Pollution Prevention and Waste Minimization Guidelines

DEPARTMENT OF
ENVIRONMENTAL SAFETY,
SUSTAINABILITY & RISK

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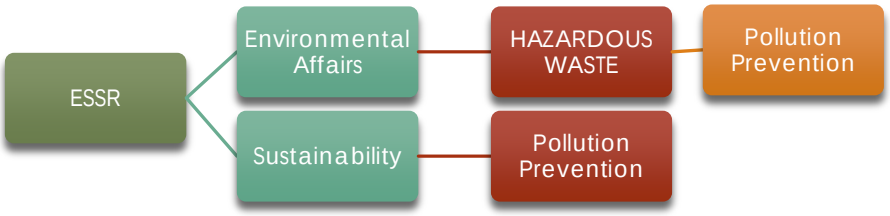
Introduction –

Pollution prevention at the University of Maryland encompasses work in many different departments. The Department of Environmental Safety, Sustainability and Risk, ESSR, manages the hazardous waste on campus with a Treatment Storage and Disposal, TSD, permitted facility and is a large quantity generator. The concept of pollution prevention has evolved substantially since its inception in EPA in 1988. Pollution prevention and waste minimization, back in the 1980's and 1990's was a specialized environmental initiative, with



a focus on regulatory compliance. This document is the pollution prevention effort for the ESSR's regulatory compliance arena of pollution prevention. The concepts herein are related specifically to hazardous waste and waste minimization.

It can be argued that the concept of pollution prevention has, in the intervening decades since its inception, become a broader concept called sustainability. Sustainability on the campus of the University of Maryland has evolved to the point that we have dedicated an entire division of the ESSR department to the effort. This document is not intended to be all inclusive of the pollution prevention topic related to sustainability at the University.

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This document focuses entirely on the regulatory compliance of the hazardous waste minimization concept.

Waste Minimization is a waste management approach that focuses on reducing the amount and toxicity of hazardous waste generated. EPA encourages the minimization of all wastes. Waste minimization techniques focus on preventing waste from ever being created, otherwise known as source reduction, and recycling. These techniques can be practiced at several stages in most waste generating processes, but require careful planning, creative problem solving, changes in attitude, sometimes capital investment, and a genuine commitment. This report is not intended to serve as the biennially waste minimization report. This guideline provides some ideas and concepts to consider during the efforts to minimize waste.

This guide will help you minimize the environmental impact of your waste producing operation. It may be difficult for your operation to minimize its waste. By its very nature, research is often the process of studying something and throwing it away. Unlike larger industrial processes, the multitude of irregular laboratory operations are intrinsically more difficult to control. Still there are many things you can do to prevent pollution and minimize hazardous waste both in your laboratory and in other campus operations.

Waste minimization:

- Saves money through avoided disposal and raw material purchase costs
- Reduces regulatory burdens and compliance costs
- Builds better community relations
- Minimizes short and long term liability
- Creates safer working conditions for employees
- Protects human health and the environment
- Demonstrates environmental leadership
- Improves competitiveness through greater efficiencies and decreased overhead costs

Regulations

RCRA specifically requires Large Quantity Generators of hazardous waste, such as the University of Maryland, to certify on waste manifests that they have a program in place to reduce the volume and toxicity of waste generated to the extent economically practical. Small Quantity Generators are required to certify, when they sign their manifests, that they have made a good faith effort to reduce the volume and toxicity of the hazardous wastes they generate. Additionally, all large-quantity hazardous waste generators must report biennially on waste minimization activities.

Pollution Prevention:

- 40 CFR 262
- 40 CFR 257
- 40 CFR 112
- Executive Order (EO) 13693 Planning for Federal Sustainability in the Next Decade
- Pollution Prevention Act of 1990
- COMAR 26.13

Waste Minimization Initiative UMD Examples

Our Waste Minimization Program has made significant progress in several areas. For example our efforts in pollution prevention and waste minimization have resulted in a total of over **$25,000.00** in savings in the year 2009. Below is a synopsis of the programs and their respective savings to the University:

Waste Minimization Initiative	Savings to the University
Mercury Thermometer Exchange Program	$3,300.00
On-Campus Aqueous Base Part Washers	$9,000.00
Silver Recovery Systems	$1400.00
Gas Cylinders	$1,800.00
Cans of Paints Redistributed (18 one gallons containers Free)	$150.00
Recycle Solvent & Rags	$1400.00
Medical Waste Cost Reduction	$2,000.00
Waste Oil Recycling (2,700 gallons)	$6,000.00

Mercury Thermometer Exchange Program - Since the beginning of this program in 2002 we have exchanged a total of approximately 2200 mercury thermometers for non-hazardous thermometers. Prior to the exchange program we were averaging about one to two mercury spills a week. Most spills required two men and taking about four hours per cleanup. Now we average about one to two spills a month. This has resulted in a reduction of mercury incidents and cost savings to the University in man hours.

