UVM Lab XL 2003 Progress Report

June 11, 2003

Summary

The Environmental Management Plan at UVM has been a significant success in many ways. The EMP has enabled staff from the UVM Environmental Safety Facility to coordinate outreach to the laboratory population around chemical waste procedures with those procedures associated with chemical health and safety in the laboratory. The improved program has resulted in:

- significant increases in laboratory worker awareness of appropriate waste disposal practices and environmental impacts (EPIs #6 and 7);
- behavioral changes in terms of increased compliance (EPIs #2 and 9); and
- physical changes in terms of a decrease in the amount of Hazardous Chemicals of Concern stored in UVM laboratories (EPI #1).

While the trends mentioned above have been encouraging, the data chosen to track some of the EPI's of interest have not fully matured. We are still developing ways to improve measurement of:

- our pollution prevention program to measure its performance (EPIs #3 and 4);
- our tracking and interpretation of the amount of hazardous waste disposed of by the institution (EPI #5); and
- the goal setting process for the EMP as a whole (EPI #8).

In order to allow these efforts and data to fully mature, we believe that a continuation of the XL project is important. Because of the large number of EPIs associated with this project, the program managers had to prioritize work on the various aspects of the project in order to achieve its goals effectively. An additional three years is necessary to provide information about the long-term effectiveness of this Environmental Management System based program.

Note: Information on the context of each EPI was included in the 2002 Progress Report. This background information and the Mid Term Evaluation of the Project written by the Office of Environmental Policy Innovation should be considered while reviewing the information below.

EPI #1: Annual Surveys of Hazardous Chemicals of Concern

Results to Date

UVM Chemical Inventories

In previous XL progress reports, the HCOC surveys have been used to assess the amount of chemicals stored on UVM lab shelves, as a surrogate for the amount of chemicals of special concern. To maintain consistency with these reports, these results are given for 2003 in Table 1. The outstanding feature of these results is that ongoing implementation of the Environmental Management Plan has increased the supervisor response rate significantly over the life of the project. In 2003, we were able to achieve a 93% response rate, including, for the first time, 100% of the Chemistry Department. Unfortunately, this affects the interpretation of the amounts of chemicals in inventory, which show an increase to levels that existed before the EMP.

Based on chemical clean outs that have occurred over the last few years and our observations of laboratory conditions, we believe that this increase in response from the Chemistry Department (which has the largest chemical inventory on campus) is the primary factor in the increase in number and amount of chemicals reported to be on UVM lab shelves in 2003. Therefore, the reported increase in amount of chemicals on the shelves is related to statistical improvements in the reporting system, rather than a physical increase in the amount of chemicals stored in the labs. We believe that there continue to be fewer chemicals on UVM lab shelves than before the EMP was implemented.

Hazardous Chemicals of Concern

The original intent of the HCOC survey was to identify chemicals that present hazards of special concern, particularly addressing materials that have exceeded their "shelf life". In order to measure this aspect of UVM's chemical inventory more directly than the HCOC survey allows, two special items addressing this issue were included in the UVM Laboratory Audit form for 2002 in the container management section. Based on these items (the 4th and 5th of the container management section), 10 of the 300 laboratories audited had expired chemicals (identified on the UVM Chemical Use Planning Form and HCOC inventory form as "time sensitive") on hand. The 2003 audit visits will be used in a similar way to determine whether this factor improves with time.

Lessons Learned

The concept of "Hazardous Chemicals of Concern" was developed to extend the reach of the EMP beyond the list of chemicals listed by RCRA regulations and to deal with concerns about "dusty crusty" chemical containers accumulating on laboratory shelves. Our work to date indicates that these goals are more problematic than envisioned when this EPI was proposed. Defining the shelf life of a chemical depends on its intended use, and varies depending on the laboratory involved. Identifying laboratory chemicals that present significant risks to the public or the environment requires professional judgment based on local factors.

We believe that the HCOC process can still provide useful information in assessing the progress of the EMP in improving chemical inventory management on campus. However, it is not clear if this information will apply directly to the question this EPI was originally designed to address. Rather, the audit process is likely to be more effective in identifying special chemical hazards in the laboratory.

The question of campus wide chemical inventories for laboratory institutions is a topic of ongoing regulatory interest. At UVM, we believe that focusing on a specific list of chemicals that includes those chemicals most likely to present a concern for the safety and health of laboratory workers, emergency responders, and the environment can significantly reduce these risks. We believe that, particularly in the biomedical research environment, where many chemicals are very low hazard (e.g. salts, sugars and cellular growth media) maintaining a chemical inventory beyond the institution-specific HCOC list would significantly increase the expense of this system without a commensurate decrease in the risks associated with the chemical inventory.

