



**FLORIDA ATLANTIC
UNIVERSITY**

Waste Minimization Plan

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WASTE MINIMIZATION PLAN

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INTRODUCTION

Florida Atlantic University is classified as a “large quantity generator” of hazardous waste by the Florida Department of Environmental Protection and the U.S. Environmental Protection Agency. These agencies enforce the Resource Conservation and Recovery Act of 1984, which requires a “large quantity generator” to certify that it has a program in place to reduce the volume and toxicity of waste generated to the degree it has determined to be economically practicable. Waste Minimization is necessary in order to minimize present and future threats to human health and the environment. The FAU Waste Minimization Plan presents guidelines that can be used by University personnel and organizations to reduce the amount and toxicity of wastes generated at Florida Atlantic University.

WASTE MINIMIZATION

It is important that every member of the University community be aware of the environmental and financial impacts related to the disposal of hazardous wastes and materials and to help minimize the volumes that are generated. Areas on campus that generate hazardous wastes and materials include laboratories, maintenance, garages, machine shops, art studios, and many more. It is important that proper waste management be an integral part of your operating procedures.

This Plan has been designed to assist waste generators in operating their areas with waste minimization in mind. General examples of waste minimization activities are presented below, and further information can be obtained by contacting EH&S at 7-3129. Using this plan, supervisors or lab managers can adopt specific minimization procedures that are applicable to their particular situations. There are three general methods of waste minimization:

- Source Reduction
- Recycling
- Treatment

Source Reduction

Changing practices and processes to reduce or eliminate the generation of hazardous wastes and materials is referred to as source reduction. Some source reduction methods include process modification, chemical substitution, and improved operating procedures. Here are some examples of reducing chemical waste generation at the source.

- Implement waste minimization procedures and train all personnel in those procedures.
- Do not mix hazardous and non-hazardous waste.
- Neat operations reduce waste.
 - Take care when weighing or transferring chemicals to minimize spills.
 - Seal and contain processes to prevent the escape of fumes or leaks to the environment.
- Use heat guns to remove paint rather than chemical solvents.
- Consider the use of micro scale laboratory experiments.

- Consider pre-weighed or pre-measured reagent packets where waste generation is high.
- Minimize your inventory (buy less, store less, use less).
 - Purchase chemicals in quantities that will be used in the near future.
 - A significant amount of campus hazardous waste is a result of poor purchasing practices. (i.e. buying too much and having it go bad before it's used.)
- Date all chemical product containers when received so that older products will be used first.
- Keep all chemical product containers labeled to prevent accumulation of unknown products.
- Centralize purchasing of chemicals and products within the department or laboratory to prevent order duplications.
- Substitute computer simulations/modeling, videos or demonstrations for wet laboratory experiments, when possible.
- Evaluate procedures to see if a less hazardous or a non-hazardous reagent can be substituted, some examples include:

Hazardous Chemical	Safer Substitute	Used For
Acetamide	Stearic Acid	Freezing point depression
Benzene	Xylene or hexane	Many solvent uses
Benzoyl Peroxide	Lauryl Peroxide	Some polymer catalysis
Carbon Tetrachloride	Cyclohexane	Qualitative test for halides
Formaldehyde (Formalin)	Ethanol	Specimen storage
Halogenated Solvents	Non-halogenated solvents	Some extractions and other solvent uses
Sodium Dichromate	Sodium Hypochlorite	Some oxidation reactions
Sulfide ion	Hydroxide ion	Qualitative test for heavy metals
Toluene-based Scintillation Cocktail	Non-ignitable Scintillation Cocktail	Studies using radioactive materials
Chromic acid solution	Ultrasonic baths, Alconox or similar detergents, Pierce RBS-35 or similar detergents	Cleaning laboratory glassware
Mercury thermometers	Alcohol (red liquid), digital or thermocouple thermometers	Temperature
Solvents	Detergent and hot water	Parts cleaning
Oil-based paint	Latex paint	Painting operations

Recycling

Another method of waste minimization is recycling. Recycling is when a waste material is used for another purpose, treated and reused in the same process or reclaimed for another process. Some examples include:

