Laboratory Pollution Prevention (P2) Training

This training is designed for lab managers/staff or environmental staff who inspect or audit lab facilities. It addresses all types of labs such as: commercial testing labs, academic teaching facilities (middle, high schools and universities/colleges), QA/QC labs for manufacturing facilities, TSDFs with labs, and hospital/medical labs. (Please note some slides have been grouped for various lab types). A list of these sources and references is included at the end of this training.

Laboratory P2 Basics

Material Substitution, Inventory Control, Process Efficiency, Re-use/Recycling, Innovation

Lab P2 has common elements regardless of lab type. All labs can benefit from the establishment of waste and hazard minimization procedures and frequent assessment and measurement to achieve continuous improvement of environmental health and safety performance. Ideally, hazardous materials should be substituted with a less hazardous material before they are even ordered. If an organization is large, such as a university, excess material may be found within the organizations inventory system. Materials should be ordered in the smallest quantity that can be used before expiration/instability. They should be used in the smallest quantity possible. Ways to recover, re-use and recycle materials as an alternative to disposal should be evaluated. Innovative approaches that will eliminate or minimize the use of hazardous substances in the laboratory should be considered. **P2 should be a cycle of continuous improvement of waste and hazard minimization.**

Use of alternative chemicals

Review laboratory chemical purchases in advance of placing orders and explore alternative substitutes that will not generate hazardous wastes.

This may not be possible in some cases where specific chemicals must be used and specific experiments/tests must be conducted.

Evaluating the use of alternative materials should be an on-going activity at all labs. Almost all analytical methods have opportunities to use alternative materials under certain conditions. Analytical methods are constantly under review and change over time. U.S. EPA is currently reviewing numerous analytical methods for a variety of media and regulatory programs to identify and implement the use of less hazardous preservatives, catalysts, reagents etc. There are opportunities to submit alternative analytical methods or modifications to existing methods for approval and incorporation into regulations.

Examples of Substituting Less Hazardous Chemicals

Propylene glycol	Instead of	Ethylene glycol
Ethyl alcohol	Instead of	Methyl alcohol
Alcohol Thermometers	Instead of	Mercury Themometers
Alconox, Pierce RBS35 and Nochromix	Instead of	Chromic acid cleaning solutions
Detergent and hot water	Instead of	Organic solvent cleaning solutions

Due to the variety of lab types; radiological, organic, health care, academic, QA/QC, environmental etc. including a list of substitutes in this training was not possible A listing of the substitution guides that were found will be included in the reference list. When evaluating alternative chemicals an important consideration should be to ask why any material is being used. In some situations, samples or experiments may be done within a time period or under physical conditions (temperature, pressure, etc.) that do not require a preservative, or catalyst, or solvent etc. In the example of a water sample analysis; choosing a weaker acid as a preservative is good, eliminating the need for a preservative by running a sample within a certain time, or cooling to a specified temperature, would be better.

What is the Cost of Unused Chemicals?

- According to the American Chemical Society (ACS) **unused chemicals make-up 40% or more of the hazardous waste stream generated.**

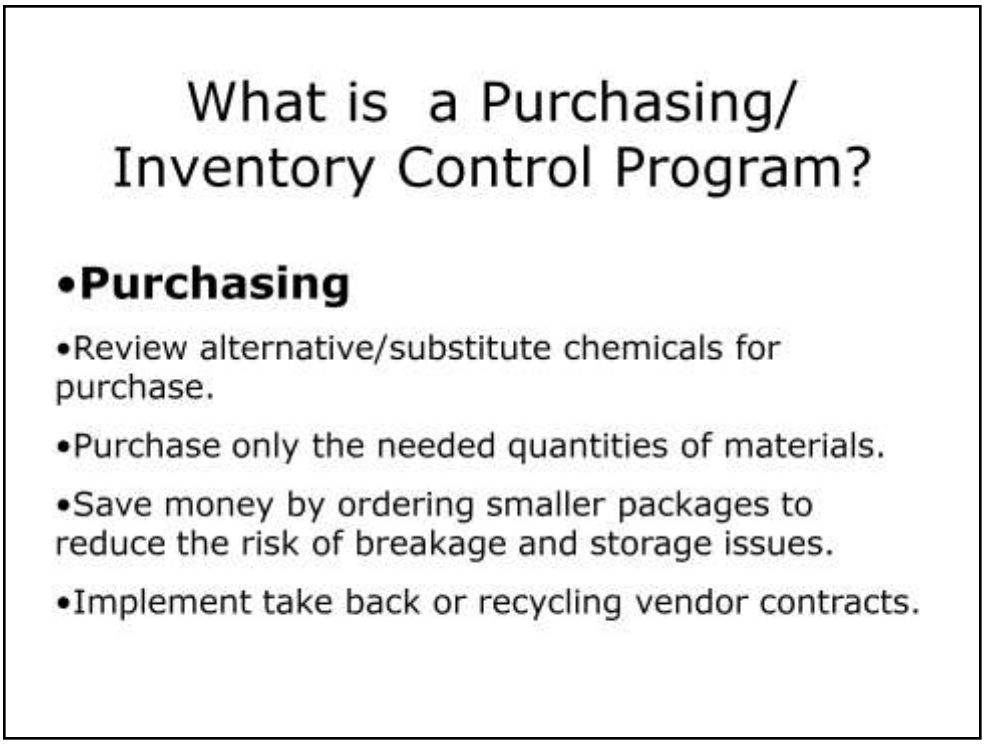
- Costs incurred as a result of this are: analytical expenses of unknowns, storage, packaging, transport and disposal, and the increased risk of accidents by long term storage of a chemical.

Economy of Size Myth-Cost Analysis-Xylene

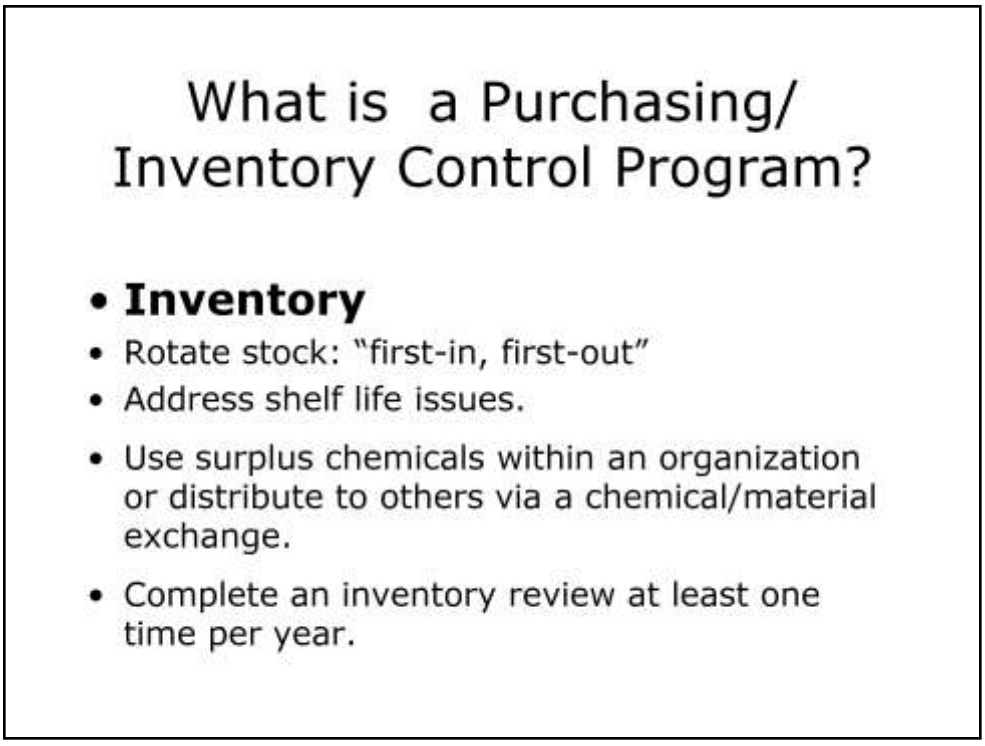
Package Size	1 Liter	4 Liter
Purchase price	$42.49	$93.72
Unit Purchase price per mL When 2000 mL are used	$.04	$.02
Unit purchase price per mL used	$.04	$.05
Disposal costs	$0	$29.80
Purchase + disposal unit cost per mL used	$.04	$.06
Purchase + disposal costs	**$84.98**	**$123.52**

From: "Less is Better," American Chemical Society, see reference list

Many smaller containers are priced higher in the market place, so some buyers select the larger package, assuming they are saving money. However, this may result in partially filled containers of chemicals that have degraded, expired, or become unusable. Now the containers take up space and must be maintained, as well as added risk from fire, explosion and personnel exposure to the chemical. Smaller containers are emptied faster, so there is less chance of degradation. Frequent purchase ensures a supply that is fresh, less labor to subdivide the chemical into smaller containers, and reduction of the risk of spills and chemical exposure.

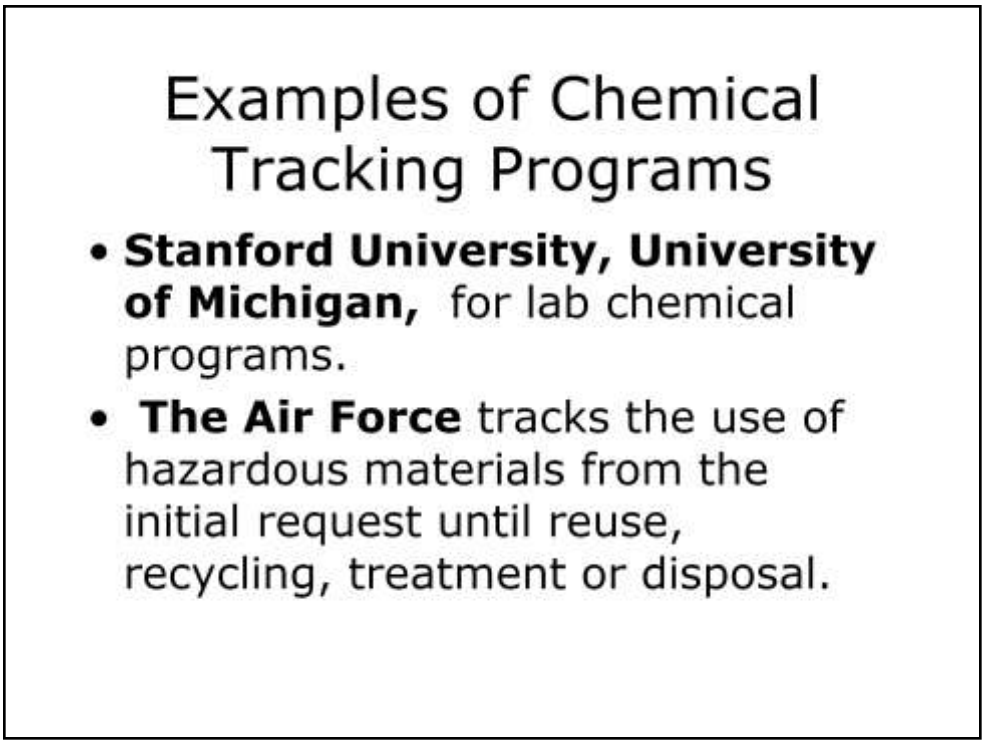


Purchasing/Inventory control is one area where all labs can continually improve waste and hazard minimization. The periodic review of chemicals purchased by an organization should be a routine program even if the laboratory is small or highly specialized. Organizations may also want to specify take-back or recycling arrangements with vendors in contracts. In this type of agreement, the vendor takes back unopened bottles of chemicals.



