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Policy:

It shall be the policy of the University of Tennessee to conduct a program that will reduce the volume and risks associated with the generation of hazardous waste to the minimum levels that are economically and technically feasible. This program shall be in full compliance with the requirements of all applicable federal, state and local regulations. The reduction efforts shall extend beyond the minimum regulatory expectations so that the potential for environmental pollution is minimized with health and safety protection maximized.

The university administration shall support this endeavor by committing human and financial resources to the successful implementation of this plan. Each employee who has involvement in a waste generating operation shall consider waste reduction as an integral component of their job and shall be committed to successful implementation of the program. It shall be the responsibility of each department head or manager to support and enforce the policies and procedures written in the waste management plan.

____________________________________  ______________________________
Chancellor       Date
The University of Tennessee
Scope:

This waste minimization plan meets all of the requirements of the Tennessee Hazardous Reduction Act of 1990 (TCA 68-212-301), and encompasses all chemical waste operations conducted on the Knoxville campus and all off-campus activities that are part of the Knoxville campus’s mission. The plan requires all individuals on campus who generate any type of hazardous waste to implement this plan by using resources that are economically and technically feasible to reduce or eliminate waste generation. Waste in any form represents lost money, lost resources, and lost labor.

Implementing a waste minimization program benefits everyone at UT Knoxville and the community by:

* Lowering waste disposal and compliance costs
* Reducing long-term liability for disposal
* Reducing costs of chemical purchases
* Reducing health and safety hazards
* Promoting environmental awareness
* Preventing pollution and conserving resources

Objectives:

The main objective of this plan is to reduce or eliminate the generation of hazardous waste to the extent that is economically and technically feasible. In research, teaching, testing and many other operations on campus, generating chemical waste cannot be avoided. However, chemical waste can be managed as efficiently as possible to minimize the amount that is generated. The Director of Environmental Health and Safety (EH&S) will be primarily responsible for coordinating the waste minimization plan.

The Pollution Prevention Act of 1990 requires all hazardous waste generators to reduce or eliminate the generation of hazardous waste whenever feasible. The University of Tennessee must report its efforts towards waste minimization to the Tennessee Department of Environment and Conservation (TDEC) on an annual basis. As a result, the university sets waste reduction goals for each waste stream. These goals are outlined in detail in Appendix A.

Methods to Minimize Hazardous Waste Generation:

Waste reduction should be considered during all phases of a process including project/process design, purchasing, and use. The most effective location to minimize the amount of waste generated is at the point of waste generation. The policy of the University is to maintain an open-minded attitude towards application of any waste reduction option. Therefore, all faculty and staff are encouraged to constantly search for ideas that can be implemented to improve waste reduction efforts. The following methods should be considered to reduce the amount of hazardous waste produced on campus and the university will encourage use of these methods to meet its waste reduction goals.

- **Process modifications:** This involves the use of micro-chemistry or using reduced volumes in an experiment. Procedures to switch to micro-chemistry include:
  - Switching from conventional to fast microprocessor-based, top loading balances that are sensitive to 0.1 mg.
  - Use of chromatographic techniques, such as high performance and ion exchange, that can clearly separate and purify milligram quantities of a substance.
- Use of microscale glassware, including pipettes, burettes, syringes, reactors and stills for handling reagents and their products.
- Switching from conventional to sensitive spectrometers that can analyze milligram quantities of substance.

**Chemical waste exchange:** Laboratories should check with other departments on campus, with EH&S or on the chemical waste exchange list on-line before ordering a specific chemical. It costs 20-40 times the original purchase price of a chemical to dispose of that same chemical. In fact, the American Chemical Society estimates that 40% of the chemical waste generated by labs consists of unused chemicals. This could be reduced if labs checked with other departments or their own stock before ordering chemicals. Do not accept any chemicals from another department or outside organization unless you are sure these substances will be used. UT Knoxville has an on-line chemical exchange, which is a list of all reusable chemicals that is brought to EH&S. The exchange can be found on [http://www.pp.utk.edu/ChemInv/cheminv](http://www.pp.utk.edu/ChemInv/cheminv).