- Re-distilling used-solvents (stringent Standard Operating Procedures should be developed for recovering solvents since solvents can be extremely flammable or explosive).
- Recovering some solvents like ethers should be avoided.
- Acetone or ethanol used for drying glassware can be collected and reused several times before disposal.
- Purchasing gas cylinders (including lecture bottles) from manufacturers who will accept the return of the empty or partially used cylinders.
- In some cases, excess pesticides can be returned to the distributor, or donated to another organization. Contact EH&S (7-3129) before returning or donating pesticides.
- Photographic waste can be treated with silver recovery units to recover silver.
- Some materials are commercially recycled by FAU including; used oil, hazardous batteries, solvent soaked rags, fluorescent lamps and ballasts. Contact EH&S for assistance if your area generates any of these types of wastes. (Note: If at all possible, do not contaminate used oil with heavy metals or solvents.)
- Reclaiming metallic mercury.
- Re-circulate unused, excess chemicals within your department. EH&S also maintains a surplus chemical inventory which is available free of charge to the university community. Call EH&S or view chemicals available for redistribution on EH&S website at www.fau.edu/ehs under “Waste Minimization/Chemical Surplus.”

Treatment

The last technique for waste minimization is treatment of waste. Wastes that are neutralized or detoxified and managed at the source can reduce environmental risks that might occur during transportation and handling. EH&S encourages in-lab chemical management, such as neutralization of acids or bases and chemical treatment of toxic chemicals **as the final step** of the experiment. These steps either decrease or eliminate toxicity or help to reduce the volume of waste. ***It should be noted that if treatment is not a part of the end step and is done separately from the experiment, it is considered hazardous waste treatment, which cannot be done without a treatment permit from the State.*** Before initiating treatment procedures contact EH&S. The following are some examples:

- Neutralize acids and bases.
- Inject gels directly with ethidium bromide to eliminate large volumes of liquid waste.
- Precipitate metals out of solution to reduce volume of waste.
- Polymerize acrylamide solutions
- Oxidize cyanide salts and ethidium bromide solutions with bleach.
- Convert Osmium tetroxide less volatile form.

Many other in-lab chemical treatment procedures can be found in the *Hazardous Laboratory Chemicals Disposal Guide* by Margaret A. Armour, CRC Press, 1991 and *Destruction of Hazardous Chemicals in the Laboratory* by George Lunn and Eric B. Sansone, Wiley-Interscience, 1990.

MANAGING WASTES EFFICIENTLY

In most cases, waste can be minimized, but not eliminated. Waste is a natural product of research, teaching, testing and many other operations. It is prudent to manage all wastes as efficiently as possible. The management of chemical waste is most efficient when waste types are properly segregated, which also helps to reduce disposal costs.

The importance of proper separation of chemical wastes into various groupings cannot be over emphasized. Florida Atlantic University disposes of large quantities of the waste streams shown below. In most circumstances, the volumes and types of wastes, rather than the concentrations of wastes, determines the costs of disposal. As a result, EH&S requests that areas generating waste make an effort not to dilute their wastes anymore than is necessary. Also, do not mix hazardous chemical with non-hazardous wastes, and do not mix hazardous chemical with radioactive wastes. EH&S supplies appropriate labels and containers for the proper collection of hazardous wastes and materials. For more information on specific waste disposal procedures contact EH&S at 7-3129 or refer to the [FAU Hazardous Materials Manual](#), Appendix B of the *FAU Chemical Hygiene Plan*.

The following sections are meant to give waste generators some information on how to minimize disposal costs of some of the more common waste streams generated at FAU. In some situations, these suggestions will be difficult or impractical to implement. In such cases, consult with EH&S (7-3129) to determine the best method for collection and disposal.

Flammable Liquids

Examples: acetone, methanol, ethanol, toluene, xylene, hexane, acetonitrile

Flammable liquid wastes are typically burned as fuel in waste disposal incinerators, and as a result, disposal is relatively easy and inexpensive. For this reason, the lower the water content in the waste-the less expensive the costs of disposal. Solvents contaminated with materials not permitted for incineration will require alternative, costly treatment methods.

Some suggestions for reducing disposal costs

- Minimize water content of waste by minimizing any unnecessary dilutions.
- If possible, keep separate from wastes that contain heavy metals, pesticides, cyanides, or acute hazardous “P-listed” wastes. (Refer to EH&S *Chemical Hygiene Plan*, Appendix B – *Hazardous Materials Manual*.) These wastes tend to drive up the costs of disposal due to the need for more complex waste treatment.
- Recycle or redistill solvents.
- Investigate the use of nonflammable or biodegradable alternative solvents.

- Replace solvent based inks in printing operations with soy-based inks.
- Make multiple use of cleaning solutions before disposing of them.

