Awareness of Hazardous Waste Management Recommendations in UC Berkeley Laboratories: Who Knows What?

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Introduction

Much of the research conducted on the University of California Berkeley (UCB) campus involves the use of chemicals with properties which are environmental and health hazards, and are therefore subject to legislation. In addition to these chemicals, termed hazardous substances under current laws, are some experimental byproducts which are classified as hazardous wastes (Knox, 1986). On the Berkeley campus, hazardous substances and wastes are found on laboratory premises and thereby pose a health hazard to labworkers. In addition, legislative requirements imposed on generators, transporters and storage facilities have driven the university's disposal costs to high levels and increased administrative responsibilities related to hazardous wastes. In the present circumstances it is clearly in the university's best interest to manage its waste properly, not only to avoid prohibitive future costs in terms of disposal fines but to protect its employees and the environment.

Labworkers are the primary users and producers of hazardous substances and therefore can exercise the most direct control in reducing the problems associated with waste. By ensuring that employees are familiar with good waste management procedures the university can simply and relatively inexpensively combat the waste problem. To facilitate this process, the UCB Office of Environmental Health and Safety supplies departments with pertinent waste management information, which is then to be made available to labworkers via a supervisor or written materials in the lab (EH&S, 1985d). A problem in the dissemination of this information is that it must travel through at least one intermediary (the department) to reach the labworkers, a situation which can significantly lessen the efficiency of the implementation of waste management policy. A conceivable scenario is that labworkers know less about the hazardous substances they work with than the managerial personnel of their department, who are at less risk. Therefore it is the goal of my project to analyze the extent of familiarity with recommended hazardous substance management procedures at the lower levels in the lab hierarchy. This is accomplished with a survey which was distributed to both labworkers and lab safety and waste coordinators addressing the waste management issues of

disposal, safety, storage, and waste minimization. Additional information was gathered through personal interviews.

Background

EH&S is required to provide hazardous waste information to campus personnel, develop waste disposal techniques and maintain and evaluate waste management activities on the UCB campus (Heyman, 1986) Although EH&S administers waste policy on campus, it is not a regulatory body and thus must rely on the cooperation of departments and labs to implement its recommendations. To get the assistance of labworkers EH&S has prepared several pamphlets containing guidelines for waste management activities including waste packaging and disposal, chemical storage, and emergency response. The recommendations of EH&S stem from state and federal legislation governing hazardous wastes, and in this report they have been used as standards for determining what aspects of waste handling labworkers should be familiar with.

Waste Disposal: In response to the manifesting program imposed by the federal Resource and Conservation Act (RCRA) EH&S has prepared written materials on hazardous waste disposal including a sheet on chemical waste packaging requirements, a chemical waste compatibility guide, waste packing lists, and an information pamphlet describing waste disposal procedures. EH&S recommends that a representative from each lab who is familiar with the required waste disposal procedures be designated as that lab's waste coordinator (EH&S, 1985c). In addition, EH&S urges departments to identify unknown substances prior to calling for disposal and supplies a written guide to waste characterization procedures. The characterizaton procedures consist of simple tests for chemical properties such as pH, flammability, corrosivity, and oxidizing capacity.

Waste Minimization: The minimization of waste at its source is stressed by RCRA, which requires that a report on the nature and quantity of hazardous wastes generated by the university be submitted to the EPA biennially (Knox, 1986). The federal Hazardous and Solid Waste Amendments (HSWA) of 1984 ruled that after September 1, 1985 the university's waste manifest should include certification that the volume of hazardous waste generated is reduced by using economically feasible techniques (EPA, 1985).

Storage: HSWA also requires that all hazardous substances and wastes be stored in a manner which minimizes risk to workers and the environment. In response, EH&S offers the manual "A Guide to the Safe Storage of Laboratory Chemicals" (1985). Also related to the storage of chemicals is Title III, Subtitle B of the federal Superfund Amendments and Reauthorization Act (SARA, 1986), which requires that a facility with hazardous substances on-site be able to provide an estimate of the types and both the daily and annual quantities present, and that the general location of these substances be known.

MSDS: California's Hazardous Substances and Information Act (HSITA) in conjunction with SARA provides for the safety of workers by requiring that Material Safety Data Sheets be obtained for each hazardous chemical on campus. An MSDS gives information about the chemical name and family, hazardous components, fire and explosion hazards, spill, leak and disposal procedures and other pertinent safety facts (EH&S, 1985d). HSITA, also known as the Right to Know Law, requires that appropriate MSDSs be available on-site (apparently the department office is sufficient) and EH&S has responded by requesting that departments acquire MSDSs from the manufacturer of any hazardous chemicals and that the sheets be used by labworkers.