Table 1: HCOC Inventory Trends at UVM
2001 - 2003

	1990's average	2001 XL baseline year	2002	2003
Forms distributed	unknown	453	220	217
Labs reporting	103	220 (counted by room)	160	202
Supervisor response rate	Approximately 40%	49%	73%	93%
Chemical count per lab	26	16	19	24
Total pounds of HCOC per lab	216	134	153	190

EPI #2: Verification of HCOC Surveys

Results to Date

As shown in Table 1, HCOC participation rates at UVM have increased every year and in 2003 we are nearing complete participation. This increase is attributable to persistent follow-up by ESF staff with laboratory workers, both during laboratory audits and when the HCOC survey is administered at the beginning of the calendar year. This year's follow up included e-mail reminders to laboratory supervisors and then follow-up visits to laboratories that did not respond by the deadline established by ESF staff. Another factor that increased the 2003 response rate was the visit from the Vermont Department of Environmental Conservation and EPA New England auditors just before the deadline for return of the forms. In addition, some departments, including Chemistry, took internal responsibility for assuring that all of the department's responses were submitted.

Work was begun on a web-based system for entry of the HCOC data by the laboratories. However, developing a user interface that was as simple to use as the paper form has proven to be more of a challenge than expected. At this point, we have been able to implement the "back end" of the computer system so that after ESF staff inputs the data, the data manipulation necessary to produce reports for SARA Title III and XL purposes is automated. An improved system for tracking which UVM rooms are labs and who the laboratory supervisors are will have to be developed before overcoming the user interface problems mentioned above will be feasible.

Lessons Learned

The key lesson learned from the history of EPI #2 is that even a well-established program such as the laboratory chemical survey, which has been in place for over ten years requires persistent management resources in order to maintain participation. A program cannot be simply implemented once and then assumed to continue as successfully at the level first established. While maintaining an ongoing program may not require as much intense effort as establishing a system, it is not effortless.

This finding has important implications for the design and development of the overall Environmental Management Plan. Establishing too many distinct requirements within an EMP will cause these requirements to compete with each other, detracting from the overall effectiveness of the program. To whatever extent management requirements related to chemicals (including, for example OSHA and EPA issues in the same system) can be dovetailed with each other, the overall success of the program will be improved.

EPI #3: Pollution Prevention Opportunity Assessments

Results to Date

Pollution Prevention efforts at UVM took a back seat to EMP implementation in the early stages of the Lab XL project. We relied on two basic P2 strategies during this period: the ChemSource program of centralized distribution of key chemicals and the mercury thermometer exchange. While these programs are continuing, with implementation of the EMP, we are now able to approach P2 opportunities in a more systematic way.

This approach has involved incorporation of a Pollution Prevention survey of the laboratories into the ESF laboratory audits to identify common aspects of laboratory operations that afford P2 opportunities. The results of the first year of the P2 survey are given in Table 2. In the first year, 145 of the 212 laboratory supervisors (68%) returned the surveys. In 2003, follow up to that similar described in EPI #2 will focus on receiving these surveys from the remaining laboratory supervisors.

The ultimate goal of this programmatic approach is to develop a "Pollution Prevention Best Management Practices Catalog" that can be used to publicize P2 success stories in UVM labs. For example, during the 2003 regulatory audit, the auditors were able to identify several interesting ideas for pollution prevention in labs, such as solvent recovery and cleaning agent substitution. If these ideas prove their worth, they could be included in this catalog, which could be used both by UVM labs interested in improving their environmental performance, and shared with colleagues at other institutions of higher education via the C2E2 web site.

Lessons Learned

While the results of the P2 survey are still incomplete, there are three results of interest so far:

Pollution Prevention is already happening in UVM Laboratories

Table 2 demonstrates that nearly half of the laboratories have implemented at least one of the major pollution prevention strategies (substitution of hazardous chemicals, downsizing chemical reactions or changing laboratory processes) without prompting from the Environmental Safety Facility staff. This is because these changes not only decrease the amount of hazardous waste produced, but also create safer working conditions for the laboratory workers themselves.