As a P2 program matures within an organization, quantities of chemicals needed may be reduced. Therefore shelf-life issues may occur that were not previously encountered. Surplus chemicals in one part of an organization may become available for use by other departments, or other organizations via material exchange programs.

Many successful models of chemical inventory and distribution systems exist within academia, military and commercial/industrial institutions. Common names for these systems include terms such as; Hazardous Material Pharmacy, Centralized Chemical Inventory Systems, Chemical Sharing Programs, or Surplus Chemical Distribution Systems. Various chemical inventory software packages are commercially available. Some businesses have implemented bar code identification of chemical inventories. Having an internal tracking system for a business may allow departments within an organization to search for available chemicals within these types of systems. This allows an organization to reduce costs for both the purchase of chemicals and the disposal of expired chemicals.



See reference list for specific information on these programs.

Case Study: Hazmart Fort Bliss, TX, U.S. Army

- Opened in February 1998 tracking and recovering hazardous materials containers.
- **First year savings of $230,000**.
- Estimate saving $200,000 per year in avoiding hazardous waste disposal costs, due to proper storage conditions, operating a re-use center and fewer purchases.
- http://aec.army.mil/usaec/support/p203.html

In the first year of operation (1998), the hazmart received some $26,000 worth of free material and reissued these items to other organizations, saving about $14,000 in procurement costs. This practice also avoided an estimated disposal cost of about $208,000. They estimated that disposal of a hazardous item costs eight times as much to as it does to buy it.

BGSU began an in-house orphan chemical recycling program in the fall of 1991. This project was implemented to identify and transfer unwanted chemicals between University departments to minimize hazardous waste generation. Approximately 700 lbs of solid materials and 50 gal of liquids were transferred between University departments after implementation. In the fall of 1992, BGSU began to develop a plan that would expand the existing orphan chemical program to include non-University academic institutions like high schools, Jr. high schools, technical colleges, and similar facilities. To date the program has assisted participants in Ohio, Michigan, Indiana, Wisconsin, Georgia, Massachusetts, and New Jersey (approx. 108 participants).

OMEx-Ohio Materials Exchange

- Purpose of OMEx is to disseminate information on surplus and/or waste materials available from or wanted by industrial and commercial entities.
- A materials exchange program provides a mechanism for recycling and reusing unwanted materials. The exchange service provider maintains and distributes listings of materials available and materials wanted from participants.
- http://www.epa.state.oh.us/ocapp/p2/omex/omexintro.html
- There is also a listing of other exchanges in Ohio at http://www.epa.state.oh.us/ocapp/p2/omex/omexother.html

OMEx is a cooperative effort of: Association of Ohio Recyclers, Ohio EPA, ODNR , Ohio Department of Development, and Waste Alternatives, Inc. who manages and operates OMEx.

Recovery, Reuse, Recycling :

ChemCycle

Investigate recovery reuse & recycling opportunities for the hazardous waste the laboratory generates.

Consider on-site recycling of hazardous waste, including solvents, in particular.

Many wastes may have value for recovery and reuse, reducing the need for purchasing virgin material and reducing the disposal or recycling costs. Solvents are a good example of this, which may be distilled and reused. For academic laboratories, spent chemicals used for experiments may have use in other experiments designed as reverse process, or neutralization/stabilization projects.

Solvent Distillation-Case Study

- A campus lab with 20 employees in Texas began distilling xylene, ethanol and formaldehyde and **reduced 3 tons of waste in one year,** saving $96,255 in purchasing costs and $7,280 in disposal costs. **A total savings of $103,535**.
- Many common lab solvents like acetone, MEK, methanol, methylene chloride, xylene and toluene may be recovered, distilled and reused.

Distillation Technology Resources

- For more information on this technology, see **Ohio EPA's OCAPP Fact Sheet "On-Site Solvent Recycling Equipment",** which includes a list of vendors at: http://www.epa.state.oh.us/opp/solvents/fact9.pdf

Waste Segregation:

Determine whether or not wastes should be mixed. Segregation will often reduce the volume of hazardous waste.

Do an annual review and evaluation of waste min issues including costs.

As with any waste materials, costs and hazards can be minimized by segregation of wastes. A waste segregation program should be reviewed periodically, especially if chemicals or procedures are changed.

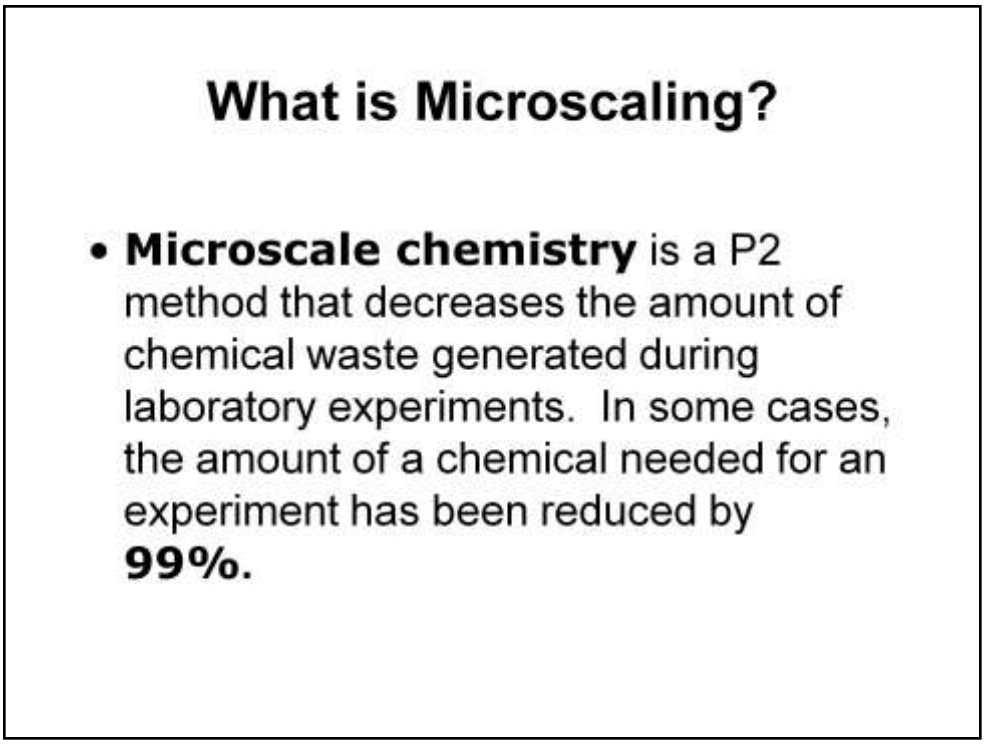
Waste Segregation Case Study

- A lab in Arizona **reduced hazardous waste generation by 87%** in one year by training employees to segregate waste.

Innovation

- Microscaling
- Computer Simulation or Video Demonstration
- Alternative methods vs. “Wet” Chemistry
- Green Chemistry

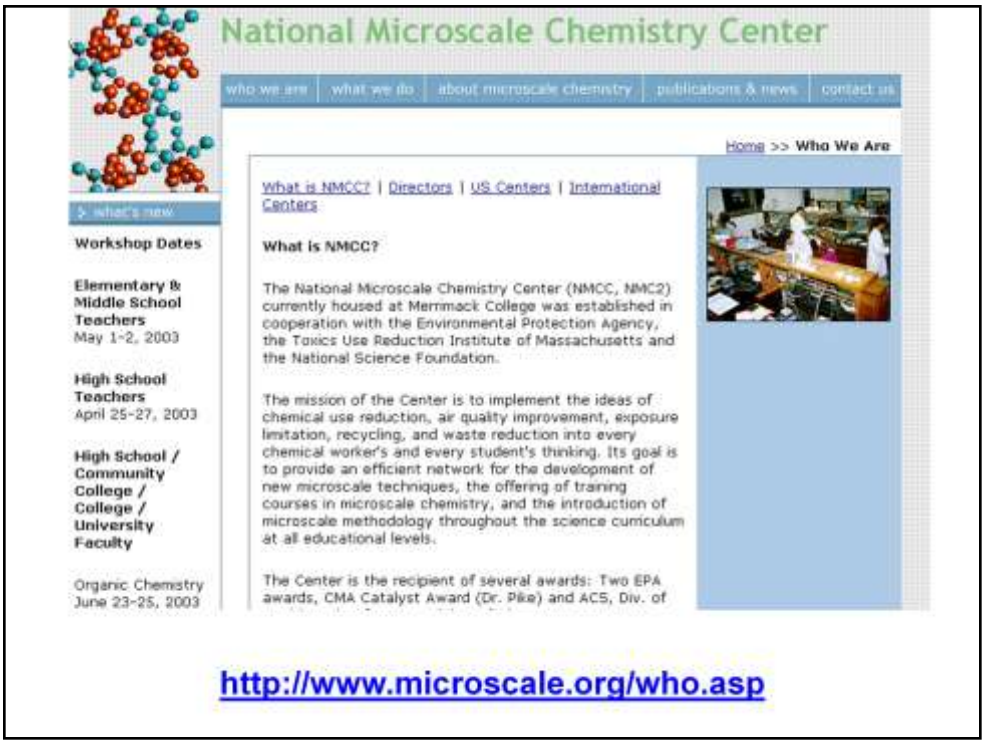
Innovation is important to any pollution prevention program. **THE FOLLOWING SECTIONS ON MICROCSCALING AND SIMULATION TECHNIQUES APPLY MOSTLY TO RESEARCH AND TEACHING SITUATIONS**.