**Product substitution with a non-hazardous or less hazardous material.**
Examples of product substitution include:
- Using a biodegradable non-toxic preservative, such as ethanol, in lieu of formaldehyde-based substances (formalin).
- Replacing flammable scintillation fluid with non-hazardous biodegradable scintillation fluid.
- Replacing hazardous solvents or cleaning solutions in parts washers with non-hazardous solutions.

**Avoid mixing hazardous waste with non-hazardous waste.** Do not mix water, or other non-hazardous substances with hazardous waste. This will generate even more hazardous waste, which increases disposal cost. In the case of flammable solvents, the more water mixed with the hazardous waste, the more expensive the disposal costs. Flammable liquids with a high BTU content are typically sent for fuel blending and water mixed with the flammables lowers the energy contents thereby requiring more expensive disposal techniques. Also, do not mix used oil with solvents or heavy metals, or the used oil cannot be recycled.

**Spill prevention:** Care should be taken when weighing or transferring chemicals to minimize spills. Containers should be sealed when not in use and processes should be contained (i.e. fume hoods) to prevent the escape of fumes or leaks into the environment.

**Limiting quantities purchased.** Purchase chemicals in the smallest volumes needed. Consider buying pre-weighed or pre-measured reagent packets where waste generation is high.

**Inventory management and control:** Laboratories should constantly monitor their chemical inventory and dispose of any unwanted or expired chemicals through EH&S. New containers should be dated when they are received so that older products will be used first.

**Good housekeeping practices:** This includes properly labeling all containers with their hazardous contents and keeping an up-to-date chemical inventory.

**Training:** Include waste minimization practices in student and employee training sessions. All employees and students who generate hazardous waste should take the hazardous waste management and waste minimization training and quiz.
Segregation: Waste should be properly segregated once they are generated and stored in chemically compatible containers. For example, acid waste should not be stored together with caustics and oxidizers should not be stored with flammables. Hydrofluoric acid waste should not be stored in glass containers. Waste should be stored in secondary containment (i.e. tubs) when appropriate to ensure proper segregation during storage.

Eliminating unknown chemicals: Chemicals that are unlabeled cost up to 10 times more for disposal than properly labeled chemicals. In fact, in 2001 UT Knoxville spent roughly $75,000.00 to identify unknown chemicals (that price does not include disposal fees). At the very minimum, containers need to be labeled with the chemical/product name and primary hazard. Lab checkouts are conducted by EH&S when an employee is leaving the university to ensure they are not leaving behind unlabeled chemicals.

Recycling. There are many good reasons to recycle. Some of these reasons include:

- Conserves energy
- Protects the environment
- Reduces the need to build new landfills and incinerators
- Saves money and energy
- Stimulates the development of green technologies
- Provides valuable raw materials to industry

Examples of current recycling programs at UT Knoxville are:

- Universal waste, such as rechargeable batteries, fluorescent lamps and used oil, are sent to commercial recyclers.
- Solvents with high BTU values are reclaimed and burned as fuel in incinerators.
- Mercury from thermometers and equipment is collected for retorting.
- Any used photographic fixer that is generated is processed for silver recovery.
- Old computer equipment is sent for electronics recycling.

Distillation: Some solvents can be re-distilled and reused. Currently, the Chemistry Department re-distills acetone for reuse.

Elementary neutralization and reclamation.

- Acids and bases can be neutralized, as long as they don’t contain any heavy metals or organics.
- Gels can be directly injected with ethidium bromide to eliminate large volumes of liquid waste.

The following methods of disposal are not acceptable and are considered a violation of state and federal environmental regulations.

- evaporation
- dilution
- combustion
- storm sewer
- sanitary sewer
- sharps container
- regular trash
- biohazard waste containers
**Mixture Rule:** In 1982, the EPA adopted the mixture rule 40 CFR § 261.3a)(2)(iv), which states that hazardous waste, when mixed with a non-hazardous substances remains hazardous. This rule does not apply when mixing occurs during a process, only when waste is being mixed. Combining wastes to render them nonhazardous is considered treatment. Intentional mixing of waste to change the characteristic is a direct violation of the US EPA Resource Conservation and Recovery Act (RCRA) land disposal treatment standards. A permit is generally required to treat hazardous waste. There are some exceptions to this rule, however, please call EH&S before attempting any method of disposal.

