LAB XL PROGRESS REPORT FOR 2003

UNIVERSITY OF MASSACHUSETTS BOSTON

Submitted July 1, 2004

Introduction

Despite resource constraints and cutbacks in the Environmental, Health and Safety Office at the University of Massachusetts Boston, we have continued to demonstrate effective management and improvement in the implementation of the Chemical Hygiene/Environmental Management Plan. Section 8 of this Report provides an overview of performance. Waste data in this Report represents activities for the calendar year 2003. Other activities and data represent the UMB fiscal and academic year, July 1, 2003 – June 30, 2004

EPI #1: Annual Surveys of Hazardous Chemicals of Concern

Results to date:

The goal of the first EPI is to assure that outdated hazardous chemicals of concern are appropriately removed from laboratory shelves and disposed properly.

As stated previously, UMass Boston is required by the Boston Fire Department to maintain chemical inventories for all labs. Therefore, all laboratories (100%) have had a survey of Hazardous Chemicals of Concern (HCOCs) and updated these inventories. EH&S implemented a chemical bar code based tracking system on a lab-by-lab basis in 2001/2002. For each Principal investigator, 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 single lab's inventory.

We have yet to conduct a second inventory of labs to verify that our existing tracking measures (e.g., purchasing records, PI updates, waste disposal) can be relied upon to provide accurate snapshots of chemical inventories. 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.

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Once the re-inventory is complete, we should be able to more carefully evaluate trends in HCOCs on the shelf.

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

We have built an on-line searchable database for our Operational Material Safety Data Sheets, which allows lab workers in the Chemistry Department to access information on any chemical as needed. We anticipate introducing this tool to all lab workers in the Fall 2004 semester. In addition, we hope to network the barcode 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 bar-coding system in place, all HCOCs have been identified, and surveys have been conducted for all (100%) labs.

EPI #3: Pollution Prevention Opportunity Assessments

EH&S continues to emphasize pollution prevention concepts during training and researchers are encouraged, during both 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 encourages 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 a treatment method can be incorporated at the end of the experiment. At a small university, we are able to remind and reinforce the P2 message with faculty, staff and graduate students during our many informal EH&S/researcher interactions.

We believe this approach is quite effective. In 2002/2003 we conducted a P2 survey of all UMB PIs. Results of that survey showed that 73%, nearly ¾ of all PIs had already downsized their experiments, substituted chemicals or changed their processes to use less toxic material in their experiments. The survey also showed that 25% of the PIs would look to another laboratory if they run out of a chemical.

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In 2004, we embedded several P2 statements into our Annual Environmental Awareness Survey and asked respondents to rank the statements from 1-5 with 1 being "strongly agree " to 5 being "strongly disagree". The survey results were very encouraging and indicated that:

- 100% believed it was the lab workers responsibility to reduce their environmental impact.
- 40% believed they could produce 10% less waste.
- 95% believed scientists should find safer chemicals to use in experiments.
- 92% believed that it was their responsibility to make changes in order to produce less waste.

For EH&S, now the task is to try and encourage the researchers to put their beliefs into practice.

EPI #4: Hazardous Materials Reuse and Redistribution

Results to date:

EH&S continues to evaluate laboratory wastes for reuse when these materials are collected from labs. EH&S maintains a list of excess chemicals and publishes them to the EH&S website. At least once a semester, EH&S notifies 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. As in previous years, there have been few inquiries or requests for these excess stock materials. Chemicals were requested from EH&S and delivered to laboratories on only two occasions.

Lessons learned:

We learned from previous years' Pollution Prevention (P2) surveys that P2 is already occurring. PIs report that they 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 promoting a central chemical waste reuse program and measuring its success.

Clearly, EH&S cannot dictate how researchers do their work and an EH&S implemented P2 program will not be effective. However, a communication from EH&S to labs on a frequent basis may be of value in reminding researchers to think about P2.

EPI #5: Laboratory Waste Generation Rates

Results to date:

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EPI #5 concerns the amount of laboratory waste generated. The data are presented in Table 1 on the next page. UMB's hazardous waste generation decreased by roughly 16% from the previous year. In total, we have experienced a 25% reduction of hazardous waste since the beginning of the XL Pilot Program. We have also seen the reduction of certain highly hazardous wastes (e.g., organic peroxides, pyrophorics, oxidizers). It is impossible to determine whether these reductions are attributable to a better managed program or these reductions simply reflect changes in research activities.

