregate organic liquids from inorganic wastes.
    v. Segregate very toxic wastes (potassium cyanide, acrolein, etc.) from less toxic wastes.
    vi. Do not mix chemical waste with normal office trash or food waste. All waste contaminated with hazardous materials is considered a hazardous waste.
    vii. Avoid reagents or paints containing heavy metals.
    viii. Use spent solvent for the initial glassware rinse and fresh solvent for the final rinse only.
    ix. Purchase lecture bottles only from companies who will accept their return when empty.

x. Reuse developers in photography labs.
xi. Recover metals for recycling or reuse by precipitation.

VII. Chemical Redistribution. Unopened or unused portions of chemicals are redistributed within the university campus. Chemicals are redistributed independently from department to department, or with assistance from the Safety and Environmental Services Office.

a. Waste Reuse. The direct reuse of a waste, as is, or with very minor modification either by the university or by others. Examples include:
   i. Used photographic fixer from university dark rooms and medical x-ray machines is processed to reclaim silver.
   ii. Mercury is collected from laboratories for redistillation and reuse.
   iii. Fuel grade solvents from various laboratories are reclaimed by vendors for use as an energy source or recycling.
   iv. Solvents used to clean parts in the Motor Pool and brushes in the Paint Shop are collected and used by an outside vendor for feeder stock for manufacturing roofing materials.
   v. Used oils are reprocessed by a vendor and recycled.

VIII. Management Practices

a. Good laboratory management can go a long way towards avoiding unnecessary waste generation. Order only the quantity of material which you anticipate using. Many chemicals have a limited shelf-life. For example, diethyl ether may begin to form peroxides within several months after opening. If you do have leftover material, dispose of it promptly through ORS instead of storing it for future use. This is especially important for peroxide-formers and reactive material. It is much safer and less expensive to dispose of a flammable liquid than it is to dispose of a flammable liquid that contains peroxides. One person should order chemicals for a research group, thereby minimizing duplicate orders. Keep an updated inventory of all the chemicals that are in the lab so that unnecessary orders are not placed. This is a highly recommended practice and a legal requirement for some groups. Share excess and unexpired chemicals with other groups. Keep containers labeled so they do not later become unknowns which require costly analysis. Finally, remember that waste minimization begins when planning an experiment. Consider the kind and quantity of waste which will be generated and adjust the experimental design to minimize it.

IX. Hazardous Waste Characterization by TTU.

a. In the initial development of the TTU hazardous waste program, hazardous waste streams were created for chemicals that were being discarded. A total of fifteen waste streams have been created since 1987. By 2009, only seven of these waste streams remain open on active status.
b. A comparison of waste streams from 1987 to present is in Table 1.

Table 1
Comparison of Hazardous Waste Streams

Main Campus			**TND 07 823 6361**	
Waste Streams Reported Since 1987			Active Waste Streams 2013	
1	LAB PACK		1	LAB PACK
2	Sodium Bichromate		6	Waste Flammable Paint
3	Sulfuric Acid		7	Waste Diesel/Gasoline

4	Muriatic Acid		9	Biodiesel
5	Waste Petroleum Naphtha			
6	Waste Flammable Paint			
7	Waste Diesel/Gasoline			
9	Biodiesel			

Craft Center			**TND 98 216 3396**	
Waste Streams Reported Since 1989			Active Waste Streams 2013	
1	LAB PACK		1	LAB PACK
2	Waste Flammable Paint			

Facilities Services			**TNO 00 082 9556**	
Waste Streams Reported Since 1994			Active Waste Streams 2013	
1	Waste Petroleum Naphtha		2	Waste Flammable Paint
2	Waste Flammable Paint		5	Various Chemicals and Waste Chemicals
3	Waste Mixture of Oil/Freon		6	Waste Diesel/Gasoline
4	Waste Aqueous Brake Solutions			
5	Various Chemicals and Waste Chemicals			
6	Waste Diesel/Gasoline			