**Implementation:**

EH&S shall characterize the waste stream from each area that generates hazardous waste. Generators of hazardous waste will be queried about the availability and feasibility of waste reduction. EH&S shall work with all departments to implement waste reduction efforts.

**Performance Measures:**

1. Document hazardous waste minimization efforts. These records will be kept as part of Appendix A that is available in the EH&S office for review and inspection.

2. Review hazardous waste reduction results from the Annual Hazard Waste Report that is filed with the Tennessee Department of Solid Waste.


**Program Review:**

This program shall be reviewed annually and amended as necessary. When it becomes apparent that the plan is deficient, it shall be revised.

Performance measures shall be monitored at least annually.

**Training:**

Employees who generate or handle hazardous waste shall be trained to reduce hazardous waste. The hazardous waste management and waste reduction training may be presented during the annual training for hazardous waste generators. In addition, a self-study powerpoint presentation and quiz are available via e-mail by contacting April Case at 974-5084 or acase3@utk.edu.

**Waste Minimization Efforts:**

Specific Examples of waste minimization efforts that were made during 2009 at UT Knoxville:

- The Chemistry Department is re-distilling acetone.
• Many laboratories have switched from chromic acid to a non-toxic formula for cleaning glassware.
• A number of researchers have switched from using a toluene-based scintillation fluid to a non-solvent based, biodegradable fluid.
• There is an effort being made to convert the parts washing fluid in all parts washers from a flammable solvent to a nonflammable compound.
• Substitution of latex paints over oil-based paints and paint related material is being encouraged.
• EHS is working toward establishing a centralized purchasing system to track quantities and types of chemicals ordered throughout campus.
101 Ways to Reduce Hazardous Waste in the Laboratory

1. Write a waste management/reduction policy.
2. Include waste reduction as part of student/employee training.
3. Use manuals such as the American Chemical Society's (ACS) “Less is Better” or “ACS Waste Management Manual for Laboratory Personnel” as part of your training.
4. Create an incentive program for waste reduction.
5. Centralize purchasing of chemicals through one person in the laboratory.
6. Inventory chemicals at least once a year.
7. Indicate in the inventory where chemicals are located.
8. Update inventory when chemicals are purchased or used up.
9. Purchase chemicals in smallest quantities needed.
10. If trying out a new procedure, try to obtain the chemicals needed from another laboratory or purchase small amounts initially. After you know you will be using more of these chemicals, purchase in larger quantities (unless you can obtain excess chemicals from someone else).
11. Date chemical containers when received so that older ones will be used first.
12. Audit your laboratory for waste generated (quantity, type, source, and frequency).
15. If possible, establish an area for central storage of chemicals.
16. Keep chemicals in your storage area except when in use.
17. Establish an area for storing chemical waste.
18. Minimize the amount of waste kept in storage.
19. Label all chemical containers as to their content (even those with only water).
20. Develop procedures to prevent and/or contain chemical spills—purchase spill cleanup kits, contain areas where spills are likely to occur.
21. Keep halogenated solvents separate from non-halogenated solvents.
22. Keep recyclable waste/excess chemicals separate from non-recyclables.
23. Keep organic wastes separate from metal-containing or inorganic wastes.
24. Keep nonhazardous chemical wastes separate from hazardous waste.
25. Keep highly toxic wastes (cyanides, etc.) separated from the previous groups.
26. Avoid experiments that produce wastes that contain combinations of radioactive, biological and/or hazardous chemical waste.
27. Keep chemical wastes separate from normal trash (paper, wood, etc.).
28. Use the least hazardous cleaning method for glassware. Use detergents such as Alconox, Micro, RBS35 on dirty equipment before using KOH/ethanol bath, acid bath or No Chromix.
29. Eliminate the use of chromic acid cleaning solutions altogether.
30. Eliminate the use of uranium and thorium compounds (naturally radioactive).
31. Substitute red liquid (spirit-filled), digital, or thermocouple thermometers for mercury thermometers where possible.
32. Use a bimetal or stainless steel thermometer instead of mercury thermometer in heating and cooling units. Stainless steel laboratory thermometers may be an alternative to mercury thermometers in laboratories, as well.
33. Evaluate laboratory procedures to see if less hazardous or nonhazardous reagents could be used.
34. Review the use of highly toxic, reactive, carcinogenic or mutagenic materials to determine if safer alternatives are feasible.
35. Avoid the use of reagents containing: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Consider the quantity and type of waste produced when purchasing new equipment.
36. Purchase equipment that enables the use of procedures that produce less waste.
37. Review your procedures regularly (e.g. annually) to see if quantities of chemicals and/or chemical waste could be reduced.
38. Look into the possibility of including detoxification and/or neutralization steps in laboratory experiments.
39. When preparing a new protocol, consider the kinds and amounts of waste products and determine whether they can be reduced or eliminated.
40. When researching a new or alternative procedure, include consideration of the amount of waste produced as a factor.
41. Examine your waste/excess chemicals to determine if there are other uses in your laboratory. Neighboring laboratories, departments or non-laboratory areas (garage, paint shop, art department) might be able to use them.
42. Review the Chemical Exchange inventory on http://www.pp.utk.edu/ChemInv/default.htm to review the list of chemicals that EHS has stored under the Chemical Exchange program.
44. Contact EHS if you have unused chemicals to add to the Chemical Exchange program, or if you would like to obtain a chemical from the exchange.