By reducing the volume of chemicals needed to conduct tests and experiments wastes can be reduced. When this is paired with material substitution of less toxic chemicals, the impact is further enhanced.

Microscaling Benefits:

- Improve lab safety by reducing potential exposure to chemicals and reducing fire and explosion hazards.
- Improve air quality due to reduced volumes of solvents and other volatile substances used.
- Reduce costs for chemical purchase and disposal.
- Reduce chemical waste produced at the source.
- Reduce the time required to perform experiments due to shorter chemical reaction times.
- Decrease the amount of storage space necessary for chemicals.
- Encourage students/staff to think about waste minimization.



This web site is a good resource for learning more about Microscaling and it's possible application at your facility.

University Microscaling Case Study

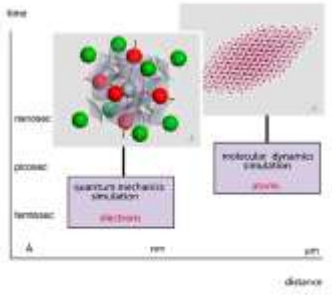
- Bemidji Sate University in MN **reduced their chemistry lab waste by almost 35%** by downsizing instructional lab experiments for its 3,350 students enrolled in chemistry classes.
- **Total waste was decreased from approximately 10,400 liters to 100 liters**. The volume of waste generated per student was reduced from 3.1 liters to .03 liters
- $**35,000** was saved annually.
- See web site for case study:http://mntap.umn.edu/intern/projects/BSU.htm

Commercial Lab Microscale Case Study

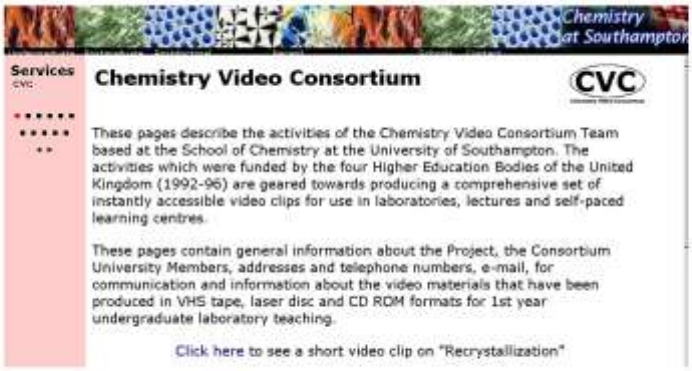
- STL, Inc. in Austin, TX, 62 employees, RCRA LQG Generator
- Modified extractors to **reduce amount of methylene chloride used by 35%,** still adhering to U.S. EPA guidelines for sample prep.
- Reduced Methylene Chloride use of 5.5 tons per year, **estimated annual savings of $15,000 in 2002, may become an SQG .**
- **See website for case study:** **http://www.zerowastenetwork.org/success/story.cfm?ID=495**

Alternative Methods

- Video demonstrations vs. “live” chemical reactions
- Computer simulation
- Direct sensing or analysis vs. wet chemistry



Alternative methods can be considered for a variety of scenarios where traditional “wet” chemistry, live demonstration/procedures have been used in the past. Computer software is available to simulate possible reaction scenarios and greatly speed analytical variations for multiple conditions. Direct sensing alternatives exist for replacing wet methods such as titrations with instrumentation.

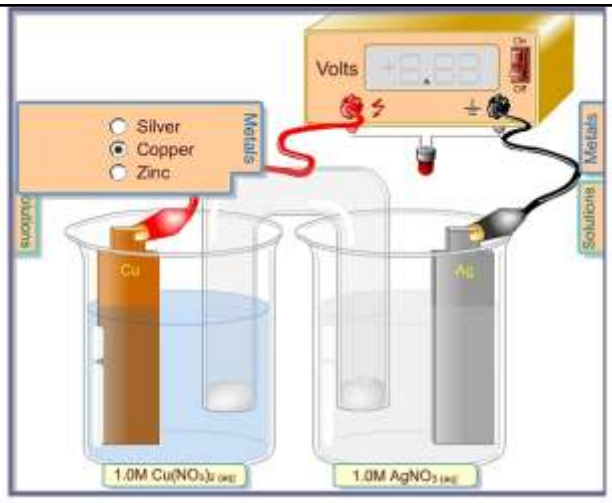


http://www.chem.soton.ac.uk/cvc/

http://www.chem.soton.ac.uk/services/multimedia/images/clip.avi

Chemistry videos are available of many basic types of demonstrations. Making demonstrations for the classroom or publication on the web have become very inexpensive to produce.

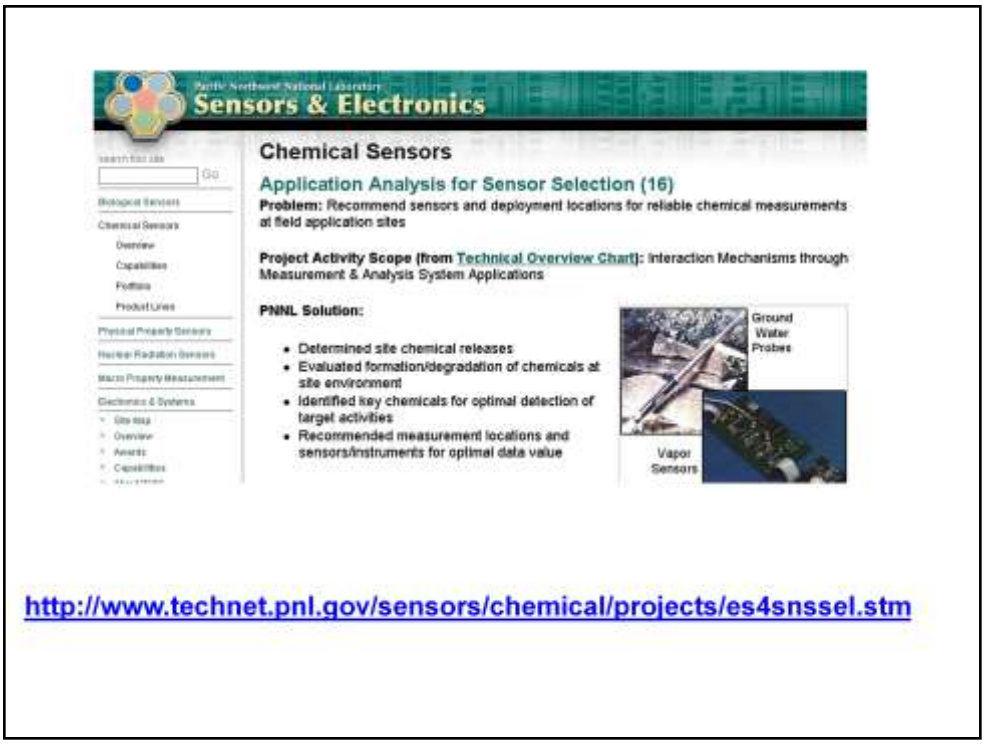
Computer Simulation



http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/electroChem/volticCell.html

http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/animationsindex.htm

This is an example of computer simulated experiments, which eliminate the need to use wet chemistries to illustrate reaction principles. These simulations are available on-line at the links listed above (Iowa State University)



A wide range of chemical analysis is being adapted to direct sensing instrumentation. These applications can be used both in the lab and also at remote locations. These applications may be useful for quality and process control applications in manufacturing and Research and Development (R&D) environments.

Substitution of hazardous chemicals with less hazardous chemicals is at the heart of green chemistry. This principle includes chemicals that come from renewable or recyclable sources and looks at the product or process design to optimize waste minimization.

Green Chemistry-Case Study

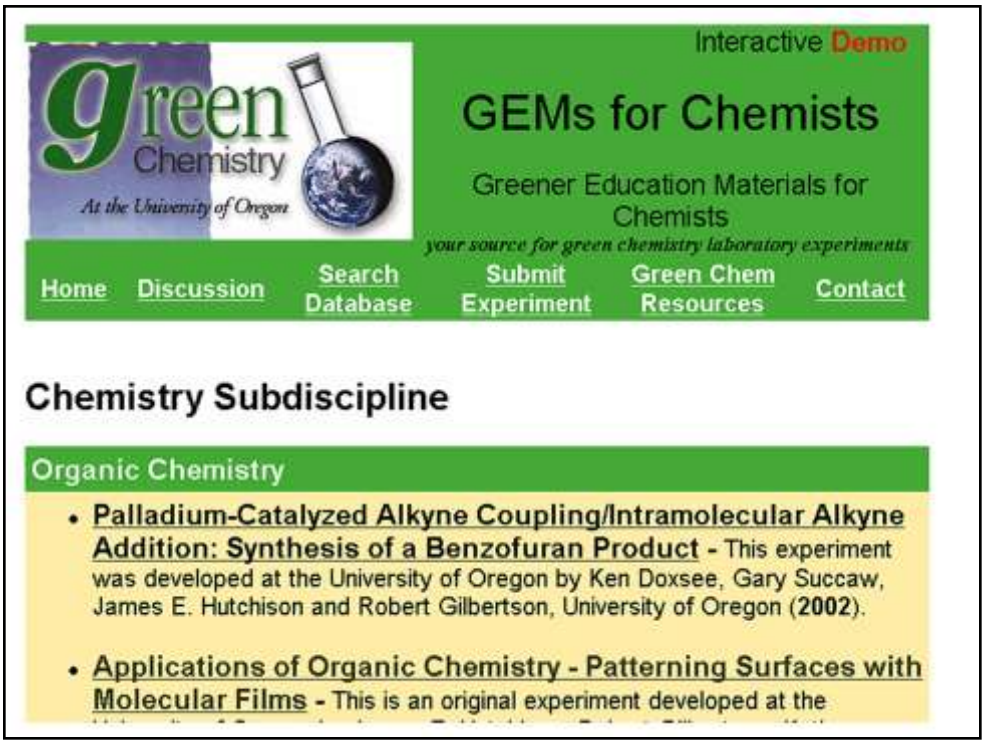
- **U.S. EPA awarded Bristol-Myers Squibb a Presidential Green Chemistry Challenge Award in 2004-** Developed a Green Synthesis for Taxol®
  - Changed process to use plant cell cultures to ferment the active drug substance instead of bark of Pacific yew tree.
  - Reduced workplace exposure to solvents.
  - **Process prevents more than 240 metric tons of biomass waste and 6.4 metric tons of hazardous waste from being generated annually.**
  - **Removed 10 specific solvents from the process.**
  - **http://www.epa.gov/greenchemistry/aspa04.html**

Yew bark can take 200 years to mature, when the tree is stripped of their bark it kills them. This bark was originally used to make a cancer fighting drug. In 1991, Bristol-Myers Squibb began to develop a semisynthetic route to produce paclitaxel and to eliminate the need for yew bark. This new process was developed in the lab and scaled to manufacturing in only three years.