UVM laboratories don't routinely change their chemical use

62% of the laboratories report changing their laboratory processes monthly or less often. This conservatism in process management (necessary to maintain compatibility with previous work or work being conducted in other laboratories) means that opportunities for changing processes to implement specific pollution prevention ideas are limited. However, if appropriate pollution prevention ideas can be identified and implemented, they are likely to remain in place for a significant length of time.

Laboratories prefer to know where their chemicals are coming from

The survey results showed that the laboratories are more likely to borrow chemicals from another laboratory when they need them than to use the UVM Chemical Exchange program. This is because the quality of chemicals that other laboratories have already identified as excess is suspect. By

connecting directly with the laboratory that acquired the chemical, the potential user can check on the quality of the chemical. This is particularly true in biomedical laboratories, which reported that they are twice as likely to get surplus chemicals from their neighbors than through the ESF.

This finding demonstrates one of the significant cultural hurdles involved in recycling surplus chemicals on a campus wide basis - chemical quality is a much higher concern than cost or recycling of chemicals. This is the reason that the ChemSource chemical distribution program has focused on the distribution of new chemicals rather than recycled chemicals (see EPI #4).

Table 2: Pollution Prevention Survey results			
		Number of labs	% of labs
Type of Wastes Generated (multiple answers possible)	Toxics	104	72%
	Solvents	76	52%
	Acids	68	47%
	Corrosives	60	41%
	Reactives	25	17%
Dominant Laboratory Processes (multiple answers possible)	Biomedical	72	50%
	Analysis	48	33%
	Other	14	10%
	Synthesis	25	17%
P2 Steps Taken (multiple answers possible)	Downsizing chemical reactions	62	43%
	Substitution of less hazardous chemicals	66	46%
	Changing laboratory processes	50	34%
Frequency of process changes	Annually	60	41%
	Monthly	31	21%
	Never	29	20%
	Weekly	17	12%
	Daily	8	6%
Waste generation trends	Stay the same	107	74%
	Decrease	29	20%

	Increase	9	6%

How often do you run out of a chemical?	Once a month	25	17%
	Never	40	28%
	Once a year	70	48%
Alternative sources of a chemical (multiple answers possible)	Borrow from another lab	92	63%
	Would check UVM chemical exchange program for the chemicals they need	76	52%
	Standard shipping from vendor	53	37%
	Overnight shipping from vendor	28	19%
	Substitute with another chemical	20	14%
How frequently do you borrow chemicals from another lab?	Monthly	42	29%
	Annually	60	41%
	Never	31	21%
	Weekly	7	5%
	Daily	1	1%
Laboratory distribution by college	Agriculture and Life Sciences	37	26%
	Arts and Sciences	19	13%
	Engineering and Math	3	2%
	Medicine	77	53%
	Natural Resources	6	4%
	Nursing and Health Sciences	3	2%

Total lab supervisors responding		145	

EPI #4: Hazardous Materials Reuse and Redistribution

Results to Date

Table 3 describes the activities of the UVM ChemSource program over the Project XL period. Activity in this program has doubled over the course of the XL project, primarily due to increased awareness of the program in laboratories as outreach efforts associated with the EMP have proceeded. These results indicate that the ChemSource program is becoming an increasingly important source of chemicals on campus serving the program's pollution prevention goals.

Lessons Learned

The original purpose of the ChemSource program was to reduce the amount of excess chemicals bought by UVM labs by allowing them to realize case price cost savings on individual containers. This approach has proven to be a success. The distribution of new chemicals through the ESF has become a part of the life of many of UVM's labs; about 100 (almost 50%) of the lab groups routinely use the program. (It is difficult to be more specific about the laboratory participation rate for ChemSource because the laboratory orders may come from different people, grants and/or rooms in the same laboratory group.)

We have discovered that a major challenge associated with the internal redistribution of chemicals is achieving a supply of sufficient quality and variety that redistribution becomes a meaningful alternative to commercial suppliers. In the 7 years of ChemSource operations, the number of "waste chemicals" identified as appropriate for redistribution has never been able to achieve a critical mass necessary to make redistribution a reliable option for laboratories' chemical needs. Because the new chemicals are of a known availability and quality, they are much more popular with UVM laboratory workers.

Table 3: UVM ChemSource Deliveries

	2000 (XL baseline year)	2001	2002
New chemicals	440	503	854
Recycled chemicals	11	6	35

EPI #5: Laboratory Waste Generation Rates

Results to Date

The amounts of laboratory chemical waste disposed of over the course of the XL project are shown in Table 4. In 2002, this amount rose 59% over 2001. This increase is primarily attributed to laboratory clean-outs in late 2001 that were not shipped from UVM until January, 2002. These clean-outs were stimulated by the Vermont DEC/EPA inspection in October, 2001 and are probably a one time event.

