# Pollution Prevention Initiatives

## Introduction

Penn State University has had a long-term commitment to protecting and improving the natural environment. The University has implemented numerous measures to protect the environment since the 1980’s. Initiatives implemented under the direction of the Environmental Health and Safety office have focused on reduction of hazardous waste and hazardous materials use, and petroleum products as well as sound fiscal management. In these applications, we have seen significant efforts in source reduction, redistribution, recycling, and substitution.

Education is an important component of Penn State's pollution prevention initiatives, as changes in behavior and attitude can be one of the more permanent methods to prevent pollution. Through a number of educational programs, EHS has specifically directed its efforts to pollution prevention measures and has partnered with a wide range of University constituencies to implement such programs. In addition, EHS audits areas where hazardous materials are used and stored to evaluate implementation of use, storage and housekeeping of these areas, and to ensure that these materials are not at risk of causing pollution due to poor practices.

This document presents two categories of pollution prevention initiatives: The first are those directed toward chemicals and regulated materials, both in laboratory and non-laboratory settings, and the second are those that are facility-related practices.

## Chemicals and Regulated Materials

*Laboratories and Research Settings*

Penn State is a large research university and the generation of chemical wastes in the laboratory setting is expected. There are numerous opportunities to utilize good environmental practices in the laboratory which prevent pollution while also reducing or eliminating hazards. These practices provide our students, faculty, and employees with techniques that can be incorporated beyond our institution.

The University’s Hazardous Waste Disposal Policy ([SY20](http://guru.psu.edu/policies/SY20.html)) addresses the regulatory implications of this large program. Hazardous waste generated at Penn State University is regulated by the Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (PaDEP) under the Resource Conservation and Recovery Act (RCRA). This is a complex regulation to protect human health and the environment from the point of waste generation, through transportation, storage, and disposal. This regulation is also directed at natural resource conservation by reducing the quantities of hazardous waste generated.

Researchers at Penn State have been using radioactive materials in teaching and research at least since 1955, when the Breazeale Nuclear Reactor began operation. For example, these materials are used to mark specific cells or DNA strands for biological research, determine trace constituents in environmental samples, and determine biodegradation of chemical hazards as well as in many other ways. Regulatory controls and pollution prevention practices have been in place for many years and radiological waste disposal is handled in accordance with our Nuclear Regulatory Commission (NRC) and PaDEP licenses.

Due to the scope of our research activities, we generate infectious waste at numerous locations. These wastes are all handled in accordance with the University’s Infectious Waste Disposal Safety Policy [SY29](http://guru.psu.edu/policies/SY29.html).

*Non-Laboratory Chemical Use Areas*

To support the academic function of the University, Finance and Business is a service organization that is responsible for the planning, management, and stewardship of the University’s resources. In this role, personnel work with hazardous materials and generate wastes that also need to be properly managed. Many of these materials, such as asbestos, are generated during building renovations. However maintenance chemicals are also a potential source of pollution if not handled properly. The University’s Hazardous Waste Disposal Policy ([SY20](http://guru.psu.edu/policies/SY20.html)), also applies to wastes generated from these activities.

### Hazardous Waste Management

Proper hazardous waste management is an integral part of protecting land, air, and water systems. Sound environmental management of hazardous materials includes proper handling and storage practices that reduce hazards to individuals and minimize waste generation.

Penn State enforces existing environmental regulations and strives to identify management strategies that emphasize sound science and engineering. EHS works in partnership with laboratory staff to provide assistance and regulatory interpretation, while at the same time reducing pollution. [SY20](http://guru.psu.edu/policies/SY20.html) is the University’s Safety Policy on hazardous waste management.

Through implementation of this policy, numerous positive environmental implications are clearly evident. As emphasized by training, generators of hazardous waste are required to:

* Ensure accountability of these materials through inventory control
* Ensure proper, timely disposal
* Properly segregate chemicals to minimize incompatibility
* Use secondary containment
* Use standardized labeling
* Conduct regular audits
* Incorporate waste practices into laboratory procedures

### Infectious Waste Disposal

Infectious wastes can create pollution through improper handling and disposal. Without specific practices aimed at controlling the disposition of these materials, the public can inadvertently come into contact with these wastes. In addition, occupational exposure of these materials can create a safety hazard.

In 1987, Penn State established an Infectious Waste Management Program to comply with PaDEP regulations. This program provides for strict management and handling of infectious materials, including animal wastes and sharps. EHS provides oversight of this program.