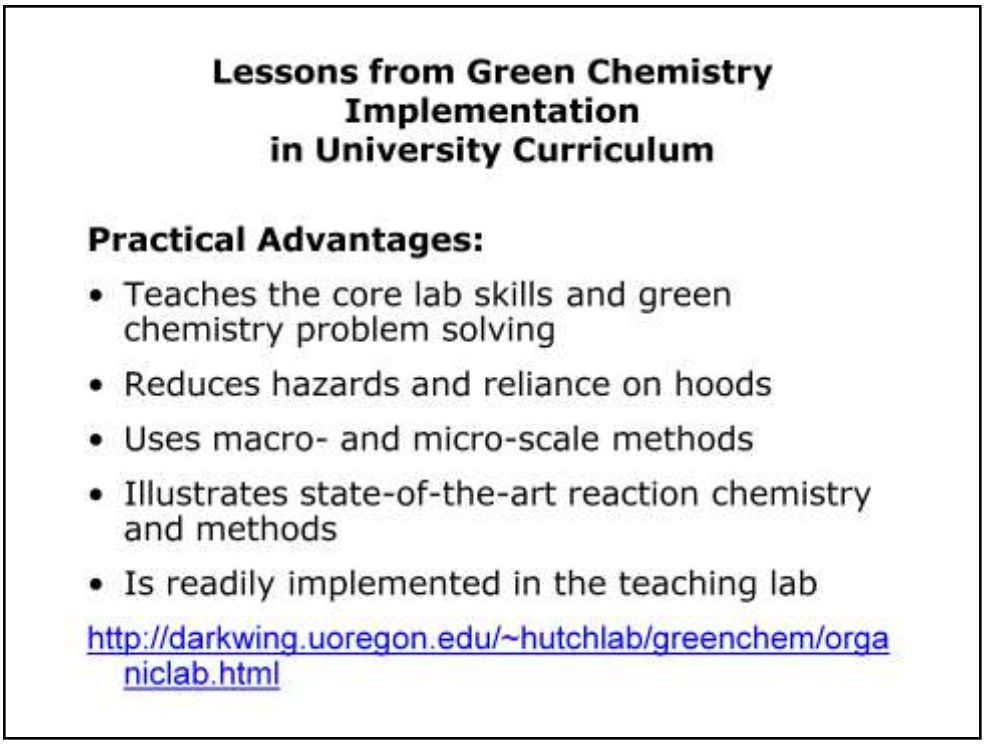
Green Chemistry-Case Study

- **U.S. EPA awarded BHC a Presidential Green Chemistry Challenge Award in 1997- Developed a new synthetic process to manufacture ibuprofen**
  - Material substitution- acetic acid for aluminum chloride
  - Acetic acid is recovered and re-used at a rate of 99%
  - **Reduction of 8 million pounds of waste**
  - Process re-engineered from 40% to 77% efficiency
  - The **6 step manufacturing process was reduced to 3 steps**
  - http://www.epa.gov/greenchemistry/aspa97.html

This process change represents a significant financial and environmental "leap" forward by re-engineering the process to make ibuprofen. Process steps, hazardous chemicals, waste and cost were all drastically reduced. Virtually all starting materials are either converted to product or reclaimed byproduct, or are completely recovered and recycled in the process. The generation of waste is practically eliminated. The anhydrous hydrogen fluoride catalyst/solvent is recovered and recycled with greater than 99.9 percent efficiency. No other solvent is needed in the process, simplifying product recovery and minimizing fugitive emissions.



Green chemistry principles can be applied in industry and academia. Several universities are using their chemistry programs for promoting this type of approach.



Universities are finding that incorporating this approach into traditional lab teaching situations provides students with the hands-on experience to use this principle in later research or commercial applications.

Lessons from Green Chemistry Implementation in University Curriculum

Unexpected Benefits:

- Teaches objective evaluation of hazards
- Provides students with a rational procedure for analyzing/minimizing hazards
- Empowers students to use chemistry to solve environmental problems - " Ambassadors of Green Chemistry"
- Changes the way students and society view chemicals, chemistry, and chemists - "Know the hazards. Not all chemicals are hazardous."

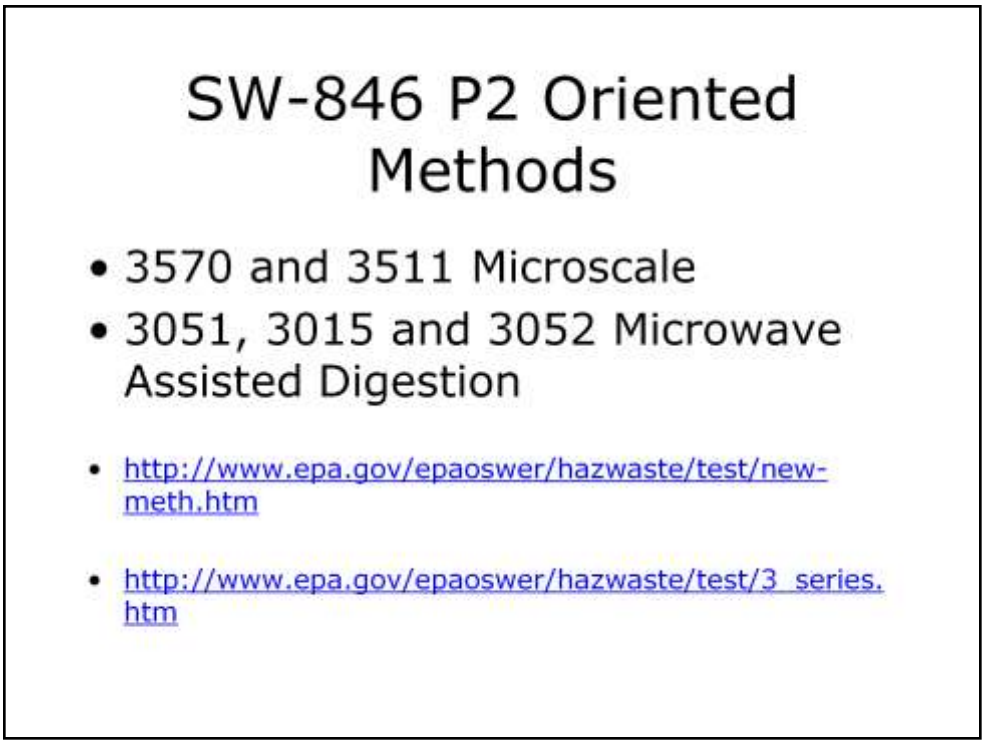




The Climatex fabric on this slide, is manufactured using no hazardous chemicals and can be composted at the end of it's life.

http://www.climatex.com/en/products/climatex_lifecycle_e.html

By using green chemistry principles in research & development laboratories, commercial products have emerged.

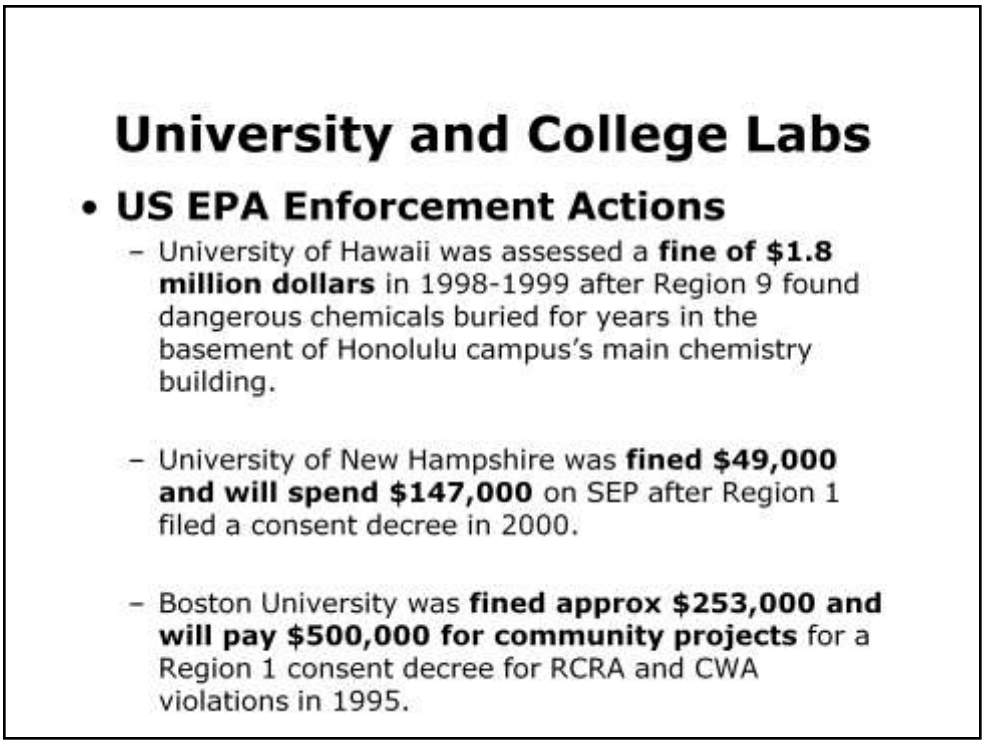


Here are examples of pollution prevention opportunities for method SW-846

University of Michigan Lab SW-846 3015 Microwave Assisted Digestion- Case Study

- **Benefits**
  - Reduction in sample prep time, sample storage and disposal.
  - Use of beakers, watch glasses and cleaning steps were eliminated saving labor costs.
- **Costs**
  - Initial capital investment of $15,000- $20,000 for set up.
  - http://www.p2000.umich.edu/chemical_waste/cw5.htm

In the conventional methods (3010 and 3020), sample digestion is performed on a hot plate, which takes several hours. The procedure requires a dedicated acid resistant hood and several square feet of lab space to store the samples, also a large number of glassware sets is required. In 3015 a sample carousel can be loaded with 10-15 samples and the entire sample prep completed in less than 30 minutes.



After US EPA inspected and found serious violations, enforcement action was taken against several colleges and universities. Many academic institutions have now re-evaluated how they were handling waste and completed P2 assessments.

