HAZARDOUS WASTE REDUCTION PLAN

UNIVERSITY OF TENNESSEE

The Office of Environmental Health and Safety
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Revised on 8/15/2016

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 Knoxville

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 EHS 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.

➢ **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 **<u>not</u>** acceptable and are considered a violation of state and federal environmental regulations.

a. evaporation
b. dilution
c. combustion
d. storm sewer
e. sanitary sewer
f. sharps container
g. regular trash
h. 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.

3. Statutory limits as defined by the Tennessee Department of Environment and Conservation.

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 course is available by contacting the Environmental Health and Safety department at 974-5084.

Waste Minimization Efforts:

Specific Examples of waste minimization efforts that were made 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).
13. Keep MSDSs for chemicals used on file.
14. Keep information about disposal procedures for chemical waste in your laboratory on file.
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, and 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

37. Purchase equipment that enables the use of procedures that produce less waste.
38. Review your procedures regularly (e.g. annually) to see if quantities of chemicals and/or chemical waste could be reduced.
39. Look into the possibility of including detoxification and/or neutralization steps in laboratory experiments.
40. When preparing a new protocol, consider the kinds and amounts of waste products and determine whether they can be reduced or eliminated.
41. When researching a new or alternative procedure, include consideration of the amount of waste produced as a factor.
42. 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.
43. 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:

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

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

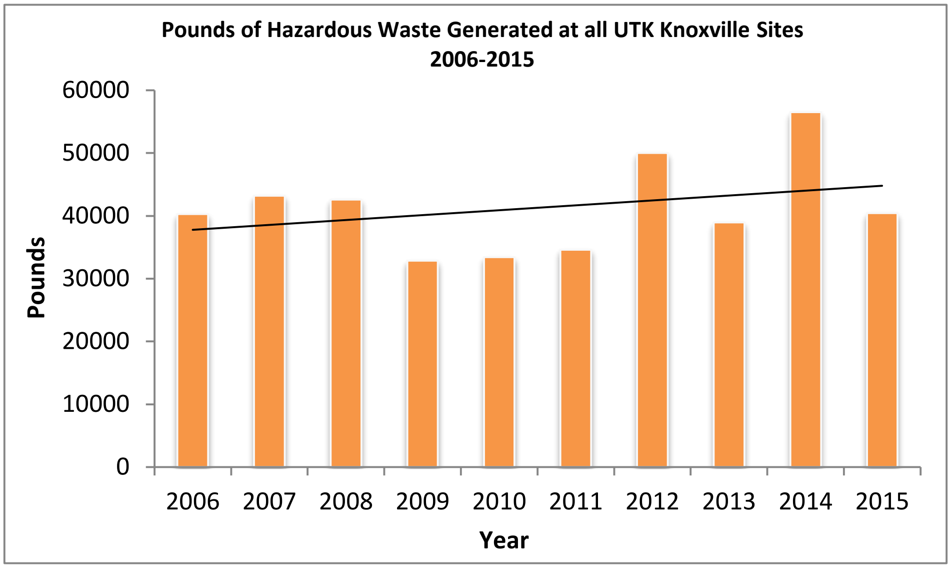
There are three departments at the UT Knoxville campus that have E.P.A. i.d. numbers on file with the Tennessee Department of Environment and Conservation (TDEC). Main Campus includes all buildings and departments on the UT Knoxville campus (such as Chemistry, Biology and Engineering) with the exception of Facilities Services on Volunteer Drive and Graphic Arts on Stephenson Drive. An additional E.P.A. id number is assigned to The Agricultural Campus and Vet School and they treated as a separate entity. The Agricultural Campus hazardous waste management is the responsibility of UTIA EH&S office. A separate Waste Reduction Plan addresses hazardous waste generated on UTIA. Table 1 lists the amount of hazardous waste disposed for each of the three departments on the UT Knoxville campus possessing an E.P.A. i.d. # from 2006-2015.