Infectious waste disposal is covered by University Safety Policy [SY29](http://guru.psu.edu/policies/SY29.html). These materials are collected in specially designated containers, sterilized, packaged, and transported by EHS, eliminating employee exposure and ensuring proper final disposition.

### Chemical Redistribution

Excess chemicals are often an end result of many scientific experiments. Disposal of these surplus chemicals results in increased volumes for disposal and increased costs. Chemical redistribution can provide a means of using some of these excess materials and reduces the quantity of materials that would otherwise need to be disposed of.

EHS has established a program that allows all chemical users at the University Park campus to obtain, free of charge, chemicals that are unused, but no longer wanted by the original user. This program is limited to uncontaminated chemicals in their original container, with a good shelf life.

EHS acts as the facilitator for this program and maintains an active listing of chemicals available for redistribution. These chemicals are used for Penn State research purposes, by or under the direction of qualified personnel familiar with the properties and hazards.

### Microscale Chemistry in Undergraduate Teaching Laboratories

Microscale laboratory experiments utilize very small amounts of chemicals, reducing the quantities of hazardous materials used and hazardous waste generated. This technique was developed in the 1980's at Bowdoin College and Colorado State University.

In 1992, Penn State’s Department of Chemistry adopted the microscale approach to organic chemistry in undergraduate teaching laboratories. Thousands of students each year utilize microscale techniques in general chemistry and organic chemistry classes. Upon graduation, these students carry forward their microscale knowledge to other endeavors.

The benefits of microscale use in the laboratory are:

* Reduced volumes of waste generated; the quantities of chemicals used are typically less than 1/10th the amount used in traditional experiments and create similar reductions in the quantity of hazardous waste generated
* Reduced volumes and costs of chemical reagents purchased, used, and stored
* Reduced hazards to laboratory personnel
* Reduced heating/cooling and set up time for experiments

### Substitution of Less Hazardous Chemicals

The use of hazardous chemicals is avoided wherever possible by using less hazardous substances. This is done in both laboratories and facilities. Using these less hazardous materials both reduces the risks to the users and the environment. For example propylene glycol, which is a more environmentally friendly coolant, is used where possible to replace ethylene glycol.

### Disposal Hierarchy for Hazardous Waste

Hazardous wastes that are generated can be dealt with in a variety of manners, each with different long-term environmental implications. Recycling and reuse of materials is a first choice, as this involves no disposal. Alternatively, landfilling is a last choice for disposition of hazardous wastes.

Penn State’s Hazardous Waste Management Program requires our hazardous waste vendors to utilize a hierarchy for the disposal of hazardous materials that considers these implications. This hierarchy is:

* Recycling/Reuse
* Reclamation
* Treatment/Stabilization
* Incineration
* Landfilling

Use of this hierarchy results in the choice of the most environmentally benign disposal option, thus protecting the University’s long-term environmental and financial interests.

### Radiological Decay-in-Storage

Radioactive material is a unique hazard because it naturally becomes less hazardous with time. For materials with a short half-life, the waste can be stored until it is no longer radioactive. It can then be disposed of as normal laboratory waste. This is allowed by federal regulation.

Penn State has had a robust decay-in-storage program since 1986. Decay-in-storage is uses far fewer resources and is less expensive than shipping waste across the country for treatment. Radioactive waste is collected from laboratories by EHS, is stored in our facility until it is no longer radioactive, and then disposed by the most appropriate method. Although the decay-in-storage program is more labor intensive than simply shipping it for disposal, the pollution avoided and cost savings by not shipping it while it is radioactive make this a very effective program.

### Mixed Radioactive and Hazardous Waste Minimization and Segregation

Waste that is both radioactive and hazardous must be handled under regulations applicable to both the hazardous constituent and the radioactive component. Dual regulation makes disposal of this material extremely difficult and expensive; there are few disposal locations that are designed to deal with it. Segregation of mixed radioactive and hazardous waste from waste that is either hazardous or radioactive, but not both, significantly limits the disposal options.

Laboratory personnel at Penn State who use radioisotopes still occasionally need to use hazardous chemicals in this research and have been required to place mixed radioactive and hazardous chemical waste into containers separate from their normal waste stream. This reduces the volume of the mixed radioactive/hazardous waste.