Flammable/Corrosive Mixtures

Examples: trifluoroacetic acid & acetonitrile, phenol & chloroform, potassium hydroxide & methanol, methanol & hydrochloric acid

Flammable acids and alkaline mixtures are difficult to dispose of due to their corrosive nature. This waste can cost at least four times more to dispose of than other flammable liquids.

Some suggestions for reducing disposal costs

- Minimize unnecessary dilution of wastes.
- Do not mix unnecessarily with other solvents.
- Keep acidic and alkaline wastes separate to minimize the risk of reactions.
- Minimize the volume of these wastes by keeping separate from other waste streams.
- If possible, keep separate from wastes that contain heavy metals, pesticides, cyanides, or acute hazardous “P-listed” wastes. (Refer to EH&S *Chemical Hygiene Plan*, Appendix B – *Hazardous Materials Manual*.) These wastes tend to drive up the costs of disposal due to the need for more complex waste treatment.

Acids and Bases

Examples: hydrochloric acid, sulfuric acid, phosphoric acid, potassium hydroxide, and sodium hydroxide.

If not contaminated with other hazardous wastes (i.e. heavy metals, listed hazardous wastes, etc.) most acids and bases can be neutralized and then drain disposed. Neutralization of acids and bases reduces disposal costs. Some acids and bases, such as chromic acid or barium hydroxide, cannot be made non hazardous by neutralization due to their heavy metal content. Diluting acids or bases with water is not neutralization and is not allowed. Neutralization must be accomplished by carefully mixing an acid with a base or vice versa. The resulting solution must be as close to pH 7 as possible before pouring down the drain. Some acids, such as hydrofluoric and perchloric acid, are quite dangerous, contact EH&S (7-3129) for disposal of these acids.

Some suggestions for reducing disposal costs

- Minimize unnecessary dilution of wastes.
- Neutralize waste if possible (contact EH&S if you’re unsure if neutralizing is appropriate, or if you do not have the right neutralizing agent).
- Do not mix unnecessarily with other waste streams.

Halogenated Solvents

Examples: methylene chloride, chloroform, trichloroethane, perchloroethylene, carbon tetrachloride

Not only are many halogenated solvents (solvents containing Cl^- , F^- , Br^-) carcinogenic, but they are also difficult to dispose of, and can cost three times more to dispose of as compared to non-halogenated solvents. An effort to keep halogenated and non-halogenated waste in separate containers will help to reduce disposal costs.

Some suggestions for reducing disposal costs

- Minimize unnecessary dilution of wastes.
- Keep separate from acidic or alkaline waste streams.
- Keep halogenated wastes separate from non-halogenated wastes.
- Substitute non-halogenated solvents in place of halogenated solvents
- If possible, keep separate from wastes that contain heavy metals, pesticides, cyanides, or acute hazardous “P-listed” wastes. (Refer to EH&S *Chemical Hygiene Plan*, Appendix B – *Hazardous Materials Manual*.) These wastes tend to drive up the costs of disposal due to the need for more complex waste treatment.
- Recycle or redistill solvents.
- Investigated the use of alternative non-halogenated solvents.

Chromerge & Chromium-Bearing Waste

Florida Atlantic University discourages the use of Chromerge[®] (potassium dichromate and sulfuric acid) for the cleaning of laboratory glassware. There are alternative solutions available such as Alconox[®], Pierce RBS-3[®] 5 and NoChromix[®]. Chromium is a concern due to its toxic characteristics. Researchers, who use chromium as part of a procedure in their laboratory, should investigate the viability of alternative procedures or chemicals.

Some suggestions for reducing disposal costs (if chromium-bearing materials must be used)

- Minimize the volume of waste generated by unnecessary dilution.
- If possible, keep separate from wastes that contain heavy metals, pesticides, cyanides, or acute hazardous “P-listed” wastes. (Refer to EH&S *Chemical Hygiene Plan*, Appendix B – *Hazardous Materials Manual*.) These wastes tend to drive up the costs of disposal due to the need for more complex waste treatment.

Formalin & Formaldehyde Solutions

Formaldehyde is a suspected human carcinogen, which is toxic, very irritating to the eyes, throat and breathing passages and can cause dermatitis. Formaldehyde is also a sensitizer, so the more a person is exposed to it, the smaller a dose it takes to have an effect on that person.

