Lab XL Progress Report
University of Massachusetts Boston
June 11, 2003

EPI #1: Annual Surveys of Hazardous Chemicals of Concern

Results to date:

The goal of the first EPI is assure that outdated hazardous chemicals of concern are appropriately removed from laboratory shelves and disposed properly. This EPI is a result of the observation that good housekeeping (particularly with respect to outdated chemicals) is an important hazardous waste minimization strategy for laboratories in general. A laboratory that tracks its chemical inventory carefully enough to prevent accumulation of outdated chemicals is very likely to avoid purchasing excess chemicals.

As we have previously stated, UMass Boston is required by the Boston Fire Department to have complete chemical inventories for all labs. In the past, paper inventory recordkeeping became increasingly difficult and cumbersome. In an effort to improve the sometimes 18-month process, EH&S implemented a chemical bar code based tracking system on a lab-by-lab basis. The bar code system has been in place for approximately 15 months. For specific Principal investigators, the EH&S Office has taken the inventory from each laboratory and generated Operational Material Safety Data Sheets for each laboratory. In addition, each information package provided by EH&S to a laboratory includes the inventory list with HCOC's marked and an explanation of HCOCs

Lessons learned:

The bar code system is currently operated by EH&S and provides only a snapshot in time of any one lab's inventory.

We have yet to conduct a second inventory of labs. A re-inventory will allow us to determine how "accurate" our inventories are at a given time and may give us some information about movement of materials from one lab to another.

Once the re-inventory is complete, we should be able to look at trends in HCOCs on the shelf.

We believe that the computerized tracking system has the potential enhance the ability of EH&S to identify potential pollution prevention and redistribution opportunities however, we have not investigated this to date.

Our next step is to network the inventory program so that individual departments will have real-time access to the inventories, which will allow them to update the system as new materials enter their labs and search for chemicals, when needed, from other labs.

EPI #2: Verification of HCOC Surveys

Results to date:

The second EPI measures the participation rate in the HCOC inventory effort. As stated above, with the barcoding system in place, all HCOCs have been identified, and surveys have been conducted for all labs.

EPI #3: Pollution Prevention Opportunity Assessments

EH&S continues to emphasize pollution prevention concepts during training and researchers are encouraged, during waste pickups and lab inspections, to incorporate pollution prevention ideas such as product substitution, limited purchasing and waste minimization into their everyday work. The EH&S Office encourage researchers to examine pollution prevention opportunities at the time of experimental design and when they are developing their Standard Operating Procedures. After the experimental design process is in place, we remind them to purchase only what they need. Finally, we suggest that they determine whether or not a treatment method that can be incorporated at the end of the experiment.

The Chemical Hygiene Committee continues to search for new pollution prevention ideas and share these with the research community at UMB. Additionally, a campus sub-committee has been formed tasked with “greening research.” This sub-committee is part of a larger campus-wide Sustainability Committee. The sub-committee continues to search for pollution prevention opportunities in the research community on campus. Additionally, we hope to build on the pollution prevention surveys (described below) and encourage PIs to come up with new pollution prevention ideas to investigate.

EPI #4: Hazardous Materials Reuse and Redistribution

Results to date:

EH&S sent out pamphlets in 2001 requesting that Principal Investigators (PIs) look through their chemicals and determine if they have any materials that are unlikely to be used. Additionally, EH&S evaluates laboratory wastes for reuse when these materials are collected from labs. EH&S compiled a list of excess chemicals and published them to the EH&S website in May 2002. EH&S notified all PIs about the list via email. PIs or laboratory workers may request excess re-usable chemicals on the list and EH&S will deliver the material to their laboratory. If an excess chemical remains in the EH&S

inventory for more than 2 years, the material will be disposed of. Over the past year there has been few inquiries or requests for these stock materials. Chemicals were requested from EH&S and delivered to laboratories on only four occasions.

In addition to the materials available for reuse, EH&S sent out a Pollution Prevention Survey in 2002 to approximately 56 PIs. Updated results (2003) of those surveys are presented below. There was an increase in response rate from 40%, in 2002, to 63%, in 2003.