### Waste Segregation by Radionuclide

The segregation of radionuclide-specific waste allows flexibility in the proper disposal of these materials. Those wastes with short half-lives can be disposed of in less resource-intensive manners and are less costly to dispose of than those with long half-lives.

Historically at Penn State, all radioactive material was treated as one waste stream. In the mid-1980’s, EHS implemented a program that required laboratory personnel to segregate their waste by different radionuclides, allowing some short-lived radionuclides to be stored until they are no longer radioactive (see Radiological Decay-in-Storage above). This allows for a reduction in the quantity of material that needs to be disposed off-site, with ancillary environmental benefits and cost savings.

### Approval for Use of Radionuclides

Enforcement of rules and procedures associated with the use of all radionuclides allows for the implementation of strict usage and storage practices related to these materials at the "front" end of the use cycle, thus preventing them from impacting the environment.

All users of radioactive material must be trained by EHS staff before they are allowed to work with the material. This ensures that students and staff are aware of the hazards, ways to minimize hazards and ways to minimize waste generation at the earliest possible stage.

All procedures involving radionuclides are reviewed by EHS and the University Isotope Committee to ensure that the material will be used safely and properly, and that the waste quantities and types are considered. Laboratory supervisors are asked to revise their procedures if the expected waste is particularly hazardous or high in volume. As part of the review, the intrinsic hazard of the particular radionuclide is analyzed to determine if other less hazardous methods could be used.

### Mercury Reduction

Mercury is a naturally-occurring element with unique chemical and physical properties that are a dangerous and often unrecognized hazard commonly found at work, home, and schools. The ability of mercury to bio-accumulate in the environment makes it particularly hazardous to humans and animals.

Beginning in 1993, Penn State, under the direction of EHS, implemented a number of pro-active approaches to reduce mercury-containing equipment in our facilities. This included the removal of thousands of pounds of elemental mercury, mercury-containing equipment, and mercury compounds from laboratories and other areas. In a 2001 expansion of this program, EHS began a Mercury Thermometer Exchange Program at Penn State. This programmed approach replaced over 10,000 mercury thermometers with highly-accurate alternatives that are safe, non-toxic, and environmentally friendly. This program was further expanded to include mercury barometers, manometers, switches, pressure gauges, and other mercury-containing devices.

### Swimming Pool Treatment Chemicals

The operation of a swimming pool requires chemical disinfection using large quantities of hazardous materials, typically gaseous chlorine. Releases of even small quantities of gaseous chlorine can endanger human health and the environment.

The University has eliminated the use of gaseous chlorine at all pool facilities, ensuring the protection of human health. In place of gaseous chlorine, Penn State pools use liquid sodium hypochlorite, solid calcium hypochlorite, or Miox, which is a technology that combines salt, water and power to generate cost-effective disinfection. These materials are all safer, easier to handle, and less chemically reactive than gaseous chlorine.

### PCB-Containing Materials

Polychlorinated Biphenyl (PCB’s) were commonly used as fluids in electrical light ballasts/capacitors. Although PCB-containing equipment is no longer manufactured, it can still be found in old lighting fixtures. In addition, PCBs were used to keep window caulking materials flexible. PCBs pose a long-term hazard due to their persistence in the environment.

University Safety Policy [SY26](http://guru.psu.edu/policies/SY26.html) governs the disposal of ballasts and capacitors in accordance with federal regulations, to ensure the proper disposition of these materials. All ballasts/capacitors that are removed and are not labeled “No PCBs” are collected by maintenance staff and treated as containing PCBs. EHS coordinates the disposal of these fixtures through our hazardous waste management program. In addition, all caulks that are to be removed during renovations are tested to determine if they contain PCBs. If PCBs are found, the material is specially disposed in accordance with the regulations.

In addition, EHS also disposes of all non-PCB oil-filled ballasts and capacitors to ensure that these materials do not cause pollution.

## Facility-related pollution prevention initiatives

Penn State follows a number of practices which prevent pollution in and from our facilities. These include assessing property for environmental hazards, reducing our use of pesticides, storing hazardous or other polluting materials safely, pre-planning for emergencies which may involve materials which would cause pollution if released, and using energy conservation measures in laboratories.

### Underground/Aboveground Storage Tanks

The use of underground and aboveground storage tanks can pose a serious threat to the environment and human health. In recognition of that potential, Penn State has developed a Storage Tank Management Program to reduce the environmental risk by ensuring that tanks throughout the system that are used to store petroleum products are safe and environmentally sound. Environmental Health and Safety administers this program.