University and College Labs

- **US EPA Enforcement Actions**
- In September 2004 US EPA and the University of California (UC) settled a case resolving 98 RCRA violations.
- Violations involved 4,000 containers of hazardous waste.
- UC estimated that it spent $1.78 million and 23,645 staff hours since 2001 completing an environmental audit of 47 university facilities.
- http://www.epa.gov/Compliance/resources/newsletters/civil/enfalert/labalert.pdf

U.S. EPA Resources for Colleges and Universities

- **US EPA Region 2**
  http://www.epa.gov/region02/p2/college/
- Web site contains lots of information with links to self-audit and P2 manuals on the web.
- **To date, 93 colleges and universities** in New York, New Jersey and Puerto Rico have come forward to disclose more than one thousand violations to EPA. Most of them have been granted a 100% waiver of certain penalties totaling more than $10 million.

Hazardous Waste Reduction at Lawrence Berkley National Lab

- **From 1993-2003 Reduced Hazardous Waste Generated 76.5%**
- Comply with waste min reporting requirements by the Department of Energy (DOE), the State of California, the University of California and the Lab itself
- **Requirements include:**
  - **Annually revise the Waste Minimization and Pollution Prevention Awareness Plan (WMPPAP),**
  - **Annual waste min and procurement reports,**
- **Have a Lab Employee Awareness Program**
  - Campaign, awards, recognition, information exchange, training
- http://www.lbl.gov/ehs/wastemin/index.html

Hazardous Waste Reduction at Lawrence Berkley National Lab- examples

Waste stream description	Generation in lbs 1993	Generation in lbs 2000	Percent decrease from 1993
Chemical labpacks from research-flammable	36,425	12,555	65.53%
Used Oil from various lab operations	34,654	2,619	92.44%
Halogenated and non-halogenated solvents	8,472	1,625	80.82%

Hazardous Waste Reduction at Lawrence Berkley National Lab- examples

Waste stream description	Generation in lbs 1993	Generation in lbs 2000	Percent decrease from 1993
Corrosive acidic waste from circuit board operations	59,934	585	99.02%
Photochemical liquids	15,586	361	97.68%
Waste off-spec machine coolant	16,140	55	99.66%
Petroleum naptha from degreasing	2,907	0	100%

University of Michigan (UM)-Waste Min Initiatives

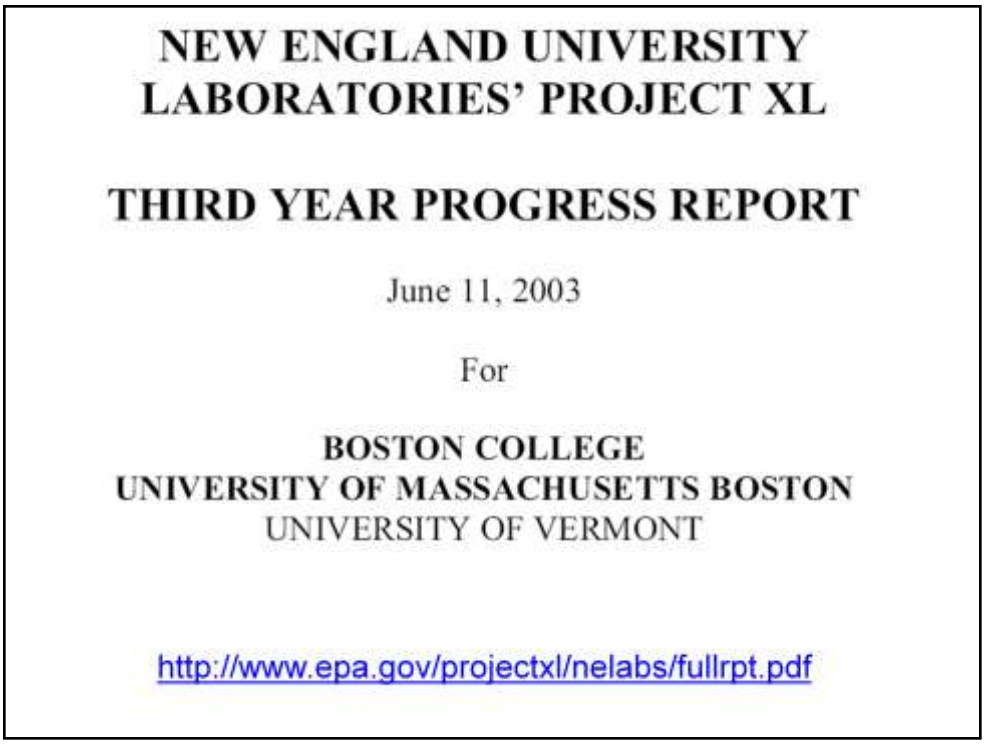
- UM launched in 1995 using the following tools:
  - Education (including micro-scale teaching)
  - Protocol Review
  - Non-haz product substitution
  - Solvent distillation
  - Chemical tracking system
  - Chemical redistribution system (Exchange program)
- **Program saves more than $200,000 annually in disposal and purchase of new chemicals**

Keep in mind, research funding for the university has grown 129% the past 10 years, lab space has increased 47% and waste generation has increased correspondingly. Yet the waste min program has been cost-effective.

UM Waste Min Initiatives-Successes

Chemical Type	Waste Min Method	Annual Reduction
Acetone, Xylene, Alcohol	Distillation	5,500 gallons
Ethidium Bromide	Filtration	100 gal
Photo Processing Waste	Silver Recovery	800 gal
Acids, Bases, Solvents	Micro-Teaching Techniques	300 gal
Varied	Chemical Redistribution	400 bottles
Varied	Chemical Tracking/Sharing	210 gal
Elemental Mercury Equip	Mercury-Free replacement	2,200 lbs
Varied	Aqueous-Based Substitution	20 gal

Overall waste generation increased through 2002, a decrease began in 2003 as programs began to take effect.



NEW ENGLAND UNIVERSITY LABORATORIES' PROJECT XL

THIRD YEAR PROGRESS REPORT

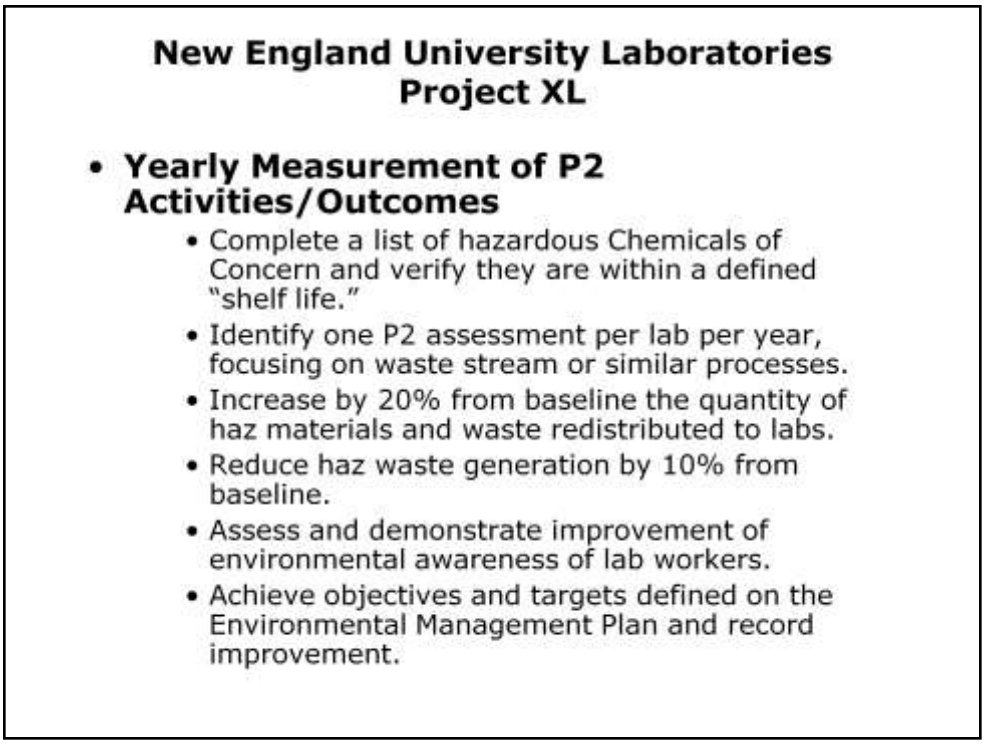
June 11, 2003

For

BOSTON COLLEGE
UNIVERSITY OF MASSACHUSETTS BOSTON
UNIVERSITY OF VERMONT

http://www.epa.gov/projectxl/nelabs/fullrpt.pdf

A case study in the development of best practices for university laboratories.



The report discusses in detail the activities, results, lessons learned, and things for further evaluation for each P2 activity.

U.S. EPA Resources for Colleges and Universities

- **Environmental Virtual Campus**
  - This project was undertaken by the Massachusetts Institute of Technology (MIT) for settlement of an enforcement action brought by the USEPA and the US Department of Justice
  - http://www.c2e2.org/evc/LabIndex.html

MIT's Environmental Virtual Campus web site

The main regulatory subject areas covered are: hazardous waste management, including toxic waste, mixed waste and waste determination, chemical storage, wastewater discharge, and air quality. Other topics are federal environmental regulations and best practices related to: fume hoods, floor drains and sinks, container management, gas cylinder management, satellite accumulation areas, emergency equipment, and training.

U.S. EPA Resources for Colleges and Universities

- **US EPA Sector Programs for Colleges and Universities**
- The Sector Strategies Program works collaboratively with 12 sectors to improve environmental performance while reducing regulatory burden and providing an expert staff liaison for each sector in the program.
- Web site has links to resources :http://www.epa.gov/sectors/colleges/index.html

Resources for Middle & High School Labs/Teachers

- **Lab Waste and P2- A Guide for Teachers** by Battelle Seattle Research Center

- This guide explains how hazardous wastes and other undesirable by-products generated by experiments that are performed in classroom labs can be minimized. It is intended for middle school, high school, and college science teachers.

Laboratory Waste Minimization and Pollution Prevention

A Guide for Teachers

March, 1996

Michelle Davis
Elizabeth Flores
Joe Hauth
Marina Skumanich
Doug Wieringa

For more information about this book, contact Jandie Ho.

Battelle
. . . putting technology to work

- To start reading at the beginning, click here.
- For a summary, see our checklist.

If you want to go to a specific topic, the list below may help. We've organized this guide to reflect the progression of chemicals through the laboratory.