Table 1: Pollution Prevention Survey results

		Number of labs	% of labs
Type of Wastes Generated *(multiple answers possible)*	Toxics	4	7%
	Solvents	27	48%
	Acids	22	39%
	Corrosives	12	21%
	Reactives	10	18%
	Other	6	11%
Dominant Laboratory Processes *(multiple answers possible)*	Biomedical	10	18%
	Analysis	10	18%
	Other	3	5%
	Synthesis	8	14%
P2 Steps Taken *(multiple answers possible)*	Downsizing	21	38%
	Substitution	12	21%
	Changing lab processes	8	14%
	Nothing	3	5%

	NA	5	9%

Table 1: Pollution Prevention Survey results (Continued)

		Number of labs	% of labs
Frequency of process changes	Annually	10	18%
	Monthly	15	27%
	Never	5	9%
	Weekly	8	14%
	Daily	1	2%
	Rarely	1	2%
	Semester	1	2%
Waste generation trends	Stay the same	24	43%
	Decrease	8	14%
	Increase	1	2%
	NA	2	4%
How often do you run out of a chemical?	Once a month	9	16%
	Never	8	14%
	Once a year	1	2%
	Once every few months	1	2%
Alternative sources of a chemical *(multiple answers possible)*	Borrow from another lab	13	23%

	Standard shipping from vendor	7	13%
	Overnight shipping from vendor	2	4%
	Substitute with another chemical	4	7%

Table 1: Pollution Prevention Survey results (continued)

		Number of labs	% of labs
How frequently do you borrow chemicals from another lab?	Monthly	8	14%
	Once every few months	1	2%
	Annually	17	30%
	Never	7	13%
	Weekly	0	0%
	Daily	0	0%
	NA	1	2%
Total lab supervisors responding		35	63%

Lessons learned:

The survey results strongly suggest that P2 is already occurring. Approximately 73% of those surveyed have downsized their experiments, substituted chemicals or changed processes to decrease their use of toxic chemicals. These changes have occurred independent of EH&S efforts.

The survey data suggests that processes change at least once per month. Clearly, a "one-size" fits all program from EH&S will not be effective. However, a communication from EH&S to labs on a monthly or quarterly basis may be of value in reminding researchers to think about P2.

While 25% of researchers would look to another laboratory if they ran out of a chemical, 20% would wait for a shipment from a vendor, which indicates there is some hesitation among researchers to use materials from other laboratories.

EPI #5: Laboratory Waste Generation Rates

Results to date:

EPI #5 concerns the amount of laboratory waste generated. The data are presented below in Table 2.

Table 2. UMass Boston Laboratory Waste Generation (in lbs)

Waste Stream	Calendar Year 1999	2000	2001	2002
Labpack with poisons	**192.83**	**335.57**	**1083.36**	**335.28**
Labpack with corrosives	**1161.46**	**959.94**	**2165.53**	**1497.22**
Labpack with acutely hazardous wastes	**31.48**	**2.00**	**16.78**	**8.39**
Labpack with misc. hazardous waste	**739.57**	**819.62**	**31.00**	**6.00**
Labpack with organic peroxides	**19.57**	**0.00**	**8.39**	**0.00**
Labpack with spontaneously combustible material	**11.68**	**0.00**	**1.00**	**14.00**
Labpack with pyrophorics	**21.34**	**10.00**	**28.39**	**9.00**
Labpack with flammable liquids	**2470.02**	**1168.39**	**1543.44**	**2010.64**
Labpack with flammable solids	**11.70**	**33.39**	**15.39**	**65.57**
Labpack with oxidizers	**148.48**	**121.75**	**225.10**	**303.42**
Compressed gases and aerosols	**264.27**	**20.00**	**156.39**	**15.57**
Non-hazardous/non-regulated waste	**512.07**	**240.00**	**310.00**	**690.00**
TOTAL	5584.47	3710.66	5584.77	4955.09
Difference (lbs)		1873.81	-1874.11	629.68
% Difference		-33.55	+50.51	-11.27

Lessons learned:

Four years of tracking hazardous waste generation at UMass Boston has given us little insight into any trends. Yearly totals vary according to many factors including type and amount of research, number of researchers and other factors. What the table does reiterate is that overall, UMass Boston is a small quantity generator if EPA p-listed materials are not considered. Even in 2000, when the smallest amount of waste was generated, one disposal event put us into the large quantity generator category because of the disposal of certain acute hazardous wastes.