Penn State has implemented a number of measures to reduce the environmental risk of tanks used at our facilities by the programmed removal of “at risk” tanks. This program includes:

* Expansion of gas service to remote locations, thereby eliminating need for heating oil storage tanks,
* Replacement of underground tanks with double-walled aboveground tanks when replacement is needed and feasible,
* Equipping storage tanks with monitors, that allow a quick and easy means of determining if a tank is leaking, and
* Reduction of existing tank volume with smaller replacements.

In addition, when tank releases have been discovered, this program ensures that they are fully remediated to ensure protection of the environment.

### Emergency Planning

The University has a number of different environmental emergency plans that address facilities with fuels/oils and significant quantities of hazardous materials. These plans provide site-specific measures that address pollution prevention, notification, and emergency response that are all aimed at minimizing the environmental impacts of spills and releases. Facets of these plans include location-specific monitoring and inspection, regular maintenance, and documentation. These activities are directed at prevention and early detection of releases.

On-site Facility Managers have been integral in the development and implementation of their specific plan, with EHS oversight. Through site-specific training, facility personnel are able to provide prompt and efficient measures to mitigate spills and releases. Absorbent materials are present at each facility for this use.

In addition, advance knowledge of the quantities and types of hazardous materials present in our facilities can ensure appropriate emergency response in the event of a fire or explosion. Knowing the location and types of chemicals present in advance provides firefighters with the information necessary to determine the appropriate fire response measures. By responding in the most immediate and appropriate fashion, environmental impacts of such emergencies can be minimized.

### Property Acquisitions/Use

Penn State University, as a leading research and teaching institution, acquires property by purchase or donation. In order to ensure that the University does not purchase properties with environmental liabilities, a strategy has been established that includes an environmental assessment of properties prior to acquisition. In some cases, this means that properties are not purchased or accepted as a gift.

For properties that are acquired where environmental liabilities have been identified through this process, those with health and safety hazards or with the potential to cause pollution are addressed immediately upon acquisition. This may include the removal of tanks or other hazardous materials, or environmental clean-up of past spills and releases.

Additionally, when we lease our land for others to build on, we have lease requirements that ensure compliance with applicable regulations, and give Penn State the right to inspect the facilities to ascertain that they are in compliance with environmental regulations.

### Integrated Pest Management (IPM)

Integrated Pest Management is a decision-making process that seeks to address pest problems by prevention, emphasizing practices such as sanitation, exclusion, and non-chemical devices/practices. Thus, IPM quite often leads to an overall decrease in the amount and/or specific types of pesticides used while more effectively suppressing pests. Use of IPM over traditional practices to eradicate pests leads to improved health and safety for both people and the environment.

There are many reasons to use IPM. It reduces hazards due to pests and pesticides, is less polluting, and is cost-effective. Many of these benefits come about through pesticide use reduction, and/or more considered choices of pesticides when needed. Although many pesticides today are much less harmful than those used many years ago, they still are poisons that are meant to kill weeds, insects, fungi, and rodents. Pesticides can present risks not only to the applicators, but also to people who may come in contact with them on food, inside buildings, on lawns, and on athletic fields. People may be hypersensitive to pesticides, and applications can cause them immediate illness. Reducing hazardous pesticide use on our campuses can help lessen all types of exposure to these compounds.

### Asbestos-Containing Materials

Asbestos was widely used in building materials from the 1940's to the early 1980's and since many University buildings were constructed during that time, asbestos management is a major program.

The University's current policy is that of in-place management. That is, asbestos is only handled or removed when necessary, prior to renovations, demolitions, when the material could be disturbed, or when the material is damaged. If asbestos needs to be removed from a building, EHS ensures that it is properly handled to prevent it from becoming an airborne hazard to people and that it is properly disposed of to ensure that it does not get into the environment.

EHS provides a listing of University buildings that are known not to have asbestos on our website.

### Used Oil Recycling

During vehicle and equipment maintenance and repair, significant quantities of used oil are generated. Recycling of this oil, which enables it to be reused, eliminates this material from being handled as a waste.