45. Call the chemical recycling coordinator to discuss setting up a locker or shelf for excess chemical exchange in a laboratory, stockroom or hallway in your department.

46. When solvent is used for cleaning purposes, use contaminated solvent for initial cleaning and fresh solvent for final cleaning.

47. Try using detergent and hot water for cleaning of parts instead of solvents.

48. Consider using ozone treatment for cleaning of parts.

49. Consider purchasing a vapor degreaser, vacuum bake or bead blaster for cleaning of parts.

50. Reuse acid mixtures for electropolishing.

51. When cleaning substrates or other materials by dipping, process multiple items in one day.

52. Use the smallest container possible for dipping or for holding photographic chemicals.

53. Store and reuse developer in photo laboratories.

54. Precipitate silver out of photographic solutions for reclamation.

55. Neutralize corrosive wastes that don’t contain metals at the laboratory bench.

56. Deactivate highly reactive chemicals in the hood.

57. Evaluate the possibility of redistillation of waste solvents in your laboratory.

58. Evaluate other wastes for reclamation in your laboratory.

59. Scale down experiments producing hazardous waste wherever possible.

60. In teaching laboratories, consider the use of microscale experiments.

61. In teaching laboratories, use demonstrations or video presentations as a substitute for some student experiments that generate chemical wastes.