Figure 1 shows the history of laboratory chemical waste generation at UVM, both in terms of the pounds of waste shipped from campus and the number of containers collected from campus labs (expressed in Figure 1 as the number of tags). Figure 1 also includes a chart of specific events related to the implementation of the EMP. The picture that emerges from this data is that the amount of chemical waste produced by UVM laboratories is generally related to specific events that motivate review of laboratory chemical inventories and culling of excess chemicals.

Lessons Learned

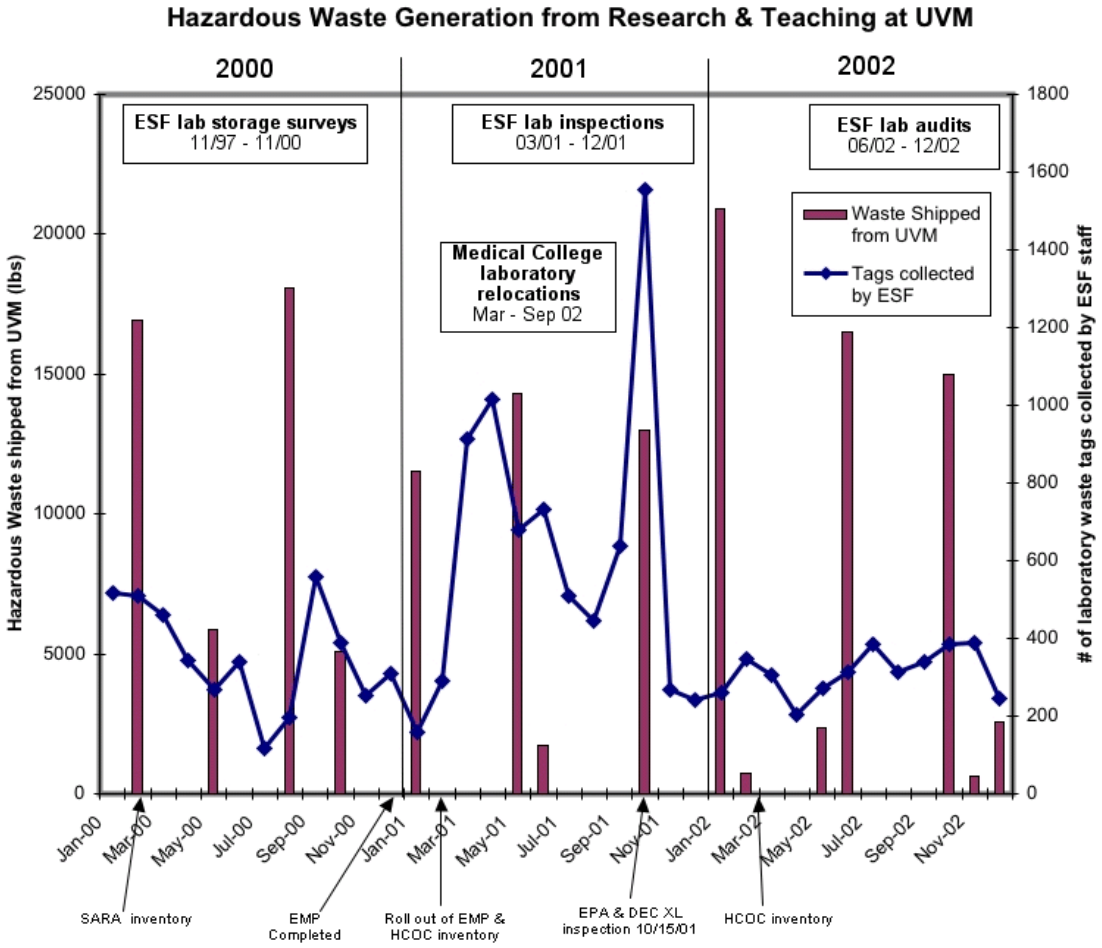
The ongoing lesson associated with EPI #5 is that the amount of chemical waste disposed of in a laboratory setting is controlled by a complex set of factors, which are not well understood at this time. Review of the disposal histories of a variety of institutions of higher education indicate that this number is not obviously related to any single operating parameter of the research enterprise, such as amount of research funding, laboratory population or square footage.