Table 1: Totals (in pounds) of all hazardous waste disposed by departments on campus

Location	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Main Campus	37501	35531	38225	65388	31635	32206	48233	37056	55300	40339
Facilities Services	441	1332	466	466	906	388	1760	853	396	100
Graphic Arts	2360	6346	3916	0	900	0	0	1050	800	0
Total Waste Disposed (Pounds)	**40302**	**43209**	**42607**	**65854**	**33441**	**32594**	**49993**	**38959**	**56496**	**40439**

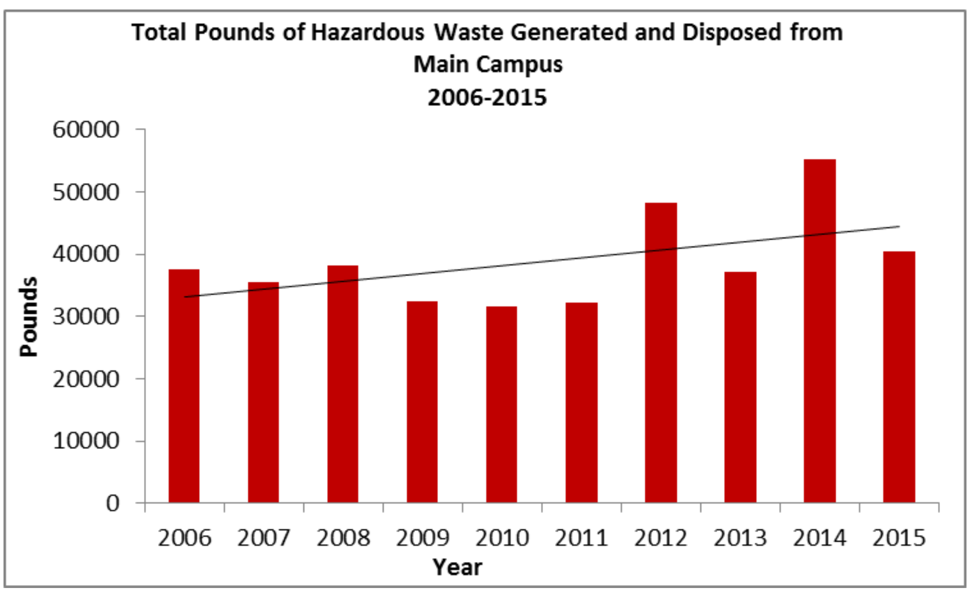
Hazardous Waste Disposal: Total Pounds Disposed at University of Tennessee Knoxville Campus

The following graph illustrates the total pounds of hazardous waste disposed by each department or division at UTK from 2006-2015 (including Facilities, Graphic Arts and Main Campus). 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. In the following graphs, the lead-contaminated building debris was left out to better demonstrate the trend for the typical types of hazardous waste generated on the main campus. Graphic Arts generated zero hazardous waste in 2009, 2011, 2012 and 2015, due to waste minimization efforts they have adopted. Fluctuation in the amount of hazardous waste generated on the Main Campus is expected due to the nature of the activities producing hazardous waste. Increases in research often correspond to increases in waste. Additionally, spikes in waste production are associated with laboratory moves resulting in cleanouts of legacy materials. With the addition of several new science buildings, increases in hazardous waste are probable for the next several years.



The following are graphs detailing the total amount of hazardous waste disposed from each site on the UT Knoxville campus from 2006-2015. Several new lab buildings have been constructed on Main Campus, such as the Tickle Engineering Building, resulting in old chemicals being cleaned out before labs are moved into the new buildings. There is an increase in research and an increase in student enrollment, resulting in more waste being disposed. This has resulted in an increase of old, expired legacy lab chemicals being disposed. There is still much room for improved waste reduction.

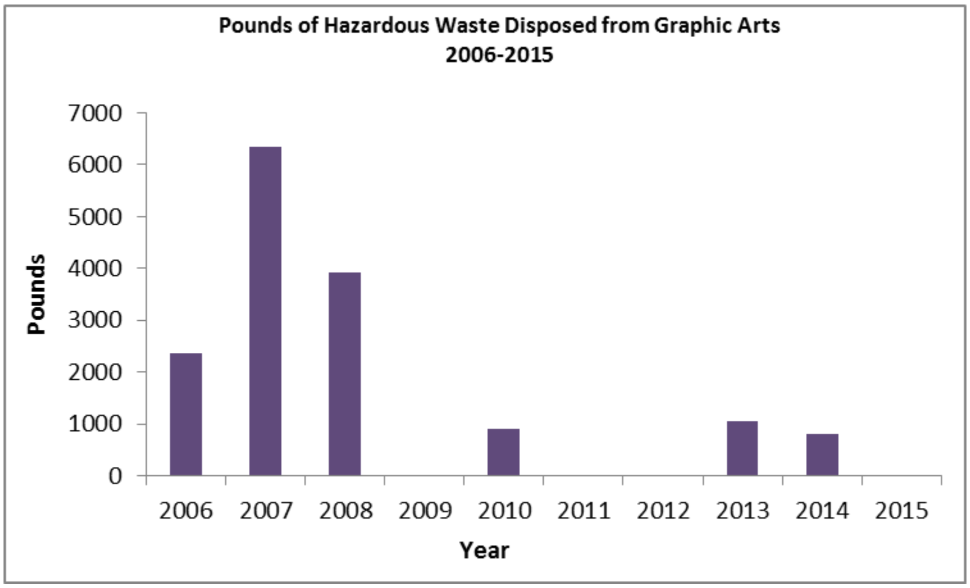
Main Campus:



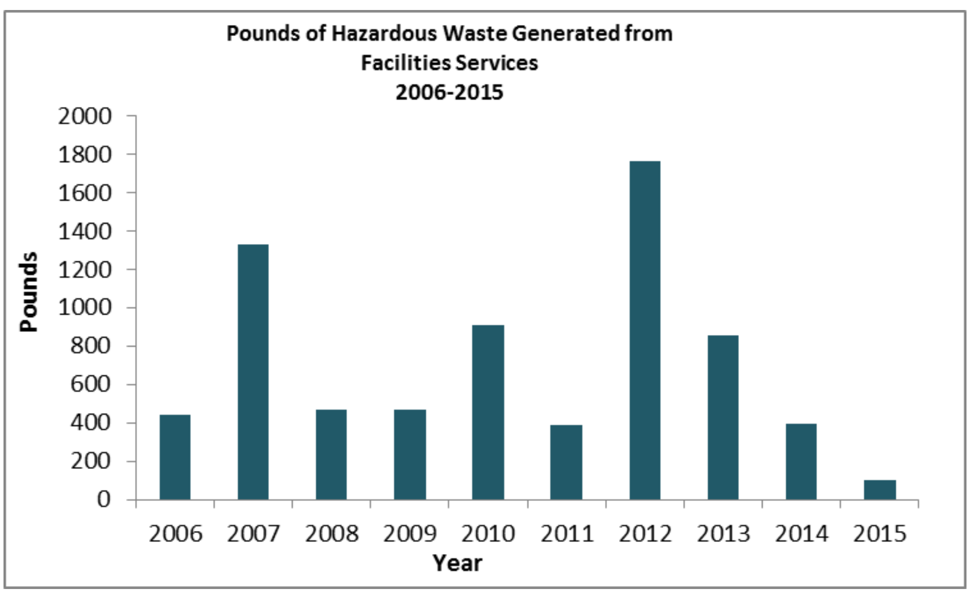
- There was a 33% increase in the volumes of hazardous waste generated from 2011-2012. This was due to an increase in lab moves, and professors who resigned or retired, resulting in a large volume of old, expired chemicals that were declared as waste. There was also an increase in research activities. These same factors resulted in the highest volume of hazardous waste produced to date in 2014. In 2015 the production of hazardous waste declined by about 28%. However, it is possible that the volume generated over the next two years will increase as more lab clean outs are performed in preparation for relocation to JIAMS, Strong Hall, and the Mossman Building.

Graphic Arts:

- Graphic Arts department has made great strides in reducing the volumes of hazardous waste they generate and dispose. They have done this by gradually switching to less and non-hazardous cleaners and inks, and by installing a more environmentally friendly press, which uses less cleaners and inks. As a result, they have greatly reduced the total volumes of hazardous waste they dispose from 2006-2014. None of this waste was disposed in 2015.