Aqueous Base Part Washers - Four water-based parts washers were purchased on campus in 2005. Five were purchased off campus. Currently three units on campus are being used daily. These generators are pleased with these units, because they take less man hours to process their parts and are much safer than the solvent base units used previously. These units generate no waste and have paid for themselves. As a result of purchase these units have save the University in labor and disposal cost.

Silver Recovery Systems - Two silver recovery systems were purchased in January 2000. These units have paid for themselves and have eliminated hazardous waste costs.

Paint Waste Cost Avoidance - Since our last report we donated 18 one gallon containers of paint to the Habitat Humanity group. These materials are normally packed in a 55 gallon drums and sent out for disposal. The Habitat Humanity is a non-profit organization that receives donated construction materials to build homes.

Gas Cylinders - Since July 2009 we collected 12 compressed gas cylinders that have been re-used, vented, redistributed, recycled, scrapped, or returned to the vendor. These methods of disposal have resulted in waste disposal reductions and cost savings to the University.

Recycle Solvent & Rags – The Pollution Prevention and Waste Minimization Program has minimized waste in the Art Department. This was achieved by using recycled solvents and recyclable rags. These two initiatives reduced waste disposal costs and most importantly reduced regulatory requirements for this department.

Medical Waste Cost Reduction - In early 2005 we were contacted by the Health Center asking assistance in minimizing their disposal cost. The handling process was modified for handling medical waste at the Health Center and resulted in a 40 % reduction in disposal cost. Projected cost savings from January 2009 to June 2009 has resulted in cost savings to the University.

Waste Oil Recycling – From July 2009 to January 2010 we shipped approx. 2,700 gallons of waste oil to a recycler in lieu of a disposal facility. This material came from various automotive shops on campus. This has resulted in cost saving to the University in disposal cost.

Prevent Pollution –

A variety of methods can be used to prevent pollution to the air, water or land. There are two categories of pollution prevention: methods that reduce pollution at the source (the laboratory or other campus operation) and environmentally sound recycling.

Air and water pollution cost health and the environment in indirect ways. Hazardous waste disposal costs the University directly. Not including labor and operating costs, the University of Maryland spends nearly $120,000 annually to safely dispose of chemical waste commercially. Each carboy costs up to $20 to dispose of; disposal of one lecture bottle (a

small gas cylinder) can cost up to $1,800. So when you prevent pollution, you also reduce costs.

Reduce Pollution at its Source

Changing practices and processes to prevent pollution at its source is referred to as source reduction. Source reduction methods include process modification, improved operation and material substitution. Some businesses can prevent pollution by modifying their product, but this method is not as applicable at an educational institution.

Modify Processes

Pollution can be prevented by changing the process by which the pollution is created. In

the laboratory, modern extraction techniques, (such as those that use a solid phase or supercritical fluid) minimize waste by using much smaller volumes of organic solvents. Computer simulations and modeling eliminate all environmental impacts when they are substituted for wet laboratory experiments. Around campus, paint can be removed from structures using heat guns rather than chemical solvents to reduce chemical waste.

Reduce the Scale of Laboratory Processes.

One of the most successful pollution prevention modifications is reducing the scale of laboratory procedures. Innovative laboratory glassware and microscale techniques are now available that reduce quantities used to milligrams. Reducing the scale of laboratory processes not only prevents pollution, but has many other benefits:

- Small scale experiments cost less because they use less chemicals--valuable raw materials are also conserved;
- Small scale experiments usually run more quickly;
- Heating and cooling is easier with smaller volumes;
- Your exposure to chemicals is reduced; and
- The amount of fugitive emissions (evaporative losses) will be reduced.

Reduce Air Emissions –

Reduce Air Emissions. One potential source of pollution from campus operations is the emission of volatile chemicals into the air. To prevent chemical exposure to personnel, many operations are designed to include fume hoods, local ventilation, ventilated cabinets and room ventilation. The exhaust of these systems is often not filtered or controlled for volatile chemicals, fumes or gases. As a result, you should use these ventilation systems to protect you from chemical exposure, but you must use them prudently to prevent excessive air emissions of chemicals. Evaporation of laboratory organic solvents alone contributes significantly to the University's toxic releases. It is obvious when an organosulfur compound escapes into the atmosphere, but most chemicals do not have such a low odor threshold to indicate their release.

Simple management practices can minimize air emissions:

- Keep containers of volatile chemicals capped--if a cap is not tight, replace the cap or transfer the contents to another container;
- The best container seals have an even rim on the bottle and an appropriately-fitting cap with a polyethylene or teflon liner;
- Minimize the amount of volatile chemicals in your area (order and store only what you need in the immediate future;
- Do not store chemicals in the fume hood (use a ventilated cabinet, which has only a slight negative pressure and is less likely to draw volatiles into the air);
- Keep operations using volatile chemicals as closed as safely possible.
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- Wasteful energy use results in unnecessary pollution. Your efforts to conserve energy prevent pollution.