We believe that this is primarily because different types of research vary widely in how much they rely upon chemical products as they proceed. And as research projects progress, their reliance on chemical processes changes. Because the largest expense associated with research is the cost of the highly specialized labor necessary to carry out the research (well over 80% of the cost of research), careful management of the chemicals used in the process is a low priority at the laboratory level.

An important clue to interpreting this EPI could be development of a “normalization factor” that is able to account for changes in the level of research activity responsible for generating hazardous chemical waste. Such a factor is likely to be based on a variety of factors, including the type of research conducted at the institution, the rate of growth in teaching and research activities, and the level of central support for chemical inventory management. A more extensive study of this issue could provide important insights into understanding the value of this EPI and many other Environmental Indicators in the higher education sector.

Table 4: UVM Laboratory Waste Generation Trends			
	2000 (XL baseline year)	2001	2002
Lab Waste (pounds)	38,269	33,387	53,112
Change from previous year		-13%	59%
Cumulative change since 2000			39%

Figure 1:



EPI #6: Environmental Awareness Survey

Results to Date

The environmental awareness survey results are given in Table 5. The years shown include a pre-XL year for comparison, as well as the results for each of the three years the EMP was in place. The overall scores showed continued improvement in 2003 (5% increase in total score over 2002), although not of the magnitude of the 31% increase shown in the first year of the program.

The demographics of the population surveyed seem to be reasonably steady, with the dominant population surveyed full time laboratory technicians (58%). More demographic information about the people being reached by ESF outreach efforts can be found in the discussion of the next EPI. Close to 90% of the surveyed people reported that they had attended ESF training sessions.

Lessons Learned

Using an environmental awareness survey has proven to be an important feedback mechanism in the development of an effective EMP at UVM. The results of the survey have given us valuable information about the issues that require greater explanation during outreach efforts, as well as valuable information about who constitutes the laboratory population. It has given 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 that outreach. This tool has proven valuable enough that we will be instituting a similar survey related to laboratory worker health and safety issues to be used in parallel with the Environmental Awareness Survey in order to evaluate the effectiveness of these training efforts.

Table 5: Environmental Awareness Survey Results at UVM				
Question	2000 (pre-XL)	2001 (XL baseline)	2002	2003
1. Agency (%correct)	69	84	84	96
2. Lab Waste Disposal	26	47	32	50
3. Container Closed	46	61	61	59
4. Cost (%correct)	78	87	90	90
5. P2 Hierarchy	52	67	73	65
6. Mineral Acid Disposal	77	82	74	76
7. P-listed Waste (%correct)	31	57	58	65
8. Emergency Equipment	73	81	70	76
9. Waste Water (%correct)	72	82	87	84
10. Fume hoods (%correct)	38	51	55	59
11. Information	57	55	63	67
12. Environmental Impact	20	32	45	48
13. Label Information	17	39	38	33
14. Documents (%correct)	0	32	35	41
Total Score (% change from previous year)	656	857 +31%	865 +1%	909 +5%
15. Years in UVM labs (% 2 years or less)	28	47	41	45
16. Role (% lab techs)	56	42	59	58
17. Training (% attended)	0	86	96	87

EPI #7: Environmental Awareness Training

Results to Date

The number of UVM workers receiving chemical safety and environmental awareness training in 2002 was nearly the same as in 2001, which was more than twice that before EMP implementation. This ongoing success in outreach to the laboratory and support population is based primarily on support from the departments in organizing and managing worker attendance at the training sessions.

New data of interest this year are the trends in who is receiving the training. In 2001, as the EMP was being implemented, faculty represented 20% of the people receiving training. In 2002, the representation decreased, presumably because faculty represents the most stable proportion of the laboratory population. The proportion of students and non-lab staff who are receiving this training increased as the EMP began to reach further into the populations affected by laboratory practices.

Lessons Learned

The primary lesson learned with regard to the training program is the importance of departmental assistance in identifying people who need to be trained and encouraging them to attend training. The fact that we were able to maintain the level of training activity in 2002 associated with the initial roll out of the EMP indicates that departmental commitment to an ongoing training effort has been established.

This commitment has been encouraged by the ESF's development of innovative training methods, such as the "ESF Road Show", which provides refresher environmental awareness training to laboratory workers through interactive exhibits, rather than traditional "stand and deliver" training. It will be further assisted in 2003 as "CASEY" (the Computer Assisted Safety Engine), an electronic system for tracking safety training is rolled out to provide a tool for supervisors to manage their employees' training more effectively. CASEY is currently in the final stages of initial development and several campus users have begun to test its value in their operations. Early feedback is encouraging.