62. Use pre-weighed or pre-measured reagent packets for introductory teaching laboratories where waste is high.

63. Include waste management as part of the pre- and post-laboratory written student experience.

64. Encourage orderly and tidy behavior in laboratory.

65. Use the following substitutions where possible:

<table>
<thead>
<tr>
<th>Original Material</th>
<th>Substitute</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetamide</td>
<td>Stearic Acid</td>
<td>In phase change and freezing point depression</td>
</tr>
<tr>
<td>Benzene</td>
<td>Alcohol</td>
<td></td>
</tr>
<tr>
<td>Benzoyl Peroxide</td>
<td>Lauryl Peroxide</td>
<td>When used as a polymer catalyst</td>
</tr>
<tr>
<td>Carbon Tetrachloride</td>
<td>Cyclohexane</td>
<td>In test for halide ions</td>
</tr>
<tr>
<td>Chloroform</td>
<td>1,1,1-trichloroethane</td>
<td></td>
</tr>
<tr>
<td>Chromic Acid cleaning</td>
<td>Alconox, Micro, Pierce RBS-35, or similar detergents</td>
<td>In glassware cleaning</td>
</tr>
<tr>
<td>Formaldehyde; Formalin</td>
<td>“Formalminate” or Ethanol</td>
<td>For storage of biological specimens</td>
</tr>
<tr>
<td>Halogenated Solvents</td>
<td>Non-Halogenated Solvents</td>
<td>In parts washers and other solvent processes</td>
</tr>
<tr>
<td>Mercuric Chloride Reagent</td>
<td>Amitrole (Kepro Circuit Systems)</td>
<td>Circuit Board Etching</td>
</tr>
<tr>
<td>Mercury Salts</td>
<td>Mercury-free catalysts (Copper Sulfate, Potassium Sulfate, Titanium Dioxide)</td>
<td>Kjeldahl digest</td>
</tr>
<tr>
<td>Mercury Thermometers</td>
<td>Mineral Spirit dilled, stainless steel, bimetal, digital</td>
<td></td>
</tr>
<tr>
<td>Mercuric Chloride (biocide)</td>
<td>5-10% Methylene Chloride, 1 % Formalin; 1 N Hydrochloric acid, Sodium Hypochlorite</td>
<td></td>
</tr>
<tr>
<td>Sodium Dichromate</td>
<td>Sodium Hypochlorite</td>
<td></td>
</tr>
<tr>
<td>Sulfide Ion</td>
<td>Hydroxide Ion</td>
<td>In analysis of Heavy Metals</td>
</tr>
<tr>
<td>Wood’s Metal</td>
<td>Onion’s Fusible Alloy</td>
<td></td>
</tr>
<tr>
<td>Xylene or Toluene</td>
<td>Simple Alcohols and Ketones</td>
<td></td>
</tr>
<tr>
<td>Xylene or Toluene Scintillation Vials</td>
<td>Non-Hazardous Proprietary Liquid scintillation cocktails</td>
<td>In radioactive tracer studies</td>
</tr>
</tbody>
</table>

84. Use best geometry of substrate carriers to conserve chemicals.

85. Polymerize epoxy waste to a safe solid.
86. Consider using solid phase extractions for organics.
87. Put your hexane through the rotavap for reuse.
88. Destroy ethidium bromide using household bleach.
89. Run mini SDS-PAGE 2d gels instead of full-size slabs.
90. Treat sulfur and phosphorus wastes with bleach before disposal.
91. Treat organolithium waste with water or ethanol.
92. Seek alternatives to phenol extractions (e.g. small scale plasmid prep using no phenol may be found in Biotechnica, Vol. 9, No. 6, pp. 676-678).
93. Collect metallic mercury for reclamation.
94. Investigate possibility for recovering mercury from mercury containing solutions.
95. Recover silver from silver chloride residue waste and gold from gold solutions.
96. Purchase compressed gas cylinders, including lecture bottles, only from manufacturers who will accept the empty cylinders back.
97. When testing experimental products for private companies, limit donations to the amount needed for research.
98. Return excess pesticides to the distributor.
99. Be wary of chemicals donations from outside the University. Accept chemicals only if you will use them within 12 months.
100. Replace and dispose of items containing polychlorinated biphenyls (PCBs).
101. Send us other suggestions for waste reduction by campus mail or email to: Environmental Health and Safety, 916 22nd Street, or safety@utk.edu.

Source: *Pollution Prevention and Waste Minimization in Laboratories*, by Peter A. Reinhardt, K. Leigh Leonard and Pete
Appendix A

Waste Reduction Analysis
Hazardous Waste: UTK Campus

The UT Knoxville campus has five main sites with E.P.A. generator ID #s.

<table>
<thead>
<tr>
<th>Site Name</th>
<th>E.P.A. ID #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin Peay (Main Campus)</td>
<td>TN0000879809</td>
</tr>
<tr>
<td>Pellissippi</td>
<td>TND982094302</td>
</tr>
<tr>
<td>Vet School/Agricultural Campus</td>
<td>TND980316269</td>
</tr>
<tr>
<td>Graphic Arts</td>
<td>TNR000011551</td>
</tr>
<tr>
<td>Facilities Services</td>
<td>TND003387891</td>
</tr>
</tbody>
</table>

The main campus at UTK is by far, the largest waste generator of all five sites.