Facilities Services:

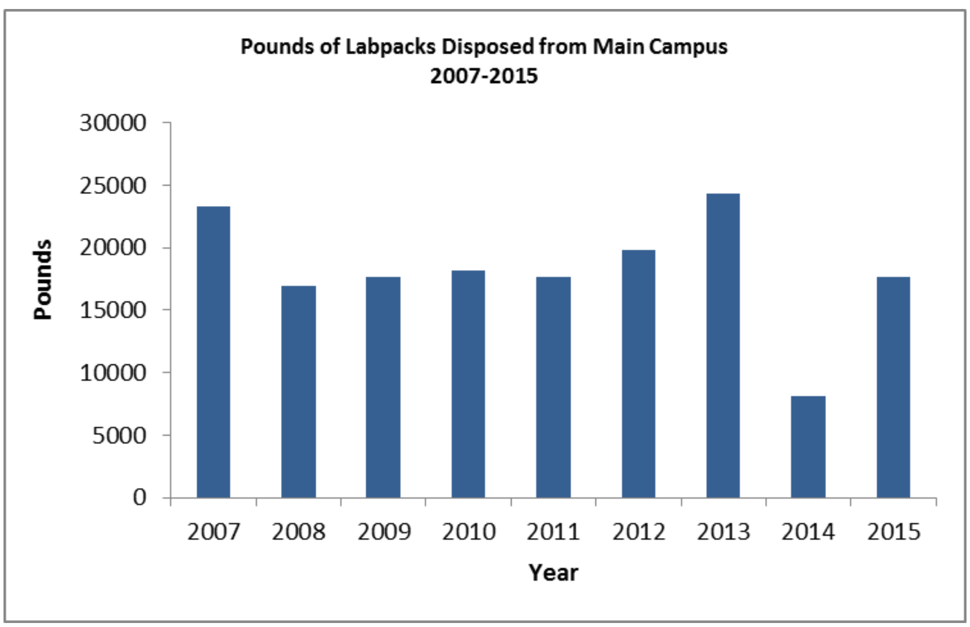


- There was a significant spike in the volumes of hazardous waste disposed during 2012 due to efforts to clean-out and dispose of old paint related materials. In 2013, the volumes decreased by almost 50% compared to 2012. A similar reduction was seen in 2014 where the volume generated decreased by over 50% from 2013. Less than one drum of this waste was generated in 2015. This waste is generated on an inconsistent basis, depending on the types of painting projects being completed on campus. However, switching to latex based paints whenever possible has significantly reduced the amount of hazardous waste produced by Facilities Services. It is anticipated that less than 2 drums of paint related waste will be produced each year going forward.

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. We have been encouraging labs to clean out and dispose of old, chemicals. However, if there is an increase in research, sometimes that can increase the amount of hazardous waste generated. Efforts should be made to examine specific laboratories to determine which waste minimization efforts would meet their specific needs.

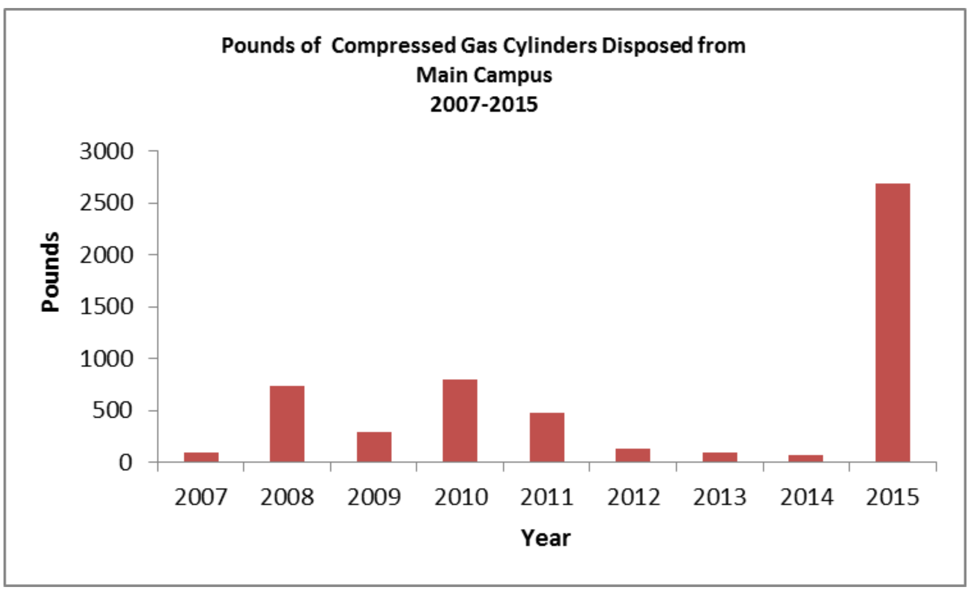


- The volume of labpack waste generated on the Main Campus has remained fairly consistent from 2007 through 2015. In 2014, labpacks decreased by over 66%. However, this was an artificial reduction due to how the waste was classified and does not reflect a true overall decrease. Much of what was previously considered labpack waste was classified as either organic solvents or acid waste so those waste streams spiked in 2014 as those graphs demonstrate. In 2015 we returned to the classification system previously used which accounts for the return to approximately the same level seen prior to 2014. It is very difficult to control this waste generation. EHS will continue to push waste minimization efforts on campus.