- We begin by introducing waste minimization and pollution prevention and defining some important terms. Click here to go to that section (Chapters 1, 2, and 3).
- We then discuss waste minimization

http://www.seattle.battelle.org/Services/ES/P2LabMan/

Resources for Middle & High School Labs/Teachers

- **US EPA Schools Chemical Cleanout Campaign (SC3)**
  - In summer of 2004, EPA provided initial funding to the ten regions to support Schools Chemical Cleanout Campaign (SC3) programs. Each region is using this money to fund former, current or newly developed school cleanout programs in schools with a self-identified need for assistance.
  - http://www.epa.gov/epaoswer/osw/conserve/clusters/schools/index.htm

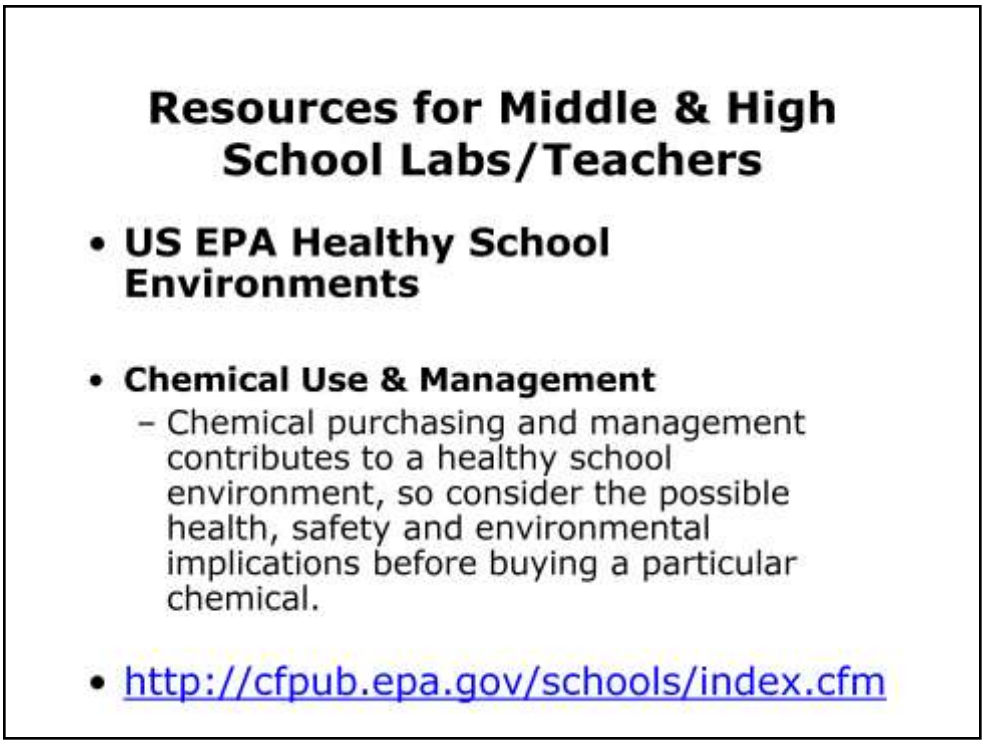
The goal of the SC3 is to create a chemically safer school environment in which chemicals are purchased wisely, stored safely, handled by trained personnel, used responsibly, and disposed of properly.

Resources for Middle & High School Labs/Teachers

- **Region 5**
- Regional Contact: Maryann Suero
  suero.maryann@epa.gov
  (312) 886-9077

- Funds for the SC3 will be used to assist an under-served area in school chemical cleanouts in Region 5. Within the designated area, schools will be given the option to participate in a one-time disposal of expired and used lab chemicals and will also be given the option to participate in a voluntary audit of their lab.

http://www.epa.gov/epaoswer/osw/conserve/clusters/schools/index.htm



Chemicals are used by students, teachers, facility personnel, and administrative staff throughout schools in science classes and labs, in art classes, in vocational shops such as autobody, auto repair,and printing, and in facility maintenance and operations such as cleaning, painting, and pest control. The Healthy School Environments Web pages are intended to serve as a gateway to on-line resources to help facility managers, school administrators, architects, design engineers, school nurses, parents, teachers and staff address environmental health issues in schools.

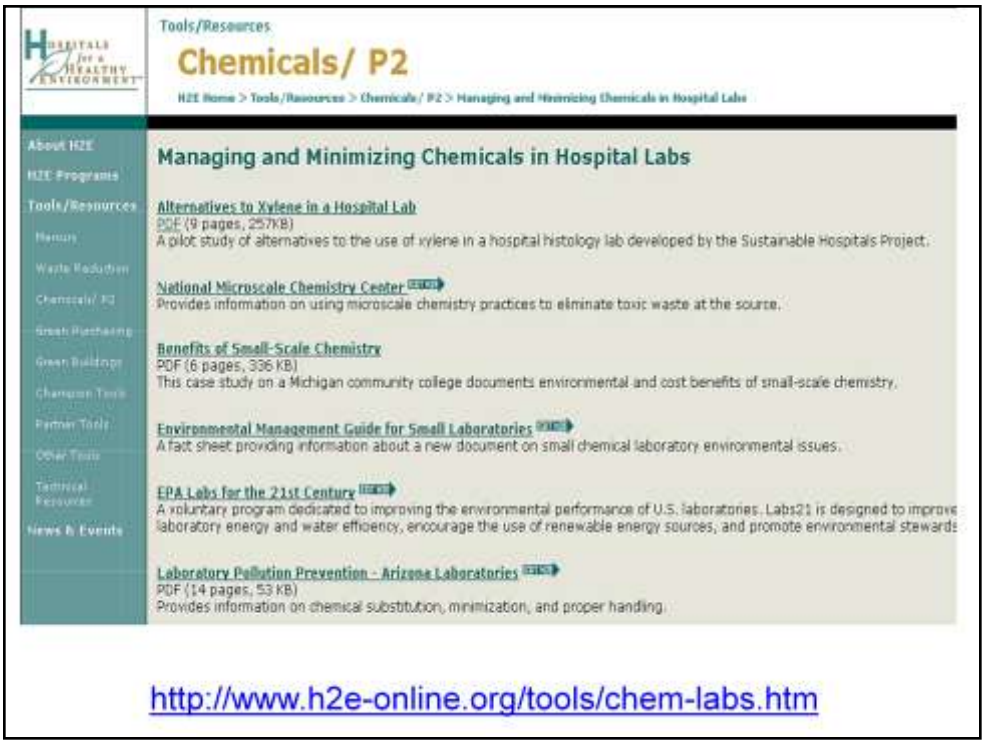
Local Hazardous Waste Management Program in King County
LOCAL GOVERNMENTS FOR HEALTH AND THE ENVIRONMENT

This program was put together by King County, WA to help schools manage their hazardous materials. A collection of fully-scripted, least-toxic chem labs for use by high school chemistry teachers can be downloaded.

http://www.govlink.org/hazwaste/schoolyouth/rehab/

You can download fully scripted lesson plans for use by high school chemistry teachers, information on ways to reduce

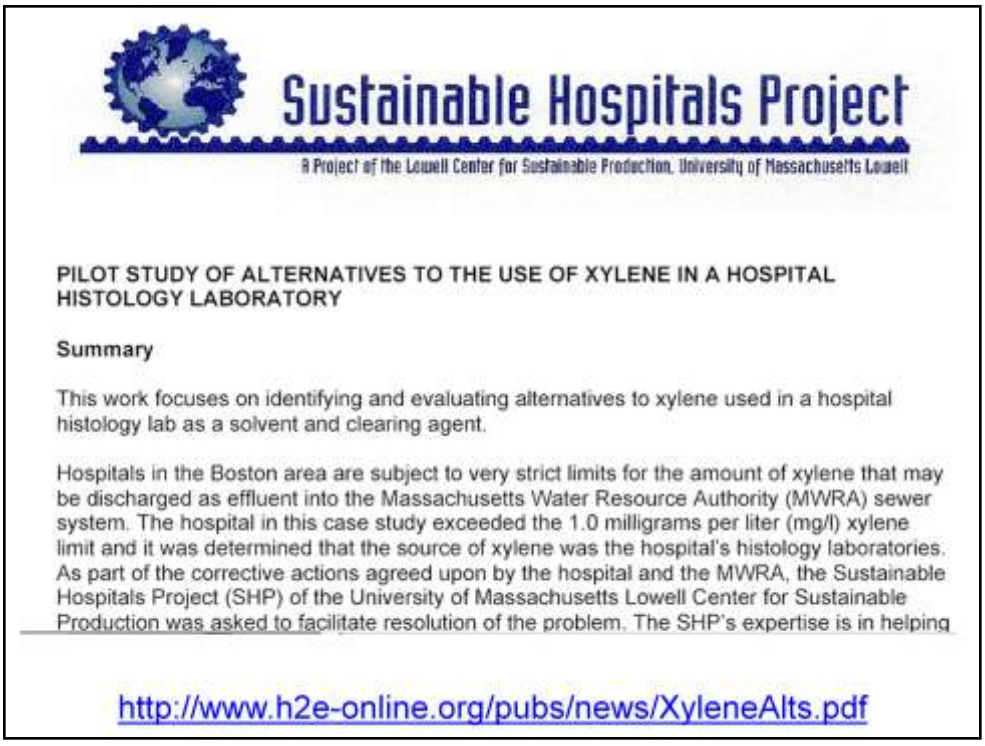
chemical stockpiles in biology labs and a list of chemicals whose risks outweigh their educational use.



There are a lot of resources to help hospitals to reduce waste. Hospitals for a Healthy Environment is a great resource.

Quite a number of chemicals in hospitals can be recovered and reused. An example of this is formaldehyde, or a variety of solvents that may be used. The site listed above includes a listing of solvent recovery vendors.

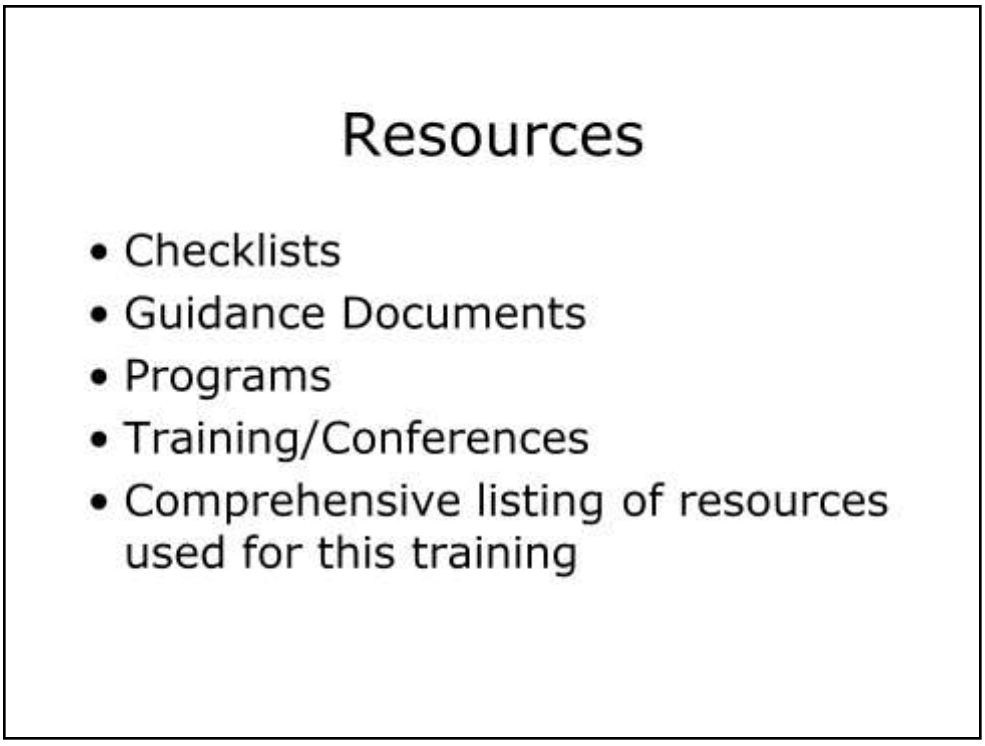
This is a resource for hospitals by the Minnesota Technical Assistance Program.