EPI #6: Environmental Awareness Survey

Results to date:

Results (45 respondents), shown in Table 3, indicate little to no change in answers. There are, however, some signs of increased awareness on specific questions related to general environmental awareness. Correct answers on two questions--fume hood emissions and environmental impacts of laboratory work—rose 5% each from the corresponding 2002 scores. In addition, the percentage of respondents trained in the EMP grew by 6%.

Table 3
Environmental Awareness Survey Results

	2000	2001	2002	2003
Number of Respondents	87	54	60	45
1. Which federal agency regulates the disposal of chemical wastes:				
a. Occupational Safety and Health Administration	29%	15%	23%	27%
b. Environmental Protection Agency	*48%*	*80%*	*72%*	*67%*
c. Department of Transportation	10%	5%	3%	2%
d. National Institutes of Health	13%	0%	2%	0%
2. Ultimately, most chemical wastes generated in laboratories are:				
a. incinerated	*32%*	*17%*	*23%*	*18%*
b. sent to a land-fill	15%	6%	10%	9%
c. release to a sewer	23%	28%	12%	11%
d. treated	30%	49%	55%	53%
3. What are the four main reasons researchers should keep containers of laboratory waste securely closed except when adding chemicals?				
0 reasons	0%	0%	3%	4%
1 reason	62%	13%	17%	9%
2 reasons	14%	22%	35%	33%
3 reasons	24%	31%	27%	18%
4 reasons	*0%*	*24%*	*18%*	*16%*
4. Which costs more, purchase or disposal of laboratory chemicals?				
a. disposal costs more	*51%*	*78%*	*77%*	*51%*
b. purchase costs more	24%	4%	5%	17%
c. costs are roughly the same	25%	18%	18%	15%
5. In the book, "Prudent Practices in the Laboratory", what is the preferred waste management hierarchy for pollution prevention? Use a scale of 1-4 with 1 being the preferred management method.				
Source Reduction		37%	47%	44%
6. What is the proper way to dispose of strong mineral acids?				
a. Dilution with water	26%	13%	17%	9%
b. Neutralization with lime	33%	24%	24%	24%
c. Collection for pick-up by hazardous waste personnel	*8%*	*56%*	*53%*	*42%*

d. Mixing with organic chemicals	8%	0%	3%	2%
e. Other	25%	7%	3%	0%

	2000	2001	2002	2003
Number of Respondents	87	54	60	45
7. What is the maximum amount of acutely hazardous laboratory waste that your laboratory is allowed to accumulate?	36% Correct	41% Correct	36% Correct	29% Correct
8. What emergency response equipment is available in your laboratory to respond to a hazardous chemical spill?				
0 items	14%	19%	12%	11%
1-3 items	78%	70%	65%	47%
4-6 items	8%	11%	23%	22%
7 items	0%	0%	0%	0%
9. How is waste water from your laboratory buildings treated?				
a. Purification before release to the sewer	24%	7%	10%	11%
b. pH is controlled by acid neutralization, then released to the sewer	37%	37%	27%	27%
c. Diluted with the rest of the building's water, then goes to the sewer for municipal treatment by aerobic digestion	25%	56%	50%	38%
d. other		0%	7%	2%
unknown		0%	6%	22%
10. In general, how are fume hood emissions controlled in your laboratory?				
a. Filtration to remove particles	21%	17%	40%	13%
b. Carbon filtration to remove gases	*30%*	*20%*	*35%*	*40%*
c. Dilution with laboratory room air	24%	63%	13%	20%
d. No hoods in lab		0%	7%	4%
Unknown		0%	5%	22%
11. The last time you needed health and safety information about a particular chemical, what resource(s) did you use?				
0 responses	17%	22%	13%	20%
1 response	47%	41%	55%	38%
2 responses	17%	24%	19%	13%
3 responses	5%	13%	3%	2%
4 responses		0%	5%	2%
N/A		0%	5%	5%