Old Maintenance Building			**TNO 00 082 9614**	
Waste Streams Reported Since 1994			Active Waste Streams Since 2013	
1	Waste Petroleum Naphtha			NONE

Main Campus and Craft Center

- Lab-packed Chemicals. Lab packs are official packaging units recognized by the U.S. DOT. They are the most appropriate way to ship waste laboratory chemicals, because they allow different materials in the same hazard class to be packaged together. Lab pack containers range from 55-gallon containers to 5-gallon pails. Containers are filled with small containers of chemicals packed in and separated by vermiculite. Most all lab packed chemical wastes are incinerated with the exception of mercury and other heavy metal wastes that are placed in approved landfills. Acids and oxidizers are neutralized when possible.

Main Campus

- Waste Flammable Paint. This waste results from the painting operations that frequently occur in department labs and technicians' workshops.
- Waste Diesel/Gasoline. This waste is occasionally generated by various labs, as well as operations conducted by the Water Center and Co-op Fisheries at the Boat Storage Facility.

Facilities Services

- Waste Flammable Paint. This results from the painting operations conducted by Facilities Services.
- Various Chemicals and Waste Chemicals. This waste is occasionally generated through maintenance operations by Facilities Services.
- Waste Diesel/Gasoline: This waste usually results from small spills which occur during fueling operations in Facilities Services.

Hazardous Waste Generation. Tables 2, 3, 4, and 5 show the amount of hazardous waste generated by Tennessee Tech University. The total amount of waste generated varies per year. This wide range is due somewhat to the diversity of research, but primarily to the disposal of outdated/excess chemical inventories.

Waste Generation Reductions/Actions/Goals:

- Naphtha Waste and Brake Cleaner: These streams will no longer be generated as hazardous wastes. In 2004, TTU switched our parts cleaning service contract from Safety Klean to Crystal Clean who uses these wastes as ingredients for manufacturing roofing materials. Crystal Clean provides a virgin solvent with a flash point greater than 150 degrees. As long as our use of the solvent doesn't add any components which are included in the TCLP toxicity list, the waste can be shipped from our campus as nonhazardous. These waste streams were closed during the 2004 reporting year.

Table 2
Hazardous Waste Generated By TTU
Main Campus TND 07 823 6361
From 1987 through Present

Waste Stream #	Waste Stream Name	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	LAB PACK	**1688**	**273**		**256**	**973**	**2016**	**2084**	**999.99**	**1096.36**	**475.9**
2	Sodium Bichromate	**1251**									
3	Sulfuric Acid	**1502**									
4	Muriatic Acid	**1490**									
5	Waste Petroleum Naphtha		**393**	**1166**	**1205**	**1187**	**1462**	**2025**	**1635.37**		
6	Waste Flammable Paint		**723**								
7	Waste Diesel/Gasoline										
Total		**5931**	**1389**	**1166**	**1461**	**2160**	**3479**	**4109**	**2635**	**1096**	**476**

Waste Stream #	Waste Stream Name	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	LAB PACK	**779**	**1159**	**361**	**1252**	**1050**	**479**	**635**	**602**	**864**	**1314**
2	Sodium Bichromate										
3	Sulfuric Acid										
4	Muriatic Acid										
5	Waste Petroleum Naphtha						**40**	**83**	**46**		
6	Waste Flammable Paint										**181**
7	Waste Diesel/Gasoline						**295**				**45**
8	Waste Lead										**10206**
Total		**779**	**1159**	**361**	**1252**	**1050**	**814**	**718**	**648**	**864**	**11746**

Waste Stream #	Waste Stream Name	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	LAB PACK	**955**	**830**	**2894**	**1275**	**1348**	**1220**	**3301**	**3663**	**3366**	**2618**	**1889**
2	Sodium Bichromate		**5**									
3	Sulfuric Acid											
4	Muriatic Acid											
5	Waste Petroleum Naphtha											
6	Waste Flammable Paint											
7	Waste Diesel/Gasoline											
8	Waste Lead											
9	Biodiesel							**544**				
Total		**955**	**835**	**2894**	**1275**	**1348**	**1220**	**3845**	**3663**	**3366**	**2618**	**1889**