Compressed Gases:

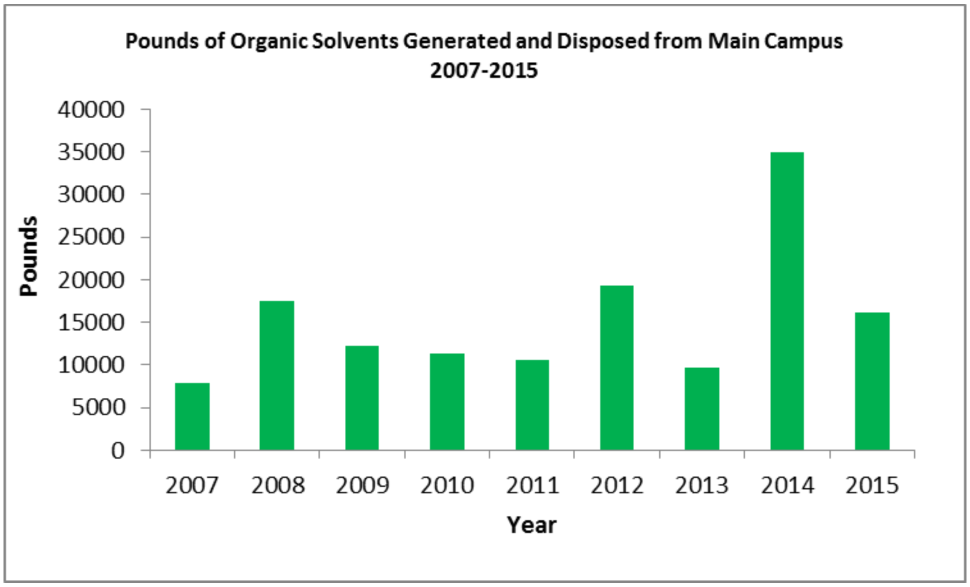
There are many serious safety concerns associated with compressed gas cylinders, including physical hazards associated with pressurized aging cylinders. In addition, inhalation of hazardous substances, or asphyxiation could occur from an unintentional release. Efforts are being made to encourage departments 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.

- Historically, there has been a relatively low volume of this waste stream produced during most years. Spikes in 2008, 2010 and 2011 were primarily due to lab cleanouts where compressed gas cylinders were present. The volume of gas cylinders disposed has continued to decrease steadily since 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. The large increase seen in 2015 resulted from including aerosol cans in this waste stream. Previously, EHS punctured aerosol cans and recovered the contents for disposal. This was a labor intensive process which was deemed to be inefficient. It is possible that in future years aerosol can waste will be reported with the flammable liquids waste stream.



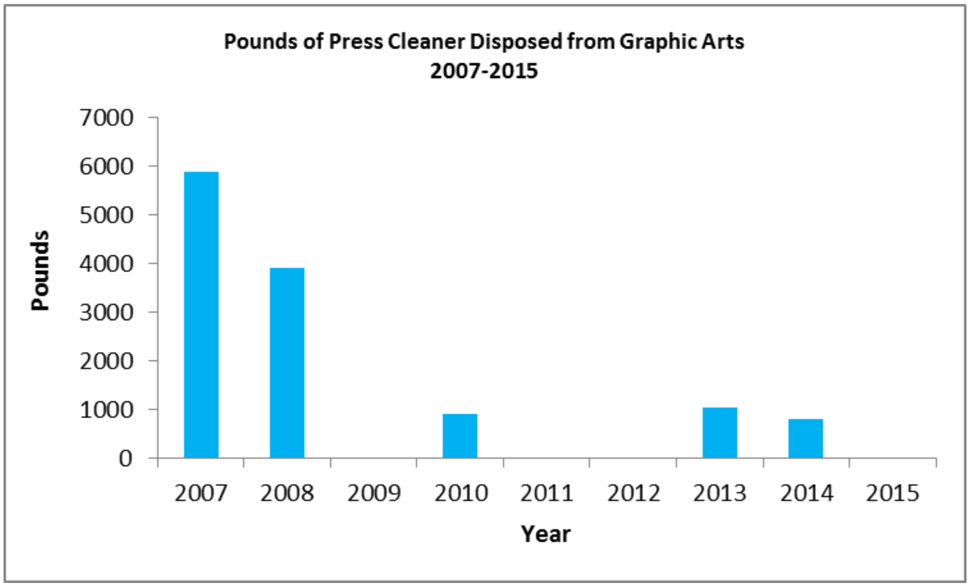
Flammable Liquids:

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, unless the flammable liquids are 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.