Safety and Emergency: EH&S and campus departments cooperate to create training programs covering health hazards, personal safety equipment and emergency procedures. EH&S recommends that an individual in each lab should be aware of emergency response and reporting procedures, and that on-site training be provided to labworkers (EH&S, 1985b).

The Laboratory Hierarchy: To analyze the extent of familiarity with hazardous waste management in the UCB lab network it is necessary first to define a hierarchy with respect to information distribution and to define the constituents of these hierarchy groups. EH&S occupies the top of the waste information hierarchy since it is the source of information. At the second level is the department. Departmental representatives such as chairmen, safety committee heads and principal investigators constitute this hierarchy group, which is responsible for forwarding information to the third level of the hierarchy. This is the coordinator group, composed of the waste and safety coordinators from each lab. Among the duties of the coordinators is the training of the lowest level of the hierarchy, the labworkers. The labworker group generally is composed of graduate student or staff researchers.

Methodology

A questionnaire was developed to assess the coordinator and labworker groups' familiarity with waste management procedures. The questionnaire was generally given to coordinators who then distributed it to their labs. Interviews were conducted with some departmental representatives and all the coordinators, and the opinions and remarks expressed were incorporated into the analysis of the questionnaire results. Some respondents were reached in the Paleontology, Geology, and Forestry departments through contacts made by Doris Sloan, and some through the personal connections of the author, but the majority of respondents were chosen from a list of researchers who called EH&S for disposal services.

Each question on the survey refers to a legislative requirement or an EH&S recommendation mentioned in the Background section of this report. The questions are answered by checking the appropriate YES, NO, or DON'T KNOW box, and have been formulated such that the following assumptions apply: first, a response of YES is a positive response and indicates knowledge of a recommendation/requirement and success in compliance; second, a response of NO is a negative response and indicates knowledge of a recommendation/requirement but a lack of compliance (i.e., a disinclination or inability to comply); and third, a response of DON'T KNOW indicates a lack of knowledge of a recommendation/requirement and a possible lack of compliance by the respondent (although the lab as a whole may be in compliance). Structuring the questions in this fashion allows a distinction to be made between a failure to comply due to a lack of familiarity, and a failure to comply due to a disinclination or inability.

Procedure for Calculating Response Percentages: The following procedure was applied to coordinator and labworker groups separately:

1. Tabulate YES, NO, and DON'T KNOW responses to each question separately.
2. To find the percentage of positive responses, divide the number of YES responses by the total number of responses:

$$\frac{\text{YES}}{\text{YES} + \text{NO} + \text{DON'T KNOW}}$$

3. To find the percentage of negative responses due to a disinclination or inability to comply, divide the number of NO responses by the total number of responses:

$$\frac{\text{NO}}{\text{YES} + \text{NO} + \text{DON'T KNOW}}$$

4. To find the percentage of unfamiliarity, divide the number of DON'T KNOW responses by the total number of responses:

$$\frac{\text{DON'T KNOW}}{\text{YES} + \text{NO} + \text{DON'T KNOW}}$$

Data

This section enumerates the results of responses to the laboratory questionnaire (see Appendix for the text of the questionnaire). The data for the labworker hierarchy group and the coordinator groups are presented in Figures 1 and 2 respectively. The horizontal axes of the figures represent the numbered survey questions grouped into categories corresponding to Material Safety Data Sheets, waste handling, safety and emergency procedures, waste minimization, and storage procedures. The vertical axes indicate the percentages of YES, NO, and DON'T KNOW responses to each question.

The labworker group data presented in Figure 1 comes from a total of twenty-one respondents: eleven from the College of Chemistry, three from the Paleontology Department, three from the Immunology Department, two from the Geology Department, and one each from the Entomology and Molecular Biology departments. The coordinator group data shown in Figure 2 come from eight respondents: two from the Anatomy Department, two from the Genetics Department, two from the Microbiology Department, and one each from the Forestry and Geology departments. The average number of responses to each question is seventeen in the labworker group and about seven in the coordinator group. Due to the length of the lab questionnaire it is impractical to do more than highlight the major findings. The following results of the survey are particularly significant:

Q. 1. While 100 percent of coordinators are familiar with the MSDS, only 62 percent of labworkers claim familiarity.

Q. 3a. Sixty percent of coordinators, but only 35 percent of labworkers, knew that MSDSs were available on-site.

Q. 4. Only 52 percent of labworkers indicated knowledge of a designated waste coordinator for their lab.

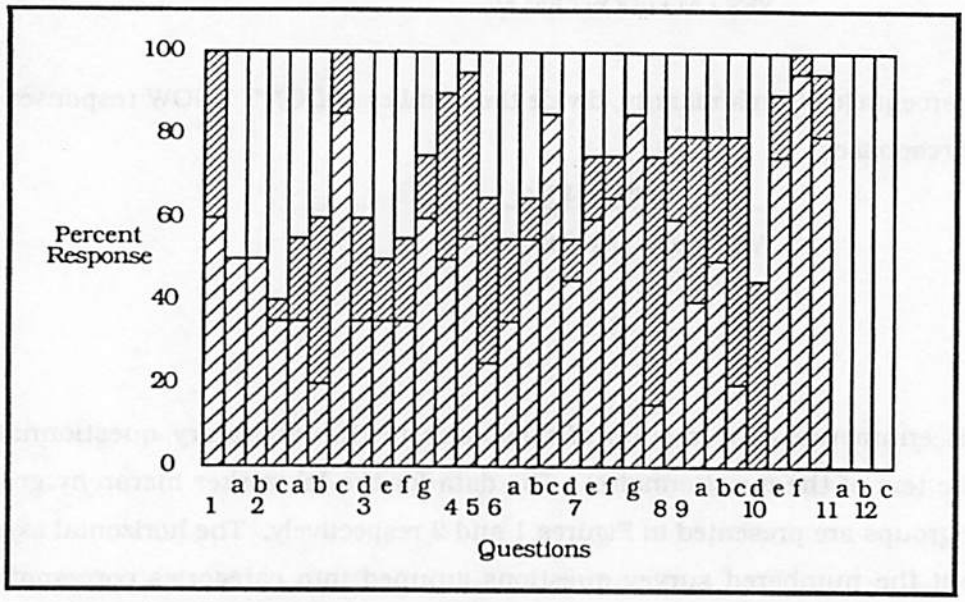

Figure 1: Labworker Responses

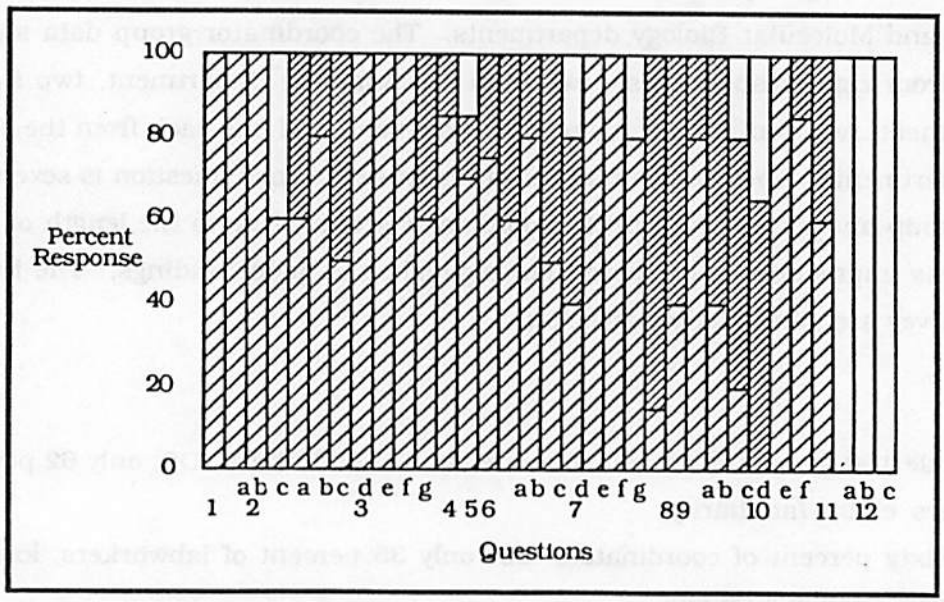

Figure 2: Coordinator Responses

Q. 5. Seventy-five percent of coordinators, but only 55 percent of labworkers, were aware of a designated area in the near vicinity of their lab set aside for the storage of wastes awaiting packaging or pickup.

Q. 6. While 75 percent of coordinators indicated that their lab had a written emergency plan, only 24 percent of labworkers were aware of one in their lab.

Q.7a. Thirty-six percent of labworkers reported that their labs had a designated emergency coordinator.

Q. 8. Only 13 percent of labworkers and 17 percent of coordinators said that a safety coordinator provides on-site training.

Q. 9. Sixty-three percent of labworkers and 40 percent of coordinators employed some form of waste minimization in their lab.

Q. 11. Eighty percent of labworkers and 60 percent of coordinators indicated that if an unknown substance is found in the lab attempts are made to identify it.