- Do not dispose of any chemical by evaporation.
- Keep processes involving volatile chemicals as closed as safely possible;

- Consider performing procedures in a glove bag instead of a fume hood--glove bags may be more effective in the prevention of exposure and will minimize fugitive emissions;
- Keep waste solvent collection carboys capped at all times, unless you are adding waste;
- To minimize the amount of waste solvents in your lab, routinely dispose of carboys by requesting a waste pick-up through the ESSR's web site (at a minimum, request a pick-up for disposal within three days of filling a container);
- Do not dispose of any chemical by evaporation--it is illegal to evaporate hazardous chemical waste for the purpose of disposal; and
- Do not dispose of any gas by venting.

Reduce Wastewater Effluents –

Reduce Wastewater Effluents. To reduce the potential for unwanted discharges to the sanitary sewer system, remember to:

• Make sure containers of liquids are not leaking;
• Make sure systems that create wastewater do not leak or have inadvertent or unnecessary discharges;
• Make sure liquids are stored in trays, other containers or diked areas with no floor drains so that spills are contained;
• Work with others in your area to limit sewer discharges; and
• Do not dispose of any waste into a storm sewer--most outside drains and sewers are storm sewers that discharge directly into surface waters.

Substitute With a Safer Chemical –

One of the most successful ways to prevent pollution is by substituting a hazardous chemical with a less hazardous chemical. For many operations, an environmentally sound alternative exists.

Use Non-ignitable Liquid Scintillation Cocktail. One excellent pollution prevention practice is substitution of non-ignitable liquid scintillation cocktail (LSC) for toluene-based cocktails. This substitution reduces the risk of laboratory fire and personnel exposure from toluene. Toluene-based cocktails must be incinerated as a hazardous waste. Most non-ignitable, water emulsifiable LSC can safely be disposed of as non-hazardous.

The following table includes some common chemical substitutes

Hazardous Chemical	Safer Substitute	Used For
Acetamide	Stearic Acid	Freezing point
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
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

Stop Using Chromic Acid Solution. Chromic acid solution is a mixture of concentrated sulfuric acid and potassium dichromate, Chromerge® (chromic acid), or chromium anhydride (chromium trioxide). It is used to clean laboratory glassware because it oxidizes most residues and eats away a very thin layer of the glass surface, leaving a new, clean surface.

Chromic acid solution is a dangerous chemical. It is a strong corrosive. It is a strong oxidizer that has been known to react violently and explode when combined with oxidizable materials. It contains chromium (VI) (as chromic or dichromic acid), which is a known human carcinogen. Chromium is toxic in other ways to humans, flora and fauna. These properties make it extremely difficult to handle safely.

There are many commercially available alternatives for chromic acid solutions. The Department of Environmental Safety Sustainability and Risk strongly encourages you to stop using chromic acid solutions unless you have tried the alternatives below and found them to be unsatisfactory. They are listed in groups of increasing hazard. This information is derived from the University of Illinois study.

Nonhazardous cleaning solutions (safest; try these first)

- Ultrasonic baths (these work well for many labs);
- Alconox or similar detergents;
- Pierce RBS-35 or similar detergents; and
- Biodegradable surfactants.

Avoid Mercury and Its Compounds. Like chromium, mercury is a toxic metal that cannot be neutralized (as corrosives can) or destroyed (as organics can). As a result, mercury is very difficult to safely dispose of.

Mercury and its compounds are used widely in laboratories. Mercury waste from broken thermometers and manometers is far too common at the University of Maryland. Although free-flowing metallic mercury can be recycled commercially for reuse, mercury contaminated thermometers and spill cleanup supplies are expensive wastes.

Anyone who has broken a mercury thermometer or spilled free-flowing mercury knows how difficult and time consuming it can be to clean up the residue. In the extreme case, residual mercury from a spill or careless handling can pose a chronic health risk to laboratory personnel because the mercury volatilizes and creates contaminated indoor air.

To prevent these problems, the Department of Environmental Safety Sustainability and Risk strongly recommends that you use alternatives to mercury thermometers. These include alcohol (red liquid) thermometers, thermocouples and other electronic temperature devices.

Thermocouples are preferred for monitoring the temperature of a water bath, where glass thermometers are prone to breakage. If alcohol thermometers and thermocouples are unsatisfactory, we recommend using Teflon® coated thermometers that will contain the mercury in the event that the capillary is broken.