Hazardous Waste Disposal-Total Pounds and Figures

Graph #1 represents the costs that Environmental Health and Safety incurred for disposal of hazardous waste for departments on campus who generate hazardous waste on a consistent basis from 2007-2009. This portrays the disposal costs that were billed to EHS from the hazardous waste contractor(s), which include disposal, supplies, labor, transportation etc. This graph does not include any hazardous waste disposal costs incurred by other departments on campus (i.e. Facilities Services) who paid their own disposal costs. However, those cases are rare. The reason for the spike in cost for the main campus in 2008 was due to a large one-time lab cleanout by a professor who retired, and several building cleanouts before renovations took place. There was also a large-scale one-time chemical cleanout of Brehm and McCord on the Agricultural Campus in 2008 before those buildings were renovated. In addition, there was a change in waste contractors in July 2008 which lowered disposal pricing of some waste streams. Graphic Arts generated zero hazardous waste in 2009, due to waste minimization efforts they have adopted. The Pellissippi Research Campus is now longer under management by UT Knoxville (as of June 30, 2009). The sudden increase in disposal costs there were due to a one-time cleanout before closing that facility. The Graduate School of Medicine has stayed fairly consistent in their waste generation and disposal costs.
Graph #2 illustrates the pounds of hazardous waste disposed by each department (who is a major contributor of hazardous waste generation) at UTK and covers the years 2005-2009. Although the main campus generated 65388 pounds of hazardous waste in 2009 (which is a 42% increase from 2008), 32,500 pounds of that total is attributed to the disposal of lead-contaminated building components during a major building demolition project on campus. EHS did not pay the disposal costs for the lead contaminated building components. Thus, that is why the disposal costs are lower for 2009 on main campus (see previous graph).

Graph #3 illustrates the total disposal costs (for all departments combined) that EH&S incurred for hazardous waste disposal from 2007-2009. This does not include costs for hazardous waste disposal that were incurred by other departments on campus.
The following are charts detailing the total amount of hazardous waste disposed from all sites on the UTK with a registered E.P.A. ID # from 2006-2009. There is still much room for improved waste reduction.

**Main Campus:**

There was a 7% increase in the volume of total waste disposed on the main campus in 2008 vs. 2007. This was due to a large scale one-time lab cleanout that occurred in February 2008. There was a 47% increase in total waste disposed from 2008-2009. This was due to a one-time demolition project in which approximately 15 tons of lead contaminated building materials were disposed. Below is a graph depicting the total volume disposed for main campus, minus the lead demolition waste. Our goal is a 5% reduction in the total volume of waste generated on the Main Campus by 2010.
• If the volume of lead demolition waste is removed, the main campus actually had a 5% decrease in volumes of hazardous waste disposed from 2008-2009. This would be a more accurate representation of the volumes of waste disposed in 2009, since the lead demolition was a one-time activity.

Ag Campus/Vet School:

• The Ag Campus/Vet School has a 30% increase in the amount of total hazardous waste generated from 2006-2008. This is due to an increase in one-time cleanouts of buildings due to several building renovations occurring on that campus. Surprisingly, there was a 39% decrease in the volumes of hazardous waste disposed on the Ag Campus/Vet School from 2008-2009. There were no major building cleanouts on these campuses during 2009.