- There was almost a 50% increase in the volume of flammable organic solvents that were generated and disposed on main campus from 2011-2012, due to an increase in research. The volumes steadily decreased from 2008-2011. We were able to reduce the volume of flammable liquids disposed by 24% from 2008 to 2009, by another 15% from 2009-2010, and by a total of 40% from 2008-2011. The spike in this wastestream in 2008 was due to a large scale one-time lab cleanout that year. Since 2008, the volumes have remained consistent until 2012. There was a decrease of approximately 50% between 2013 and 2012. In 2014, there was a dramatic increase. However, as described in the section of this report summarizing the labpack waste stream, much of this increase was due to classifying organic solvents that were previously reported as labpack waste because of container size in this waste stream based on chemical type. In 2015 we reverted back to our previous classification system. Consequently, the volume of this waste stream declined closer to levels seen prior to 2014.

Press Cleaner Waste:

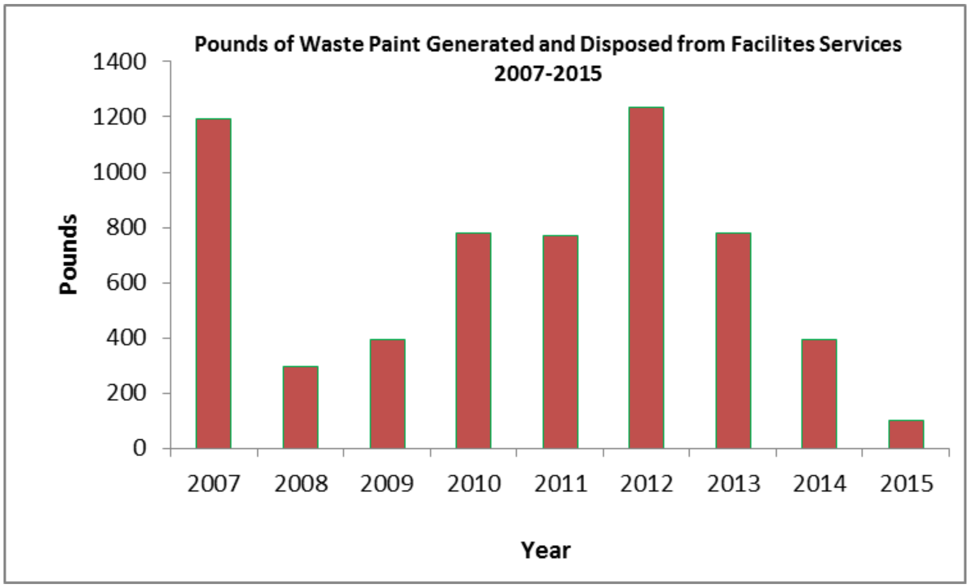


- In 2008, Graphic Arts began substituting their press cleaners and inks for non-hazardous formulations. The volume generated decreased by 36% from 2007-2008, and decreased by 100% from 2010-2012. This decrease is due to the fact that Graphic Arts has made great strides in reducing the volumes of hazardous 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. Disposal of press cleaner was did not occur in 2015.