Due to their toxicity, mercury compounds and solutions containing mercury must be carefully stored and used. Laboratories are encouraged to reduce the amount of mercury they use and mercury-containing wastes they generate. Several alternatives exist:

- If a mercury compound is specified for a procedure, first determine if a less toxic substitute can be used (for example, in most cases copper sulfate can be substituted as the catalyst in Kjeldahl analyses with no loss in total organic nitrogen recovery);
- Reduce the scale of the process to reduce the amount of mercury used and disposed of;
- Minimize the volume of waste generated by including precipitation or other treatment methods as the last step; and
- Only buy as much mercury and mercury compounds as you will use in the immediate future.

Distill Waste Organic Solvents –

In-laboratory distillation is a useful way to recycle waste organic solvents. Some laboratories recover xylene for reuse in tissue preparation; many other histology laboratories have successfully recycled their solvents. Recovered acetone and ethanol can be used for rinsing glassware, where technical grade quality solvents are satisfactory. Call the ESSR is you would like to explore solvent distillation.

Reduce Environmental Risks –

After you've tried the above pollution prevention and waste minimization methods, there are many other things you can do to reduce environmental risks. Wastes that are

neutralized, treated and/or managed at the source are not subject to accidents and releases that can occur during transportation and handling. The Department of Environmental Safety Sustainability and Risk encourages In- Lab Chemical Management, such as neutralization of acids and chemical treatment of toxic chemicals as the final step of an experiment.

The majority of non-solvent hazardous chemical waste disposed of by Environmental Safety Sustainability and Risk is incinerated. Incinerators reduce the environmental risks of hazardous waste by destroying more than 99.99% of its organic constituents. Air pollution control equipment is used to further reduce emissions.

Neutralize Waste Acids and Bases

The Department of Environmental Safety Sustainability and Risk strongly encourages laboratories to neutralize their uncontaminated waste acids and bases as a final step of an experiment. After neutralization, these wastes can be safely and inexpensively disposed of. Waste acids are very difficult to transport and handle. In-laboratory neutralization can be done safely and is very efficient. However, if such neutralization is performed separately from an experiment, it is considered hazardous waste treatment, which is subject to stringent regulatory requirements.

Chemically Treat Laboratory Wastes

The Department of Environmental Safety Sustainability and Risk encourages you to chemically treat certain chemical wastes in your laboratory by making treatment the last step of your experiment. In- lab chemical treatment reduces transport and handling risks, and reduces the cost of collecting and storing chemical waste. If you routinely generate wastes that can be treated, include waste treatment as the final step in your procedures. However, if such chemical treatment is performed separately from an experiment, it is considered hazardous waste treatment, which is subject to stringent regulatory requirements.

The Department of Environmental Safety Sustainability and Risk can suggest methods for deactivation, oxidation using bleach, precipitation and reduction to yield a less toxic waste. Some of the chemical treatment procedures available for use include:

- Acrylamide solutions (polymerization)
- Chemical carcinogens and mutagens

- Cyanide salts (oxidation with bleach)
- Ethidium bromide solutions (oxidation with bleach)
- Neutralize Acid 6: Chromic acid cleaning solutions (reduction and neutralization of Cr(VI)) and COD waste
- Osmium tetroxide (conversion to less volatile form)

MANAGE WASTE EFFICIENTLY–

In most cases, waste can be minimized, but not eliminated. As mentioned at the beginning of this Guide, waste is a natural product of research, teaching, testing, and many other operations. It is prudent to manage all wastes as efficiently as possible. Resources saved from efficient waste management can be used to improve the University's teaching, research and public service programs. Resources saved can be reallocated to other environmental protection projects.

The management of chemical waste is most efficient when personnel keep waste types separate, prudently use the sanitary sewer and normal trash, and help us collect waste efficiently. For example, the Department of Environmental Safety Sustainability and Risk collects and handles waste organic solvents in carboys because it is safer and more efficient than collecting such waste in many smaller bottles.

Safely Use the Sanitary Sewer and Normal Trash

There are many laboratory wastes that can safely be disposed of in the sanitary sewer or in the normal trash. Proper use of these methods prevents unnecessary handling of these wastes. Contact the Department of Environmental Safety Sustainabilty and Risk for specific procedures for using the sanitary sewer and the normal trash.

Minimize Chemically Contaminated Labware

One growing wastestream is chemically contaminated labware. There are several ways to reduce the volume of contaminated labware. First, discard only wastes known to be chemically contaminated as hazardous wastes. If your gloves and benchtop covers were not contaminated, dispose of them as normal trash. For contaminated labware, try

to decontaminate it. Contact the Department of Environmental Safety Sustainability and Risk for guidance.

A SUSTAINABILITY ETHIC

Individuals who value the environment bring a special zeal to pollution prevention. On campus, an environmental ethic means taking responsibility for the byproducts of your operations and the waste that is generated.