![Ag Campus/Vet School: Pounds of Hazardous Waste Disposed/Unit 2006-2009](image)

Graphic Arts:

• Graphic Arts have made great strides in reducing the volumes of hazardous waste they generate and dispose. They have done this by gradually switching to less hazardous cleaners and inks, and by installing a more environmentally friendly press, which uses less cleaners and inks. As a result, they have reduced the total volumes of hazardous waste they dispose from 2007-2009.
Pellissippi:

- UTK terminated their lease on the building in July 2009. There was a spike in the volumes of hazardous waste disposed in 2009, as the labs were cleaned out and moved to the main campus. UTK will no longer generate any more waste at Pellissippi, since they no longer have use of that facility.
Facilities Services:

- The amount of total waste disposed at Facilities Services decreased by 73% from 2007 to 2008, but increased by 32% from 2008-2009.
Specific Waste streams

Mixed Waste Labpacks:

Due to the nature of research and teaching, a university produces small amounts of a diverse group of chemicals, which are defined by DOT 49 CFR as labpack quantities. In order to reduce the amount being generated EHS encourages laboratories to limit quantities of chemicals they order, use the oldest dated chemicals first, discard expired chemicals, and check with other departments on campus to see if they can use discarded chemicals before disposing of as waste. However, it is very difficult to gain control of labpack generation, because this waste stream is generated in varying quantities by different processes in several dozen locations. Efforts should be made to examine specific laboratories to determine which waste minimization efforts would meet their specific needs.

- The volume of labpack waste generated on the Main Campus has decreased by 35% from 2006-2008, and increased only slightly (28%) from 2008-2009. Our goal is a 30% reduction in disposal of labpacks from 2009-2010. EHS will continue to push waste minimization efforts on campus.
• The volume of labpack waste generated on the Ag Campus/Vet School increased by 37% from 2006-2008 due to one-time building cleanouts and an increase in research. Our goal was to reduce the volume of labpack waste on the Ag Campus by approximately 40% in 2009. We did not meet those goals, and will have to set more realistic goals next year. However, there is an overall decrease in the volumes of labpacks disposed from 2007-2009.

• There was an 89% increase in the volumes of labpacks disposed of at Pellissippi from 2008-2009. This was due to a one-time building cleanout before UTK gave up the lease on these facilities. This facility should not generate and dispose of any more labpacks.
Compressed Gases:

There are many serious safety concerns associated with compressed gas cylinders, including physical hazards associated with pressurized aging cylinders. In addition, inhalation of hazardous substances, or asphyxiation could occur from an unintentional release. Efforts are being made to encourage departments to purchase cylinders from manufacturers that will accept empty or partially full cylinders or checking with other departments to see if there is an existing cylinder available for use. It is very important that cylinders are properly labeled based on the fact that disposal of “unknown” cylinders is very expensive. Our goal is to reduce the volume of compressed gases generated on the main campus by 30% in 2009.

- There was a 66% increase in the amount of compressed gas cylinders generated from 2006-2008 on the Main Campus. There was a one-time lab cleanout, in which large quantities of cylinders were removed for disposal. This event caused the amount to sharply increase in 2008. There was a major cylinder cleanout for the Department of Biology in 2009. However, the disposal of cylinders decreased by 56% from 2008-2009. Hopefully, we will not increase this volume in 2010. EHS has been educating people to dispose of cylinders before they become old and must be handled by a high hazard contractor. We also discourage departments from buying their own cylinders. Labs should always rent cylinders, if possible.

![Graph showing pounds of compressed gas cylinders disposed per unit from 2006 to 2009.](image)

**Flammable Liquids:**

Examples of flammable liquids include acetone, methanol, ethanol, toluene, xylene and acetonitrile. Flammable liquids with high BTUs can typically be burned as a fuel in cement kilns, so disposal is relatively inexpensive. It is important that the flammable liquids are not diluted with water, or mixed with heavy metals or halogenated solvent waste which will increase disposal costs. The best way to
minimize the volumes of flammable liquid waste generated is to redistill solvents or find a non-flammable, biodegradable alternative.

- The amount of flammable solvent waste disposed on the main campus has increased by 60% from 2006-2008 on the Main Campus. This is due to an increase in research and one-time lab cleanouts. Our goal was to reduce the volume of flammable liquids generated on the main campus by 15% by the goal year 2009. We were able to reduce the volume of flammable liquids disposed by 24% from 2008 to 2009, and this was most likely due to a slight decrease in research.
• The volumes of flammable solvents disposed on the Ag Campus decreased by 65% from 2006-2008. This is due to a decrease in research generating this specific waste. Our goal was to reduce the volume of flammable waste generated by approximately 37% in 2009. We were only able to decrease the volume of flammable liquids disposed by around 4% from 2008-2009. However, there has been a significant decrease in volumes generated from 2006-2009.