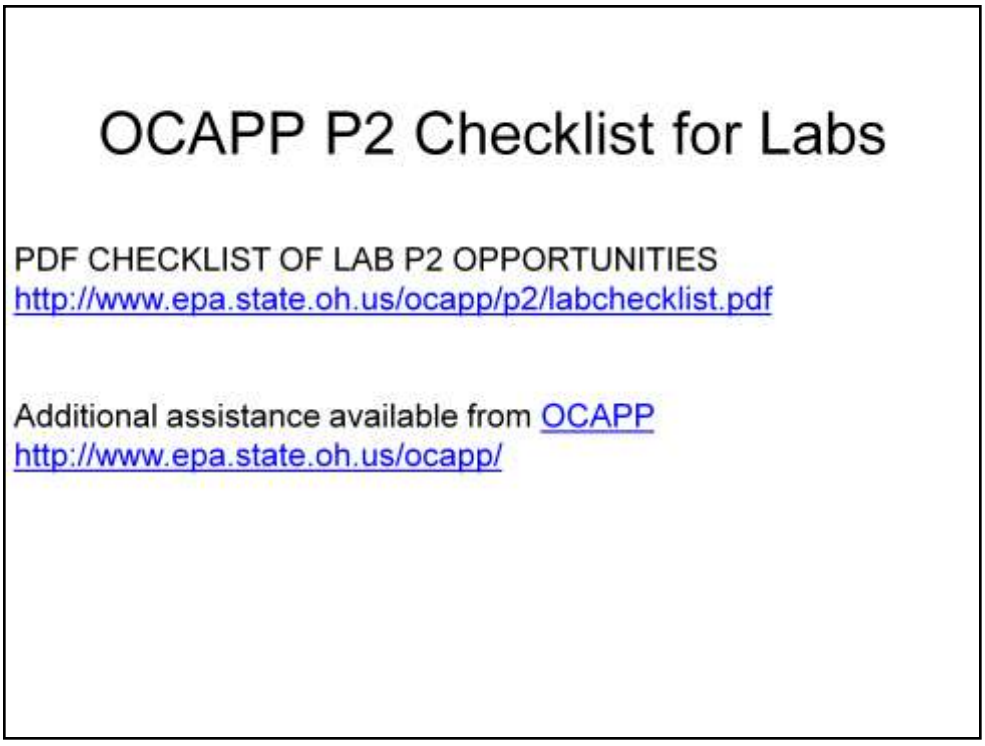
This is a demonstration project comparing alternatives to xylene.

Case Study-Formalin Recycling

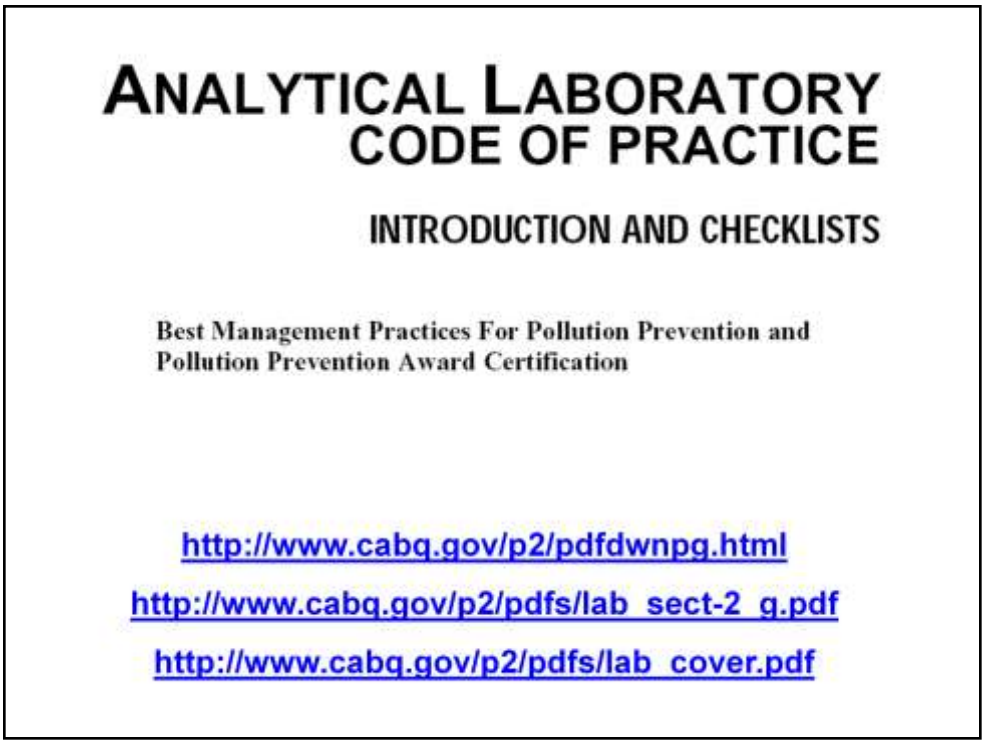
- Albany Medical College 1995-2004 **saved $327,000**
  - Purchased 5 gallon capacity unit to recycle formaldehyde waste. Cost: $10,000.
  - Recycled approx. 40,000 gallons.
  - Saved $185,000 in disposal costs and $142,000 in purchase of chemicals.
- http://www.sustainablehospitals.org/cgi-bin/DB_Report.cgi?px=W&rpt=Subcat&id=18!21



The following resources may be helpful to learn more about P2 opportunities available for labs. A P2 checklist prepared by OCAPP for use by labs is included. Other references are provided that include checklists, self audits, guides and policy manuals for labs to establish or improve their P2 programs. On the reference list, we have made notes or provided a brief description of their possible use in various situations.



This is intended as an introductory or time restricted assessment of lab P2 opportunities. Labs may request non-regulatory technical assistance from OCAPP directly for P2 opportunities or resources



The City of Albuquerque, New Mexico has a good guide to evaluate compliance and waste min opportunities. The checklists in the document are helpful to evaluate lab waste streams.

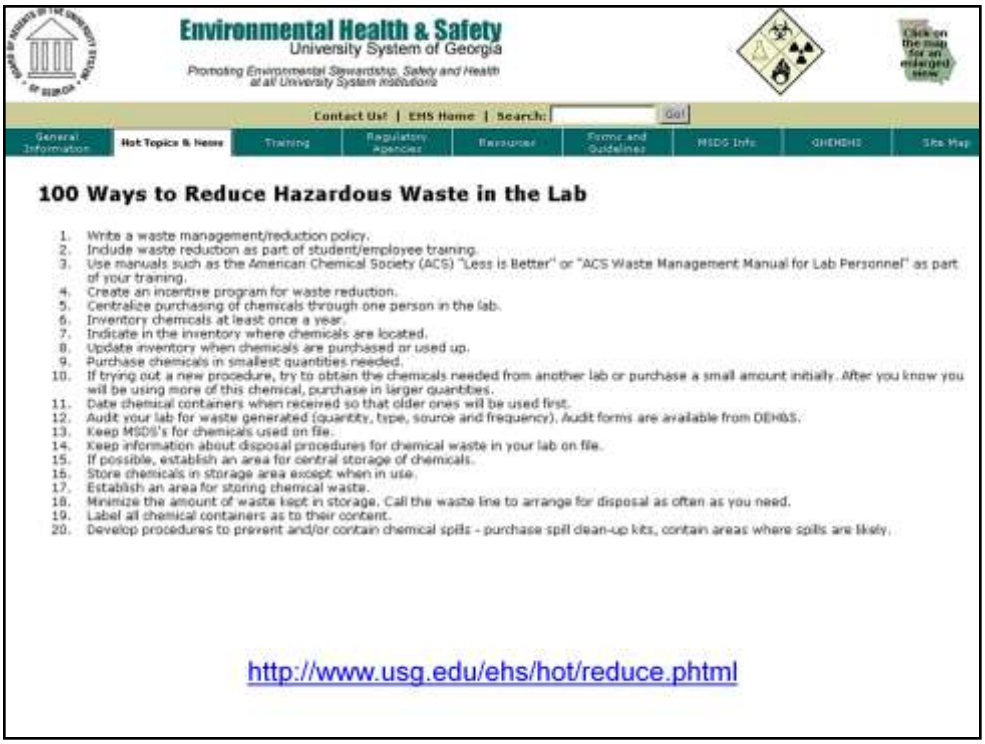
http://www.p2pays.org/ref/16/15829.pdf

This US EPA publication addresses compliance and P2.

LABS Central is being developed by the Department of Environmental Health and Safety at Iowa State University in Ames, Iowa. The project is the result of a cooperative agreement between the US EPA Office of Solid Waste (OSW) and Iowa State. The goal of LABS Central is to provide easy access to existing web resources that can enhance the environmental performance of laboratories.

The American Chemical Society (ACS) website has a lot of resources.

Division of Research Safety programs of the University of Illinois at Urbana-Champaign is a great resource for P2 fact sheets for Labs



A good collection of compliance and P2. From the University System of Georgia.

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

This guide by the American Chemical Society (ACS) is an great overview of P2 opportunities.