Penn State has established a program for the recycling of used oil. EHS coordinates this program as a component of the hazardous waste management program. Facilities that generate used oil segregate these materials from other potentially hazardous materials. This involves specially-designated "waste oil" collection containers, which range in size from several gallons to aboveground storage tanks. EHS collects the smaller containers and consolidates non-motor oils and motor oils separately for recycling by our waste vendors. Motor oil from larger containers is collected from facilities directly by our vendors. The program provides thousands of gallons of oil for recycling each year.

### Universal Waste Recycling

Universal waste is a special category of hazardous waste that includes mercury-containing devices and batteries.

Fluorescent light tubes contain mercury. Improper disposal can result in environmental hazards. Penn State, through EHS has established a centralized and coordinated program for the proper management of light tubes that are removed from University facilities in accordance with federal regulation 40 CFR 273. The mercury from these tubes is reclaimed by a contracted vendor. University Safety Policy [SY31](http://guru.psu.edu/policies/SY31.html) governs the use and requires that the replacement of these tubes be low level or non-mercury containing.

One of the most common work-related activities that provide opportunities for pollution prevention is the use of a variety of batteries. There are two main categories of batteries; rechargeable and non-rechargeable and six different types found commonly at Penn State.

Nickel cadmium (NiCad), nickel metal hydride (NiMH), lead acid, and lithium ion batteries are all rechargeable and are recycled by EHS. Non-rechargeable alkaline batteries are not hazardous, however, they are recycled by EHS. Non-rechargeable dry cell batteries (typically including mercuric-oxide, silver-oxide, and zinc-air) are considered hazardous and are disposed of by EHS.

### Biodegradable Elevator Hydraulic Oil

There are over 100 in-ground hydraulic elevators present in the University system. Some of these elevators are older and if the single-walled cylinder leaks, have the potential to introduce petroleum-based hydraulic oils directly into ground water.

In an effort to eliminate this hazard, EHS established a working group which included chemical engineers with expertise in hydraulic fluids, elevator experts, and environmental engineers to test several biodegradable hydraulic fluids. The fluids were evaluated for both their ability to perform well in the elevators and for their environmental friendliness. We worked with several companies and the PaDEP to determine that these fluids meet these requirements. The petroleum hydraulic fluid was replaced with the biodegradable hydraulic fluid in all in-ground elevators at Penn State.

### Drain Disposal

The inappropriate disposal of chemicals into the sanitary sewer system may create a variety of hazards including the following:

* Fire and/or explosion hazards within the drain system
* Inadvertent mixing, within the drain system, of incompatible chemicals from different laboratories
* Corrosion of drainpipes
* Chemical exposure hazards to plumbers and wastewater treatment plant workers
* Escape of volatile, toxic and/or malodorous substances
* Biocidal action on microorganisms that are necessary for the normal and effective operation of the waste water treatment plant
* Addition of unacceptable amounts of toxic substances (e.g., certain heavy metals) to sewage sludge and effluent.

It is a violation of both safety and environmental regulations to pour chemicals down the drain unless they are treated or neutralized and local regulation allows them in the sanitary sewer system. PSU safety policy [SY40](http://guru.psu.edu/policies/SY40.html), Disposal of Pollutants in University Sanitary Sewer Systems, prohibits the indiscriminate drain-disposal of chemicals/materials.

### Process Safety Management

Process Safety Management (PSM) is a risk-based management system approach to manage specific high risk processes within the University. Proper operation of the equipment and training of individuals working on the PSM covered processes are an integral aspect of preventing unwanted releases of highly hazardous chemicals and protecting, land, air, and water systems.

The University has developed robust requirements associated with PSM covered processes to ensure safe operation of the equipment. These program requirements include Mechanical Integrity, Management of Change, Operating Procedures and Emergency Preparedness. The 17 program elements are designed to minimize the release of even small quantities of highly hazards chemicals that could potentially impact employees, students and the general public.

Beyond the environmental and human health benefits, there are numerous advantages from implementing a PSM program including reducing operational and equipment life-cycle costs and improving operational efficiency. In addition, the detailed equipment monitoring, testing and preventive maintenance activities increase overall equipment availability or run-time.

### Chemical Fume Hoods

Chemical fume hoods are one of the largest energy users on our campuses; however they provide an important safety function that requires their use. EHS has included information on energy consumption of fume hoods in the required training of all employees who work with chemicals and checks during inspections to ensure that hoods are labeled with a sticker that instructs workers to keep the fume hood sash as low as possible. This both provides maximum protection to the user and reduces energy use.