Table 6: Environmental Training for UVM Workers			
	2000	2001	2002
Total number of people trained	284	600	607
Demographic break down of lab workers attending training (data available for 2001 and 2002)			
Faculty		20%	10%
Lab Staff		38%	38%
Non Lab Staff		14%	20%
Students		28%	32%

EPI #8: Environmental Management Program Effectiveness

Results to Date

The 2002 UVM Progress Report established interim goals for each of the other EPI's for 2003 in order to better evaluate EPI #8 this year. All of these interim goals were met or exceeded, with the exception of EPI #5 (an increase of the amount of waste disposed of was seen instead of achieving an ongoing decrease of 10%), an EPI that was expected to be problematic for the reasons outlined in the discussion above. See the 2002 report and the discussion of each individual EPI for details of these goals.

Lessons Learned

This EPI demonstrates one of the important lessons of the Lab XL project: establishing nine Environmental Performance Indicators for the project resulted in diffusion of the implementation efforts in many directions. Thus while some EPI's showed significant improvement, others showed little. As the project proceeded and attention was able to shift from the "culture change" EPI's to the compliance and physical EPI's, those began to show improvement as well. See the attached article from the May, 2003 issue of Chemical Health and Safety for more details about this observation.

Based on this experience, we believe EPI's should be carefully selected and their number minimized. Moreover, the EPI's of interest may change with time as the Environmental Management Plan matures and its focus changes from achieving compliance to going "beyond compliance" to pollution prevention in its broadest sense.

This large number of EPI's in this project does not prevent the its data from being an important research tool; however, the dispersed effort does mean that it will take longer for all of the information necessary to come together in a meaningful way. This is an important reason for extending the life span of the project beyond its initial Final Project Agreement.

EPI #9: Environmental Management Plan Conformance

Results to Date

The average scores of the UVM Laboratory Audits are given in Table 7. The Campus Consortium for Environmental Excellence developed the system used to generate these scores in cooperation with the regulators involved in the XL project in order to more completely describe the progress observed in laboratory compliance with the Minimum Performance Criteria over the course of the project.

The scoring system has been in effect for two years of audits: the second year showed a 75% increase in the average overall score, with the largest increases in the housekeeping and pollution prevention categories. These large changes resulted from the emphasis placed on these issues in the 2002 round of laboratory audits.

The item of greatest concern for EPA compliance purposes is container management, the category that directly addresses the Minimum Performance Criteria for waste handling (labeling, container condition and closure, compatible storage, etc.). This category is showing the greatest success, with an average score of 1.9 out of a possible 2. Since this was the primary area of emphasis of earlier audit rounds, the continued high score in this category is an important sign of continued laboratory commitment to maintaining their performance.

Lessons Learned

One of the biggest challenges in implementing the laboratory audit program has been balancing the need for maintaining a ongoing schedule for the audits that will assure that the EMP goal of an annual visit with every lab is completed with following up to assure that corrective actions needed for the process are completed.

In order to facilitate the follow up portion of this balance, the ESF staff is working directly with the departmental or college office of the appropriate unit rather than the Chemical and Biological Safety Committee (CBSC) in following up on problem areas. While the CBSC was helpful in assessing whether participation in the Project XL made sense from a campuswide point of view and reviewing the Environmental Management Plan as it was developed, it does not work as well on issues that require timely follow up and action.

ESF staff has already establishing reporting lines with the College of Medicine, the Department of Chemistry and the Art Department to address compliance issues as they arise. Further work with the College of Agriculture and Life Sciences and other departments in the College of Arts and Sciences will be pursued this summer. The data provided by the laboratory compliance audits will prove useful in establishing these relationships and defining the relative roles of the ESF staff and the laboratory workers in the shared responsibility of laboratory health, safety and compliance work.

Long term, we are considering the possibility of developing a risk-based system for organizing the compliance audit visits. Many laboratory settings do not use chemicals whose hazards require annual visits; others may need to be visited more often. Again, the development of such a system will be based on the data collected in pursuit of this EPI.

Table 7: Trends in UVM Laboratory Audit Scores

	2001	2002	% change
Average total score (11 points possible)	2.9	5.1	76%
Housekeeping (3 points possible)	0.2	0.6	200%
Container Management (2 points possible)	1.4	1.9	36%
Training (2 points possible)	0.9	1.6	78%
Pollution Prevention (2 points possible)	0.4	1.4	250%
Self Inspections (2 points possible)	0	1.1	