Laboratory Waste Disposal

Department of Chemistry, University of Kentucky

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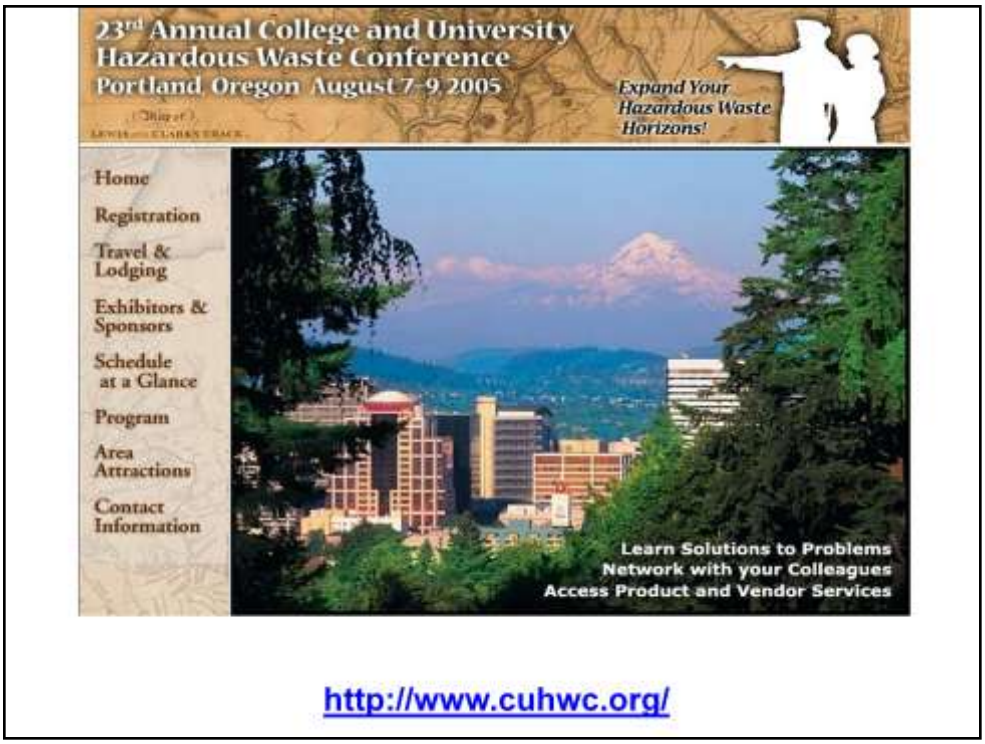
1. Introduction
2. The 5 Most Common (Deadly, and EPA-fineable) Errors In Waste Handling
3. How To Segregate Waste In The Laboratory
4. Self-Auditing Checklist For Hazardous Waste Generators
5. Taking Your Waste To The Stockroom For Disposal
6. Who To Contact For Further Information

Introduction

The Department of Chemistry is dedicated to the maintenance of a safe, healthy and productive workplace environment. As part of our commitment to environmental health and safety, we strive to ensure that our students, faculty and staff meet or exceed state and federal regulations concerning hazardous wastes, laboratory management and worker safety.

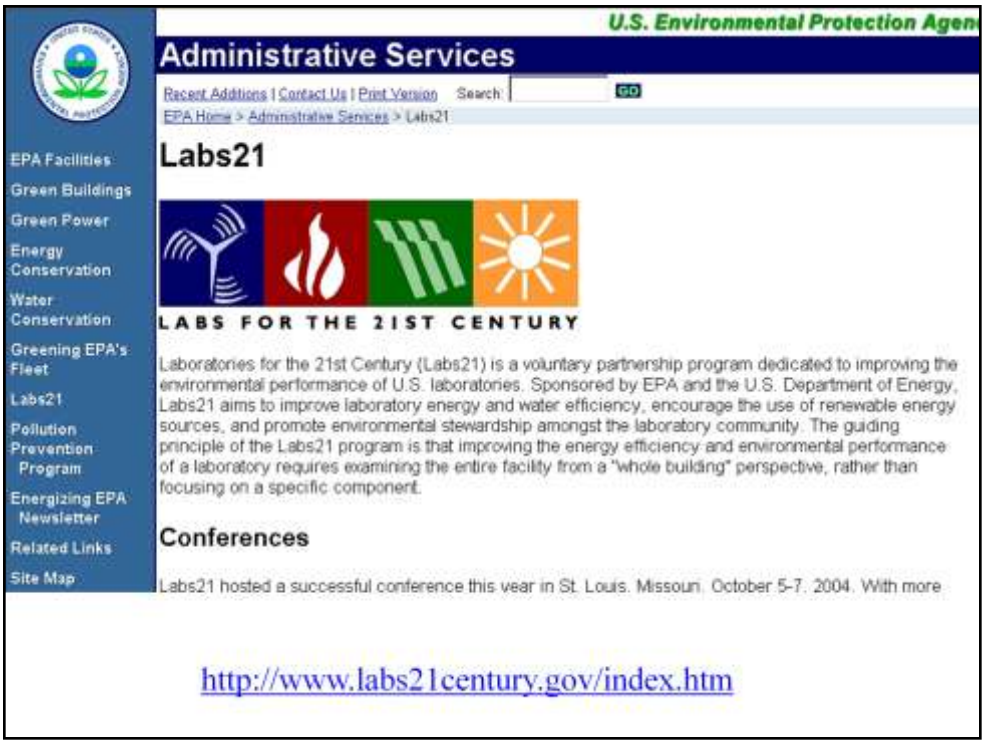
http://www.chem.uky.edu/resources/stockroom/waste.html

Many universities have p2 and compliance guidance on their web site under their chemistry department information or their environmental health and safety information. This is an example from the Department of Chemistry, University of Kentucky.



There are many opportunities for training and information sharing within lab and environmental health & safety organizations. This is a meeting for the College and University Hazardous Waste Conference.

This is a meeting for the Campus Safety Health and Environmental Association.



The primary goal of the Labs21 program is to improve the energy efficiency and environmental performance of a lab by examining the entire facility from a "whole building" perspective. US EPA and DOE established the Labs21 Program.

Lab Equipment-Recycling/Purchasing

- LabX.com is a media service founded in 1995, provides a forum where buyers and sellers of new, used, surplus, refurbished scientific, and lab equipment can find an item, negotiate the terms, and complete a purchase online.
- http://www.labx.com/

LabX.com is a media service for the exchange of scientific equipment. They do not buy nor sell equipment, but rather provide a means for buyers and sellers to connect. You must find the item or items you are looking for by searching the site. Each month, LabX receives over 10 million website hits, more than 2.5 million page views, and 450,000 visitors.

Future Technologies
Lab-On-A-Chip

From NASA

The holes on this chip are actually ports that can be filled with fluids or chemicals. Tiny valves control the chemical processes by mixing fluids that move in the tiny channels that look like lines, connecting the ports.

Many chemical and biological processes - previously conducted on large pieces of laboratory equipment - can now be performed on these small glass or plastic plates. Many companies are completing R&D on this technology for medical applications. To make customized chips for various applications, NASA has an agreement with the U.S. Army's Microdevices and Microfabrication Laboratory at Redstone Arsenal in Huntsville, Ala, where NASA's Marshall Space Flight Center is located.

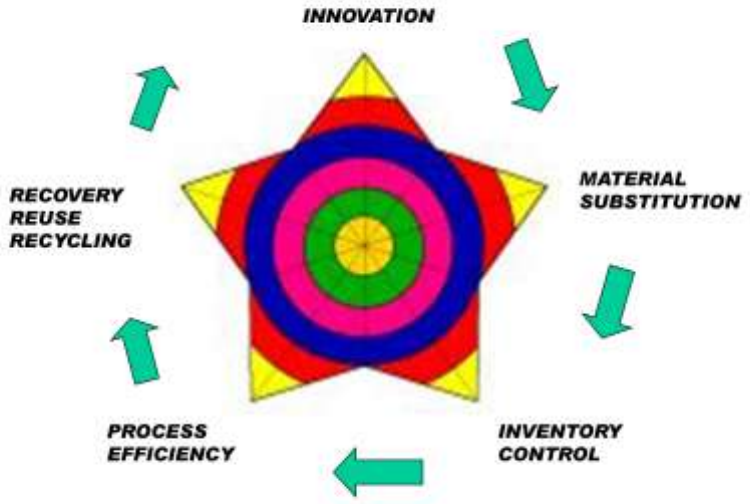
Attempts to coordinate federal work on the nanoscale began in November 1996, when staff members from several agencies decided to meet regularly to discuss their plans and programs in nanoscale science and technology. The group continued informally until September 1998, when it was designated as the Interagency Working Group on Nanotechnology (IWGN). In August 1999, IGWN completed its first draft of a plan for an initiative. The importance of a coordinated Federal program for nanotechnology R&D was given greater recognition in 2003 with the enactment of the 21st Century Nanotechnology Research and Development Act (Public Law 108-153). See also Nanoscale Science and Engineering R&D Extend Frontiers of Scientific Knowledge, Lead to Significant Technological Advances, Supplement to President's FY 2004 Budget, Oct. 2003.

Nanotechnology has both applications and implications for the environment. EPA is supporting research in this technology while evaluating its regulatory responsibility to protect the environment and human health. This site highlights EPA's research in nanotechnology and provides useful information on related research at EPA and in other organizations.

Future Applications of Nanotechnology

- Drug delivery systems, including implantable devices that automatically administer drugs and sense drug levels;
- Medical diagnostic tools: cancer tagging mechanisms and lab-on-a-chip, real time diagnostics for physicians;
- Cooling chips or wafers to replace compressors in cars, refrigerators, air conditioners and multiple other devices, utilizing no chemicals or moving parts;
- Sensors for airborne chemicals or other toxins;
- Photovoltaics (solar cells), fuel cells and portable power to provide inexpensive, clean energy, and
- New high-performance materials.

The pharmaceutical and chemical industries are being impacted greatly by nanotechnology.



In summary, laboratory pollution prevention should be a cycle of continuous improvement of waste and hazard minimization.

The intent is to examine ways to **minimize hazardous materials** in the laboratory at the earliest possible opportunity.

Ideally hazardous materials should be substituted before they are even ordered, if possible. If an organization is large, such as a university, excess material may be found within the organizations inventory system.

When necessary materials should be ordered in the minimum quantity that can be used before expiration/instability.

Materials should used in the minimum quantity possible.

Examine ways to recover, re-use and recycle materials as an alternative to disposal.

Lastly, continually look for innovative approaches that will eliminate or minimize the use of hazardous substances in the laboratory.

All the resources used for this presentation are included in"Laboratory P2 Training Reference Guide" located at:
http://www.epa.state.oh.us/ocapp/p2/labref.pdf

Please see the OCAPP website at
http://www.epa.state.oh.us/ocapp/ for further resources.

All resources used for this presentation are included in the “Laboratory P2 Training Reference Guide”