![Graphic Arts-Pounds/Unit Press Cleaner Disposed 2005-2009](image)

• In 2008, Graphic Arts began substituting their press cleaners and inks for non-hazardous formulations. The volume generated decreased by 36% from 2007-2008, and decreased by 100% from 2008-2009. This decrease is due to the fact that Graphic Arts has made great strides in reducing the volumes of hazardous waste they generate and dispose. They have done this by gradually switching to less hazardous cleaners and inks, and by installing a more environmentally friendly press, which uses less cleaners and inks.

**Paint Waste Related Materials and Paint Booth Filters:**

Facilities Services generates oil-based paint waste and solvents, as well as paint booth filters from their painting operations. Steps need to be taken to reduce the amount of paint waste generated such as: using latex paint whenever possible, cleaning out stockpiles of old paints and sending them to EH&S for disposal, and only ordering the minimum amount of paints and solvents needed to satisfy immediate needed. Our goal is to reduce the volume of paint waste and booth filters generated by 30% in 2010.

• The volumes of Paint that Facilities Services has disposed decreased by approximately 65% from 2007-2009. The volumes of booth filters disposed has decreased by 46% from 2007-2009. We have met our goals for reducing these waste streams by 30%.
**Aqueous Metals Waste:**

The cost to treat and dispose of heavy metals aqueous solutions containing metals such as barium, mercury, lead, selenium, cadmium, varies depending upon the type of metal and the concentration present. Our goal was reduce the amount of metals waste generated by 35% by the goal year 2009.
*There was an 85% decrease in the amount of metal acid waste disposed on the Main Campus from 2006-2008. Hopefully, this trend will continue over the next few years. It appears that the volumes of this waste stream being disposed has remained consistent from 2007-2009. We have met our goals to reduce the volumes disposed of by 35% from 2006-2009. New goals will need to be set next year.

**Formaldehyde and Formalin:**

Formaldehyde is a suspected human carcinogen and is a sensitizer. It is used as a preservative for biological samples.
There was a 12% increase in the amount of formalin waste generated on the Vet School campus from 2006-2008. Our goal was to reduce the volume of Formalin waste generated by 12% in 2009. We have met those goals, since the Vet School has made an effort to use a less hazardous substitute.

**Mercury:**

Mercury is a naturally occurring element. This silver-colored liquid metal can be found in rocks, soil and the ocean. Mercury can be released into the environment through natural processes when volcanoes erupt, rocks erode and soil decomposes. As a liquid metal at room temperature, mercury has been widely used throughout industry. Man-made sources of mercury include abandoned mines, energy production, sewage, industrial processes, mining, smelting, scrap metal processing and incineration or land disposal of mercury products or waste. Mercury is toxic to humans, because it is a powerful toxin that affects every aspect of brain and nerve function. It can cause tremors, memory loss, mental impairment and many other complications in the nervous system. Mercury is especially dangerous to the developing fetus as it impairs brain development, resulting in lowered intelligence and other brain deficits. In addition, mercury is Toxic to the Environment. Bacteria from river and estuary bottom sediments convert mercury into its highly toxic form through a process called “methylation.” This methylated mercury accumulates in aquatic organisms, making the fish from those bodies of water dangerous to eat.

The reason for the spike in the volumes of mercury waste disposed of on the Ag Campus/ Vet School during 2009 are because of a one-time research project which generated a large amount of mercury contaminated soils and liquid waste. Overall, the total volume of mercury waste disposed of on Main Campus has decreased by almost 92% from 2007-2009. This is due to more labs making efforts to replace their mercury-containing equipment, such as thermometers, manometers, etc. with less hazardous substitutes. EHS hopes to continue to see a decrease in the volumes of mercury disposed of overall.