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Table 1. UMass Boston Laboratory Waste Generation (in lbs)

Waste Stream	Calendar Year				
	1999	**2000**	**2001**	**2002**	**2003**
Labpack with poisons	**192.83**	**335.57**	**1083.36**	**335.28**	**374.10**
Labpack with corrosives	**1161.46**	**959.94**	**2165.53**	**1497.22**	**919.95**
Labpack with acutely hazardous wastes	**31.48**	**2.00**	**16.78**	**8.39**	**18.78**
Labpack with misc. hazardous waste	**739.57**	**819.62**	**31.00**	**6.00**	**151.96**
Labpack with organic peroxides	**19.57**	**0.00**	**8.39**	**0.00**	**0.00**
Labpack with spontaneously combustible material	**11.68**	**0.00**	**1.00**	**14.00**	**2.00**
Labpack with pyrophorics	**21.34**	**10.00**	**28.39**	**9.00**	**2.00**
Labpack with flammable liquids	**2470.02**	**1168.39**	**1543.44**	**2010.64**	**1750.24**
Labpack with flammable solids	**11.70**	**33.39**	**15.39**	**65.57**	**29.00**
Labpack with oxidizers	**148.48**	**121.75**	**225.10**	**303.42**	**52.39**
Compressed gases and aerosols	**264.27**	**20.00**	**156.39**	**15.57**	**40.39**
Non-hazardous/non-regulated waste	**512.07**	**240.00**	**310.00**	**690.00**	**830.00**
TOTAL	**5584.47**	**3710.66**	**5584.77**	**4955.09**	**4170.81**
Difference (lbs)		1873.81	-1874.11	629.68	784.28
% Difference		**-33.55**	**+50.51**	**-11.27**	**-15.83**

Lessons learned:

Despite five years of tracking hazardous waste generation at UMass Boston, it is still difficult to gain insight into any trends. While yearly totals continue to vary according to many factors including type and amount of research, number of researchers and other factors, we have experienced a 25% reduction in the annual generation of hazardous wastes from laboratories. The collected data also points to another important issue for

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colleges and universities – the generation of acute hazardous wastes. –UMass Boston would clearly be a small quantity generator if EPA p-listed materials were 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:

Summary results for five years of Environmental Awareness Survey data are shown in Table 2. We have made some modifications to the survey this year, based on lessons learned from previous surveys. The new questions were designed to elicit more feedback regarding pollution prevention and other attitudes/behaviors associated with a more mature management program. Many of the questions remain the same as in previous years to ensure year to year comparisons. A copy of the new survey can be found in the Appendix. Only selected questions that were the same each year are included below in Table 2. The correct answer(s) is italicized.

Table 2
Environmental Awareness Survey Results

	2000	2001	2002	2003	2004
Number of Respondents	87	54	60	45	38
2. Ultimately, most chemical wastes generated in laboratories are:					
a. incinerated	*32%*	*17%*	*23%*	*18%*	*34%*
b. sent to a land-fill	15%	6%	10%	9%	18%
c. release to a sewer	23%	28%	12%	11%	16%
d. treated	30%	49%	55%	53%	26%
4. Which costs more, purchase or disposal of laboratory chemicals?					
a. disposal costs more	*51%*	*78%*	*77%*	*51%*	*71%*
b. purchase costs more	24%	4%	5%	17%	8%
c. costs are roughly the same	25%	18%	18%	15%	13%
6. What is the proper way to dispose of strong mineral acids?					
a. Dilution with water	26%	13%	17%	9%	0%
b. Neutralization with lime	33%	24%	24%	24%	13%
c. Collection for pick-up by hazardous waste personnel	*8%*	*56%*	*53%*	*42%*	*76%*
d. Mixing with organic chemicals	8%	0%	3%	2%	0%
e. Other	25%	7%	3%	0%	6%

	2000	2001	2002	2003	2004

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Number of Respondents	87	54	60	45	38
10. In general, how are fume hood emissions controlled in your laboratory?					
a. Filtration to remove particles	21%	17%	40%	13%	34%
b. Carbon filtration to remove gases	30%	20%	35%	40%	29%
c. Dilution with laboratory room air	*24%*	*63%*	*13%*	*20%*	*32%*
d. No hoods in lab		0%	7%	4%	0%
Unknown		0%	5%	22%	3%
12. Typically, what is the largest environmental impact of laboratory work?					
a. release of toxic chemicals through the fume hood	15%	6%	2%	2%	23%
b. disposal of toxic chemicals with a hazardous waste disposal company	25%	19%	25%	22%	*63%**
c. release of chemicals to the sewer system	32%	48%	47%	29%	0%
d. energy use to cool or heat laboratory space	*15%*	*13%*	*23%*	*40%*	*23%**
Unknown	13%	14%	3%	7%	3%
			*most gave more than one answer		
Faculty	22%	28%	18%	18%	35%
Staff - Administrator	6%	2%	2%	0%	2%
Staff - Lab Tech	11%	17%	17%	20%	8%
Graduate Student	15%	30%	40%	45%	50%
Undergraduate Student	46%	23%	23%	18%	5%
16. How many years have you been working in college or university laboratories?					
Less than 1 year	40%	22%	16%	13%	13%
1-2 years	22%	20%	39%	18%	21%
3-5 years	10%	17%	20%	16%	18%
more than 5 years	28%	41%	25%	38%	47%
Respondents Trained in CH/EM Plan	0%	68%	47%	53%	71%