Some suggestions for reducing disposal costs

- Minimize the volume of waste generated by eliminating any unnecessary dilution.
- Do not mix with any other waste streams.
- Substitute ethanol, or a commercial fixatives like Carosafe[®] or Formalternate[®] in place of formaldehyde for storage of biological specimens

Aqueous Metals

Treatment and disposal of metal solutions such as barium, cadmium, lead, copper, selenium, silver, cobalt, mercury, etc. varies depending on the type and concentration of the metal present in the waste. EH&S recommends the substitution of less hazardous metals for those procedures that involve heavy metals

Some suggestions for reducing disposal costs

- Keep heavy metal solutions separate from other wastes.
- Keep mercury free from all other waste streams including other metal waste.
- Minimize the volume of waste by eliminating any unnecessary dilution.
- Consider using micro scale techniques.
- Substitute less hazardous metals.
- Eliminate metal catalysts in chemical procedures and allow more time for the completion of reactions.
- Consider precipitating out metals from solution.
 - Treatment of waste must be incorporated into the experiment to avoid regulatory problems.
 - Before imitating any treatment process contact EH&S for assistance.
- Silver recovery units can be used to reclaim silver from photo waste solutions. (EH&S has not incorporated any of these units on campus as yet but may in the future.)

Photographic Waste

EH&S has developed “Photographic Chemical Safety and Disposal Guidelines.” To receive a copy call EH&S at 7-3129, or access the guidelines on the EH&S web page (www.fau.edu/ehs) under “Chemical Safety.”

Oil-based Paints & Solvents

Unusable oil-based paints and solvents are hazardous wastes due to their flammable and/or toxic natures. These types of waste paint materials must be disposed of in accordance with EH&S hazardous waste disposal procedures as outlined in the FAU [Hazardous Materials Manual](#), Appendix B of the FAU Chemical Hygiene Plan. Paints that are still useable and in their original containers can be recycled. Call EH&S (7-3129) for pickup.

Some suggestions for reducing disposal costs

- Do not contaminate usable paint and always reseal the containers (allows for recycling).
- Use latex paint (FAU is phasing out the use of oil-based paints).
- Minimize the volume by reducing any unnecessary dilution.
- Clean out stockpiles of old paints and call EH&S (7-3129) for disposal or recycling.
- Minimize inventories of paints. Order only enough to satisfy short-term needs.

Latex Paints

Latex paints are not considered hazardous wastes, however unusable latex paint cannot be disposed of in the normal trash unless completely solidified. Liquid latex paints must be collected and disposed of properly by EH&S. Good useable latex paints can be recycled by EH&S.

Some suggestions for reducing disposal costs

- Do not contaminate useable paint, and always reseal the container (allows for recycling).
- Do not mix latex with non-latex paints or any other hazardous materials.
- Minimize the volume by reducing any unnecessary dilutions.
- Clean out stockpiles of old paints and call EH&S (7-3129) for disposal or recycling.

Used Oil

Used oil is not considered a hazardous waste; however, it must be collected in a container that can be closed and labeled “Used Oil,” and the oil must be recycled. Recycling is simple as long water contamination is minimal and the oil is not contaminated with any hazardous substances. Contact EH&S (7-3129) for pickup of used oil for recycling.

Some suggestions for reducing disposal costs

- Minimize the volume of waste by reducing any unnecessary dilution or addition of water.
- Avoid contamination with hazardous materials. If the oil has been contaminated or exposed to heavy metals, solvents, antifreeze and/or chemicals, it is potentially hazardous, and must be disposed of in accordance with EH&S hazardous waste disposal procedures as outlined in the FAU [Hazardous Materials Manual](#), Appendix B of the FAU Chemical Hygiene Plan.
- Call EH&S (7-3129) for disposal or recycling of used oil.

Unknown Chemicals

The generation of unlabeled and unidentified chemicals results in an expensive waste disposal challenge. The number of unknown chemicals can be significantly reduced by simply making a concerted effort to **label all containers**. Unknown chemicals can cost up to ten times more to dispose of than properly labeled chemicals. Original chemical and product labels should be retained on containers until the chemicals/products are completely used and the containers no longer have any hazards related to its contents. When transferred to secondary containers chemicals/products should be labeled at a minimum with the chemical/product name and the primary hazard (i.e. flammable, poison, etc.).

Some suggestions for reducing disposal costs

- Prevent generation of unknown chemicals/products by keeping all containers labeled.

- Do not let old chemicals and products accumulate, clean out stockpiles of old chemicals and products before they become “unknowns.” Contact EH&S (7-3129) for disposal.
- Before a laboratory researcher or graduate student leaves FAU, all samples and chemical formulations generated by that person, must be clearly labeled as to their content.
- Chemicals must be transferred to another individual or properly disposed of prior to the individual’s departure (refer to the FAU EH&S laboratory close out procedures).