	2000	2001	2002	2003
Number of Respondents	87	54	60	45
12. Typically, what is the largest environmental impact of laboratory work?				
a. release of toxic chemicals through the fume hood	15%	6%	2%	2%
b. disposal of toxic chemicals with a hazardous waste disposal company	25%	19%	25%	22%
c. release of chemicals to the sewer system	32%	48%	47%	29%
d. energy use to cool or heat laboratory space	*15%*	*13%*	*23%*	*40%*
Unknown	13%	14%	3%	7%
13. The last time you disposed of laboratory hazardous waste, what four pieces of information did you put on the label?				
0	22%	24%	17%	11%
1-3	26%	59%	22%	25%
4-6	33%	2%	50%	33%
N/A	19%	15%	11%	11%
14. What document(s) describes how to dispose of laboratory hazardous waste at your institution?	0% correct responses (EMP not yet distributed)	50% Correct	53% Correct	42% Correct
15. What is your current role in your laboratory?				
Faculty	22%	28%	18%	18%
Staff - Administrator	6%	2%	2%	0%
Staff - Lab Tech	11%	17%	17%	20%
Graduate Student	15%	30%	40%	45%
Undergraduate Student	46%	23%	23%	18%
16. How many years have you been working in college or university laboratories?				
Less than 1 year	40%	22%	16%	13%
1-2 years	22%	20%	39%	18%
3-5 years	10%	17%	20%	16%
more than 5 years	28%	41%	25%	38%
Respondents Trained in CH/EM Plan	0%	68%	47%	53%

Lessons learned:

The environmental awareness survey continues to provide important feedback of the effectiveness of the EMP at UMass Boston. The results of the survey continue to give us valuable information about the issues that require greater explanation during outreach efforts. Additionally, it gives us an objective measure of how effective our training efforts have been in reaching the laboratory population of interest and generating ideas about how to improve our training.

It is important to train graduate students because they (a) are less likely to turnover on a year to year basis, and they offer an opportunity to provide further training and instruction to temporal lab workers.

EPI #7: Environmental Awareness Training

Results to date:

EPI #7 measures the amount of training conducted for laboratory workers with regard to environmental compliance and awareness. EH&S has built an accurate training database. Each semester, we send out forms to the PIs asking them to identify all laboratory personnel under their supervision that require training. EH&S has entered the information into a database and is able to generate the information on a semester-by-semester basis for the PI to update thus insuring that our training records are accurate and up-to-date. To date, we continue to have 89% training rate for those that have been identified by PIs as people covered by the CH/EM Plan.

Lessons learned:

As long as we are flexible and available to provide training in a variety of settings, we should continue to have a high training rate. Additionally, the use of an accurate database, based on information from the PIs, is critical to insure that we are training the correct population.

EPI #8: Environmental Management Program Effectiveness

The following list represents a review of the goals of the XL Program as set for in the Project XL FPA:

- EPI#1 It appears as though there is a sharp decline in outdated chemicals in laboratory--however, it has not been directly measured to date.
- EPI#2 The EH&S Office has a complete chemical inventory from the new barcoding

system. All HCOCs have been identified and flagged on the inventories.

- EPI#3 The Chemical Hygiene Committee and the "Greening Research" Committee are searching for ideas to investigate.

- EPI#4 The amount of laboratory waste collected for reuse has increased substantially, however the amount of laboratory waste reused or redistributed has not yet increased by 20%.

- Updated EPI #5. The amount of laboratory waste disposed of decreased in total for 2002 by 11.27% from baseline and 2001.

- EPI#6 The Environmental Awareness Survey was completed and the results are similar to survey results from 2002.

- EPI#7 The number of laboratory workers trained in the CH/EM Plan remains steady at approximately 89% of the total number of laboratory workers that have been identified by PIs as being covered by the CH/EM Plan.

- EPI#8 Some EPIs are on-track (decrease in laboratory waste disposal, outdated chemicals, internal and external audits); others continue to need more attention (pollution prevention, environmental awareness surveys).

- EPI#9 Both external and internal audits show significant compliance with the Minimum Performance Criteria of the XL Regulation.