Lessons learned:

Respondents generally continue to score at levels recorded during the past two years, or slightly higher. The audience for the surveys has differed over time. This year's respondents were primarily faculty and graduate students. The environmental awareness survey continues to provide important feedback with respect to the effectiveness of the EMP at UMB. The results of the survey continue to give us valuable information about the issues that require greater explanation during outreach efforts.

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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 at UMB because they: (a) are less likely to turnover on a year-to-year basis; and (b) offer an opportunity to extend training and instruction to temporary lab workers, such as undergraduates.

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. The number of laboratory workers trained in the CH/EM Program has dropped from 89% in 2002 to 60% in 2003. This change is due to two factors: (a) a more accurate database of laboratory workers; and (b) EH&S Department cutbacks that curtailed certain training initiatives.

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 summarizes progress toward the goals of the XL Program as set for in the Project XL FPA. The Project XL goals have acted as the de facto environmental "objectives" for the EH&S Department with respect to the management of laboratories

- 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 bar-coding system. All HCOCs have been identified and flagged on the inventories.
- EPI#3. P2 continues to be an area that we would like to improve on. At this point, because of our staffing problems, we are not sure exactly how to proceed. We anticipate trying to get more involvement from the Chemical Hygiene Committee and potentially the Dean of Sciences.

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- 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 2003 by 15.83% from 2002 and approximately 25% from baseline.

- 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 has dropped to 60% from last years' 89%. EH&S believes that there are two reasons for the decrease in number of individuals trained. First, our training database is more accurate now than it has been in the past giving us better data. In addition, it appears as though more PIs are listing a greater number of students that should be trained on the plan than in past years. Second, with the decrease in staff in the EH&S Office, fewer training sessions were conducted. We anticipate that the majority of those currently needing training will be targeted in the Fall 2004 semester. See Appendix 2, Figure 2 for more data.

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

- EPI#9. Audits show significant compliance with the Minimum Performance Criteria of the XL Regulation. Overall results were similar to last year. It appears as though the only way that scores can increase in the future is to implement a large-scale P2 program for all laboratories. It is not clear to us that such a large-scale effort is feasible (e.g., EH&S budget cuts) or effective (e.g., see comments in P2 section regarding informal, small university efforts).

EPI #9: Environmental Management Plan Conformance

Results to date:

Normally, UMB EH&S staff conduct annual laboratory inspections beginning in June to measure conformance with the Environmental Management Plan. This year however, inspections began in April in an effort to complete the inspections by the current XL progress report due date. For 2004, 96 inspections were completed, and the results continue to show progress. See Figure 1.

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

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- Laboratory self inspections
- Training and awareness

This grading system was applied to UMB laboratory inspections previously conducted in 2000, 2001, and 2002. 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 in a laboratory was trained or not, since some labs were unoccupied at the time of inspection and our training database was incomplete. 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 and 2004 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 3: 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**

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Table 4: 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 5: 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**

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Table 6: 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	5	81	0	70	81	
3	89					
4						
5						1
6						0
7						4
8						18
9						25
10						49
Total	96	96	96	96	96	**96**
Average Score						**9.22**

Table 7: 2004 Audit Grading Results at UMass Boston						
Score	**Container Management**	**House-keeping**	**Pollution Prevention**	**Self inspection**	**Training**	**Total Grade**
NA						
0	0	0	0	22	4	
1	0	24	96	1	1	
2	6	72	0	74	91	
3	90					
4						
5						1
6						4
7						10
8						11
9						11
10						59
Total						96
Average Score						9.11