Unused or Excess Chemicals

The American Chemical Society (ACS) estimates that 40% of the chemical waste generated by labs consist of unused chemicals. As a result, EH&S encourages departments/laboratories to purchase chemicals only in amounts that will be used within the budget year. Bulk purchases may be cheaper (price per unit) for laboratories; however, if these chemicals are unused, disposal costs will far outweigh any savings. The ACS has an excellent publication, *Less is Better: Guide to Minimizing Waste in Laboratories*, available on the web at :

http://membership.acs.org/c/ccs/pubs/less_is_better.pdf

Some suggestions for reducing disposal costs

- Redistribute usable/unwanted chemicals within your department or the University by utilizing the EH&S Surplus Chemical List located on the EH&S web site (www.fau.edu/ehs) under “Waste Minimization/Chemical Surplus.
- Do not stockpile large quantities of chemicals, clean out old chemicals periodically, saving only those that are needed. Contact EH&S for disposal or redistribution.
- Do not accept chemicals from outside organizations or companies without prior approval from EH&S.

Mercury Compounds & Mercury Containing Devices

Mercury-containing wastes require special treatment; thus, disposal is expensive. EH&S recommends:

Some suggestions for reducing disposal costs

- Do not mix mercury-containing wastes with any other waste streams
- Mercury thermometers and manometers should be replaced with non-mercury containing instruments.
- If you must use mercury thermometers, purchase those with a Teflon coating.
- Containerize metallic mercury, so it can be recycled by EH&S.
- If mercury is spilled contact EH&S for cleanup (refer to guidelines on mercury spill procedures in the [FAU Chemical Hygiene Plan Appendix G](#)).
- Due to the high toxicity and disposal costs of certain mercury compounds use alternative procedures whenever possible.
- Use mercury free catalysts or simply let reactions run longer.
- Fluorescent lamps also contain mercury, and must be recycled. FAU has several departments that collect and recycle lamps. For more information, contact EH&S at 7-

Compressed Gas Cylinders

Compressed gas cylinders pose both physical and health hazards. Physical hazards include flammability (depending on the gas) and hazards associated with high pressures and cylinder ageing. Health hazards include inhalation of toxic or corrosive gases, chemical asphyxiation, or asphyxiation associated with oxygen displacement.

Some suggestions for reducing disposal costs

- Use a supplier that recycles empty gas cylinders. This can be accomplished by renting not purchasing the cylinders.
- Limit the purchase of specialized gas cylinders (lecture bottles) since these are hard to recycle. If lecture bottles must be purchased use a supplier that will recycle the empty or partially filled bottles.
- Before purchasing gas cylinders check with your department or check the EH&S Chemical Surplus List for existing cylinders that may be available for use.
- Call EH&S (7-3129) if you have any questions about cylinder handling or disposal.

Batteries

Many batteries contain one or more hazardous chemical components, and therefore must be recycled. Hazardous batteries may be placed in the hazardous waste collection tote. To request a pick-up call **EH&S** at 7-3129 or fill out the online form at www.fau.edu/ehs under forms. The following battery types are considered hazardous and must be recycled by **EH&S**.

1. Lead Acid (car batteries can also be recycled by the transportation department)
2. Mercury
3. Silver
4. Lithium
5. Nickel Cadmium (Ni-Cad), Nickel Metal-hydride

Common alkaline batteries (Duracell or Energizer batteries), which are not rechargeable are exempt, and may be disposed of in the regular trash. Direct any questions concerning the type or nature of batteries found in the work area to **EH&S**.

Electronic Devices

Electronic devices (computers, monitors, TVs, etc.) may contain hazardous materials and must be recycled. These types of equipment may also contain an FAU property tag; therefore, contact the Surplus/Property Records Department at 7-3767 for pickup and recycling.

CONCLUSION

All members of the University community should make waste minimization an active and

ongoing component of their operations. On campus, that means taking responsibility for the byproducts of your operations and the waste that is generated. Because the actual generators are most familiar with their work and the materials they use, they are the best source for new ideas to prevent pollution and to minimize waste; therefore, the success of the FAU Waste Minimization Program is dependent on the willing and active participation of the entire University Community.

Any questions, comments or suggestions concerning waste minimization can be directed to EH&S by email at ehs@fau.edu or by telephone at 7-3129.