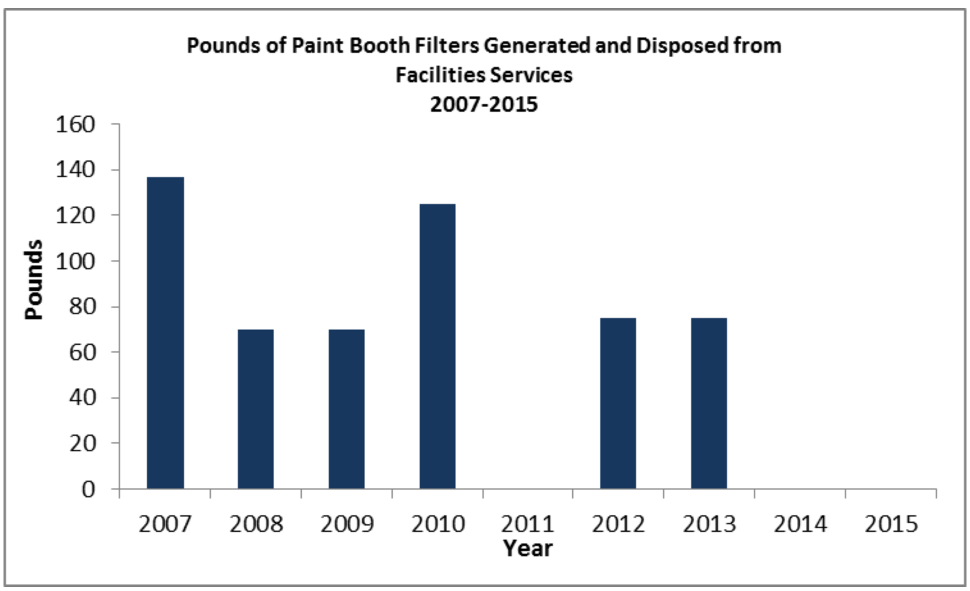
Paint Waste Related Materials and Paint Booth Filters:

Facilities Services generates oil-based paint waste and solvents, as well as paint booth filters from their painting operations. Steps have been 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 needs.

- The volume of waste paint generated and disposed increased by 38% from 2011-2012, which was due to one-time cleanouts of old oil-based paint and paint related materials. In 2013, the volumes decreased to match 2010 and 2011 totals. Overall, the volume of paint waste generated steadily increased from 2008-2012. This was because of the large number of painting projects being completed on campus. There has been a steady decrease in this waste since 2012. In 2015, less than one drum of waste paint was generated.

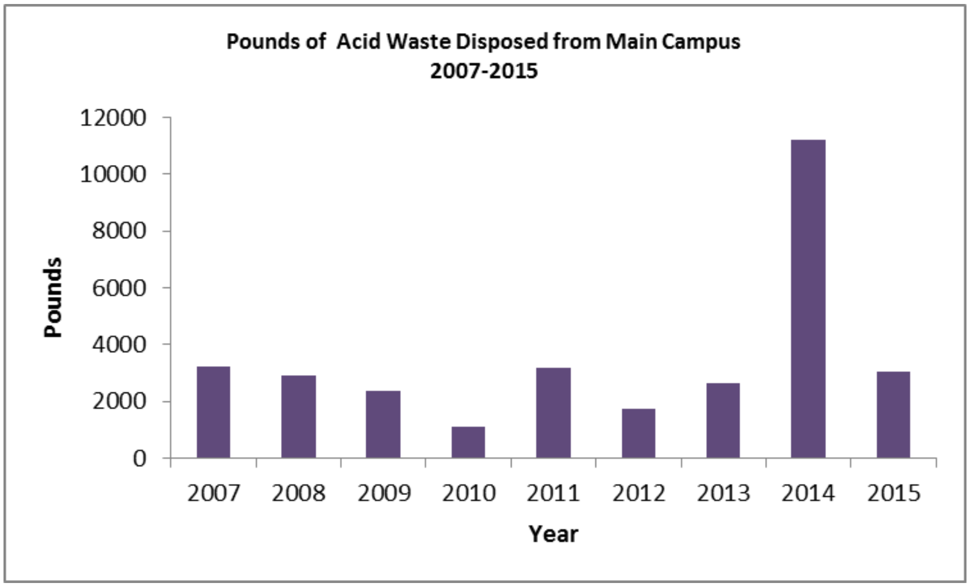


- The amount of paint booth filters remained fairly consistent from 2007-2013, with the exception of 2011. Use of the paint booth has declined significantly over the past three years. Consequently, no paint booth filters were disposed in 2014 or 2015.



Aqueous Metals/Acid 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.



*The volume of acid waste generated and disposed remained relatively constant from 2007-2013. The spike seen in 2014 is largely attributed to the way waste was classified. Much of this waste had previously been reported on the labpack waste stream. Returning to the classification system used prior to 2014 resulted in the levels of acid waste decreasing to levels similar to those seen before 2014.