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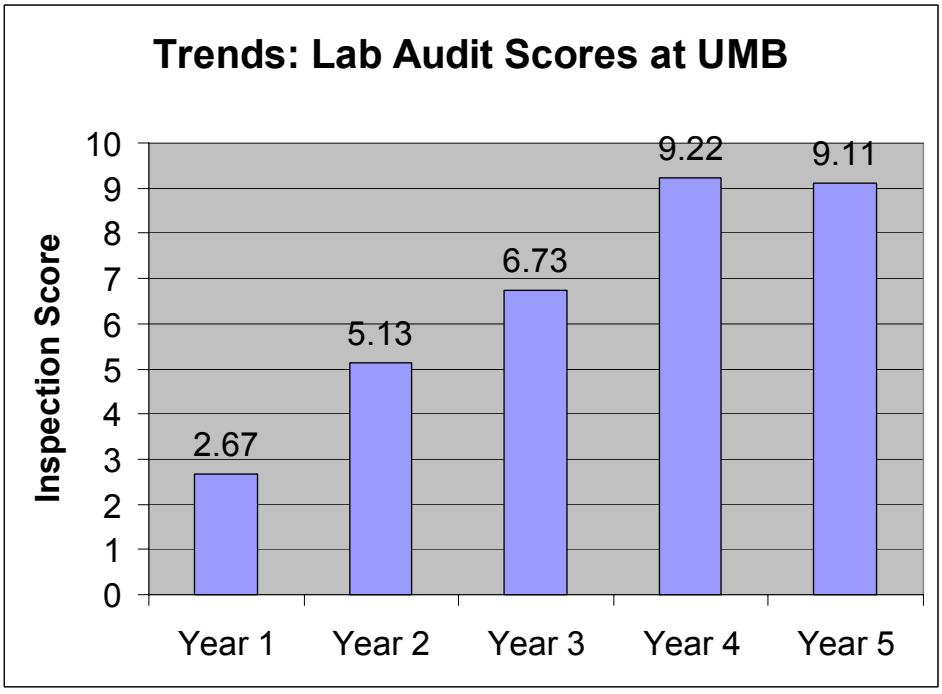
Figure 1 is a graph of all audit scores for the five years of the pilot program. Year 1 represents 2000, while Year 5 represents audits completed in Spring 2004.



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APPENDIX 1

Table 8: UMB Lab Worker Environmental Awareness Survey Spring 2004 (38 responses)					
Question	**Response chosen (%)**				
1. When I need health/safety information about a chemical I consult (indicate the two most common sources):	*MSDS* 24	*Merck Manual* 13	*Hazardous Chemical Desk Reference* 10	*Supervisor* 11	*A Lab Colleague 13*
	Use of toxic chemicals	*Utility use (energy and water)*	*Hazardous waste production*	*Biomedical/sharps waste production*	*Animal waste production*
2. Which of these factors do you think is the largest overall environmental impact of laboratory work:	9	9	21	2	1
3. Which of these factors do you think is the largest overall environmental impact of laboratory work:	9	17	24	7	2
4. The purpose of a fume hood is to protect (pick the best answer as it applies to your work):	*The laboratory worker* 38	*Equipment in the laboratory* 11	*The laboratory building and its occupants* 6	*The outside environment* 4	
	1 Strongly agree	**2**	**3**	**4**	**5 Strongly disagree**
5. It is the responsibility of every lab worker to minimize the environmental impact of their work.	36	2	0	0	0
6. With careful planning, I would be able to produce 10% less laboratory waste without affecting my research.	8	7	9	4	3

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Question	Response chosen (%)				
7. Hazardous waste is a necessary byproduct of chemical research.	8	5	13	4	4
8. It is important for scientists to find safer chemicals to use in their experiments.	26	8	3	0	1
9. It is not my responsibility to make changes in the way my research is done in order to produce less hazardous waste.	1	4	3	8	17
10. I have seen articles about pollution prevention in research in my discipline's journals.	12	7	5	3	4
11. What is the proper way to dispose of strong mineral acids?	*Dilution with water* 0	*Neutralization with lime* 5	*Collection for pick-up by hazardous waste personnel* 29	*Mixing with organic chemicals* 0	
12. Ultimately, most chemical wastes generated in laboratories are:	*Incinerated* 13	*Sent to a landfill* 7	*Released to a sewer* 6	*Treated* 10	
13. In general, the cost of disposal of a chemical is _____ the cost of buying that chemical.	*Less than* 3	*Equal to* 5	*A little more (less than twice as much)* 6	*A lot more (more than twice as much)* 21	
14. In general, how are fume hood emissions treated before being released to the environment?	*Filtration to remove particles* 13	*Carbon filtration to remove gases* 11	*Dilution with laboratory room air* 12	*Scrubbing to remove particulates, gases and toxics* 6	
15. Please check the types of laboratory worker training you have received at UVM.	*CH/EM Plan* 27	*Radiation Safety* 15	*Biosafety* 15	*Laser safety* 1	
16. What is your current role in your laboratory?	*Faculty* 13	*Staff* 4	*Grad student* 19	*Undergrad student* 2	

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17. How long have you been working in a university lab?	*less than 1 year* 5	*1-2 years* 8	*3-5 years* 7	*more than 5 years* 18	
18. Have you completed an XL Environmental Awareness Survey in the past?	*Yes* 20	*No* 18			

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