Footnote: Reported in kilograms

Waste Stream #	Waste Stream Name	2018										
1	LAB PACK	**1895**										
2	Sodium Bichromate											
3	Sulfuric Acid											

4	Muriatic Acid											
5	Waste Petroleum Naphtha											
6	Waste Flammable Paint											
7	Waste Diesel/Gasoline											
8	Waste Lead											
9	Biodiesel											
Total		**1895**										

Footnote: Reported in kilograms

Table 3
Hazardous Waste Generated By TTU
Craft Center TND 98 216 3396
From 1989 through Present

Waste Stream #	**Waste Stream Name**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
1	LAB PACK	**0**	**0**	**0**	**0**	**0**	**0**	**163**	**0**	**211**
2	Waste Flammable Paint									
Total		**0**	**0**	**0**	**0**	**0**	**0**	**163**	**0**	**211**

Waste Stream #	**Waste Stream Name**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
1	LAB PACK	**0**	**95**	**82**	**0**	**227**	**172**	**0**	**0**	**114**
2	Waste Flammable Paint									
Total		**0**	**95**	**82**	**0**	**227**	**172**	**0**	**0**	**114**

Waste Stream #	**Waste Stream Name**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
1	LAB PACK	**263**	**177**	**0**	**0**	**0**	**0**	**263**	**0**	**331**
2	Waste Flammable Paint		**23**							

Total		**263**	**200**	**0**	**0**	**0**	**0**	**263**	**0**	**331**

Waste Stream #	**Waste Stream Name**	**2016**	**2017**	**2018**						
1	LAB PACK	**0**	**0**	**0**						
2	Waste Flammable Paint									
Total		**0**	**0**	**0**						

Footnote: Reported in kilograms

Table 4
Hazardous Waste Generated By TTU
Facilities Services TNO 00 082 9556
From 1994 through Present

Waste Stream #	**Waste Stream Name**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1	Waste Petroleum Naphtha	**140.09**	**1315.55**	**980.52**	**913.6**	**1111**	**1115**	**1117**	**1162**	**1059**	**955**	**49**	
2	Waste Flammable Paint		**263.64**		**159**	**57**	**136**	**568**	**91**		**120**	**245**	
3	Waste Mixture of Oil/Freon		**2438.63**										
4	Waste Aqueous Brake Solutions			**19.55**	**58.5**	**45**	**15**						
5	Various Chemicals and Waste Chemicals												
6	Waste Diesel and Gasoline Mixture							**5**	**273**				
Total		**140**	**4018**	**1000**	**1131**	**1213**	**1266**	**1690**	**1526**	**1059**	**1075**	**294**	**0**

Footnote: Reported in kilograms

Waste Stream #	Waste Stream Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	Waste Petroleum Naphtha													
2	Waste Flammable Paint	**241**	**209**	**127**										
3	Waste Mixture of Oil/Freon													
4	Waste Aqueous Brake Solutions													
5	Various Chemicals and Waste Chemicals		**73**	**9**										
6	Waste Diesel and Gasoline Mixture													
Total		**241**	**281**	**136**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Footnote: Reported in kilograms

Table 5
Hazardous Waste Generated By TTU
Old Maintenance Building TNO 00 082 9614
From 1989 through Present

Waste Stream #	Waste Stream Name	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	Waste Petroleum Naphtha	**91**	**554**	**362**	**277**	**379**	**416**	**406**	**391**	**458**	**361**	**91**	**0**	**0**
Total		**91**	**554**	**362**	**277**	**379**	**416**	**406**	**391**	**458**	**361**	**91**	**0**	**0**

Waste Stream #	Waste Stream Name	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	Waste Petroleum Naphtha	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**No longer generating on this waste stream**
Total		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

Footnote: Reported in kilograms