EPI #9: Environmental Management Plan Conformance

Results to date:
Normally, UMass Boston EH&S staff conduct annual laboratory inspections beginning in June to measure conformance with the Environmental Management Plan. This year however, inspections began in May in an effort to complete the inspections by the current XL progress report due date. To date, 96 inspections have been completed

Again, we utilized the C2E2 "audit grading" system that converts the results of the laboratory audit checklist used by the pilot schools into grades on the issues most important to the Lab-XL project:

- Chemical container management
- Laboratory housekeeping
- Pollution prevention
- Laboratory self inspections
- Training and awareness

In the case of UMB, this grading system was applied to laboratory inspections

previously conducted in 2000 and 200. In applying scores to each laboratory for the categories listed above, certain assumptions were made. Since training in the Environmental Management Plan was not initiated until 2001, each laboratory was assigned a score of '0' for the 'Training and Awareness' category prior to 2001. In addition, the UMB pollution prevention program was not initiated until 2001, so each laboratory received a score of '0' for the Pollution Prevention' category prior to 2001.

Certain assumptions were made for the 2002 scores as well. In conducting laboratory inspections, it was often impossible to ascertain whether or not everyone who worked in them regularly was trained or not, since some labs were unoccupied at the time of inspection. EH&S personnel relied instead upon the presence of the EMP in a laboratory to determine training status. If the EMP was present in a laboratory, it was assumed that some of its regular occupants had been trained in the new regulations, since the Plan was distributed only at training sessions. Thus, a laboratory was assigned a score of '1' for the 'Training and Awareness' category if the plan was present, and '0' if it was not. In both cases, self-inspection grades were solely based in the one page checklist that laboratories send to EH&S monthly, not on the container self-inspection checklists posted in each laboratory. In many cases, the posted checklists were filled out even if the monthly self inspection sheets had not been sent to EH&S.

For 2003 inspections, audit forms were completed during the inspection and the scores are based on actual observations for container management, housekeeping and self-inspection. For training, EH&S records were examined. Again for pollution prevention, all laboratories were given a score of 1.

Table 4: 2000 Audit Grading Results at UMass Boston

Score	Container Management	House-keeping	Pollution Prevention	Self inspection	Training	Total Grade
NA	12					
0	6	12	120	103	120	1
1	39	86		16		20
2	63	22		1		31
3						42
4						25
5						1
6						
7						
8						
Total	**120**	**120**	**120**	**120**	**120**	**120**
Average Score						**2.67**

Table 5: 2001 Audit Grading Results at UMass Boston

Score	Container Management	House-keeping	Pollution Prevention	Self inspection	Training	Total Grade
NA	9					
0		3		83	50	
1	7	33	104	18	54	
2	88	68		3		1
3						7
4						20
5						34
6						33
7						7
8						2
Total	**104**	**104**	**104**	**104**	**104**	**104**
Average Score						**5.13**

Table 6: 2002 Audit Grading Results at UMass Boston

Score	Container Management	House-keeping	Pollution Prevention	Self inspection	Training	Total Grade
NA						
0		1		29	33	
1	20	36	98	24	26	
2	70	61		45	39	
3	8					1
4						8
5						19
6						16
7						18
8						24
9						7
10						5
Total	**98**	**98**	**98**	**98**	**98**	**98**

Average Score						**6.73**

Table 7: 2003 Audit Grading Results at UMass Boston

Score	Container Management	House-keeping	Pollution Prevention	Self inspection	Training	Total Grade
NA						
0	2	1	0	6	0	
1	0	14	96	20	15	
2	6	80	0	70	81	
3	89					
4						
5						1
6						0
7						4
8						18
9						25
10						49
Total						**96**
Average Score						**9.22**

Figure 1, on the next page, is a composite graph of all audit scores for four years of the pilot program. Annually, UMass Boston has shown an increasing trend in compliance scores. Increases this year are attributed primarily to better container management. In 2002, EH&S changed the laboratory waste tags to be more descriptive about dating containers when full and listed possible hazard classes instead of leaving a blank space. Researchers have improved greatly and there are consequently fewer violations for container management.

Figure 1: XL Audit Scores over Time