Discussion

Before analyzing the trends of the questionnaire responses, a qualifying statement about the nature of the polled coordinators and labworkers must be made. The survey does not represent a totally random cross-section of UCB labs because the procedure for selecting respondents contained a distinct bias in favor of labs having regular contact with EH&S. Many respondents were chosen from an EH&S disposal services log, therefore they are more likely to be well-informed than the hundreds of labs with minimal EH&S contact which were not surveyed in this report. As a consequence of this collection method, positive responses for familiarity with waste management may be higher than the actual campus-wide situation warrants. Second, the surveyed groups are not large enough to lend great accuracy to the percentages given.

The general trend relating the two hierarchy groups is that the coordinators have a substantially higher positive response and a greater familiarity with most subjects than do the labworkers. The labworkers' and the coordinators' results for the various waste management subjects will be discussed together to facilitate comparisons.

Waste Disposal and Storage: The system for waste disposal, though clearly outlined by EH&S and the College of Chemistry (Matteson, pers. comm.), is not operating ideally due to poor coordination at the laboratory level. Although some waste coordinators claimed that EH&S's

slowness in pick-up response often hampered their lab's disposal effort, EH&S's service has reportedly become prompter in the last year, and aside from that the pick-up delay can be avoided if labs call in a request a few days before they anticipate a critical quantity of wastes (Tabron, pers. comm.). The most outstanding deviation from the waste disposal procedures outlined by EH&S is the lack of a designated waste coordinator for each lab. Only 52 percent of labworkers indicated that there was a single waste coordinator for their lab; the remaining respondents either did not have a waste coordinator or the disposal procedure was a group responsibility. Some confusion arose among respondents over the definition of a lab since some felt that their lab was a specific room, others a research group composed of several rooms, and still others the entire floor of a building (Dutto, pers. comm.)--for practical purposes a building floor is too large to constitute a lab.

The delegation of waste disposal as a group responsibility does not appear to be an efficient technique, because in order for it to work *all* members of the lab must be familiar with waste handling and disposal information. The survey data show, however, that only 33 percent of labworkers had EH&S waste packaging requirements, waste compatibility guides, and packing lists available in their labs. Also, 50 percent of labworkers responded that they did not know if these materials were available on-site. Thus it is obvious that a group assigned to waste disposal in which only one-third of the members possess the knowledge to package waste correctly will not be efficient. In contrast, 100 percent of coordinators know that these EH&S requirements exist, pointing to the practicality of having a single waste coordinator per lab or lab group.

Another item requiring attention is the designation of an area in the lab or its vicinity for wastes awaiting pickup. Only 55 percent of labworkers and 75 percent of waste coordinators indicated that their lab has such an area. Often only chemicals in constant use are properly stored, while old chemicals are left unattended in any available lab space. Fume hoods often serve as a waste storage area (C. Chan; Larue, pers. comm.). In other cases, wastes are looked after by the labworkers who produced them, thereby spreading wastes over the entire lab and creating greater potential for a hazard. The lack of a specific area for waste storage in some labs may encourage labworkers to dispose of wastes through the garbage or the drain; this tendency is suggested by the result that 94 percent of labworkers and 88 percent of coordinators frequently dispose of dilute solutions through the drain. On the other hand, over half of the labworkers and coordinators responded that attempts are made to identify unknown substances that are found in the work area, a practice which reduces hazards in the lab and

possibly the EH&S workload.

Safety and Emergency: There is a significant gap between the safety awareness of labworkers and coordinators, which is due to the unavailability of existing safety information to labworkers. In the case of the MSDS, only 62 percent of labworkers--as compared to 100 percent of coordinators--knew what they were, and only 35 percent of labworkers and 60 percent of safety coordinators knew that they were available on-site (again, there was some ambiguity over the definition of on-site--some respondents indicated their lab and others the department office; apparently EH&S and OSHA consider the department office satisfactory (EH&S, 1985d)). The data suggest that the use of the MSDS by labworkers at UCB is inadequate, despite legislation requiring that the MSDS be available to ensure worker safety.

Some respondents made the point that unfamiliarity with the MSDS might arise because existing labels on chemical bottles are sufficient in providing the information that an MSDS contains (Brimhall, pers. comm.). Aside from the fact that labels are often illegible from use, the data reveal that labworkers do not know what types of information are contained in an MSDS. Fifty percent of labworkers did not know if an MSDS listed the chemical name and family, 55 percent did not know if health hazards are included, and 67 percent were unaware that spill, leak, and disposal procedures are covered. Safety information such as the last two categories mentioned are what sets an MSDS apart from a chemical label, yet labworkers and, surprisingly, safety coordinators (only 60 percent knew of spill procedures) are unaware of this. There may be a tendency among labworkers to regard the MSDS as a detailed chemical label. Among respondents who did use the MSDS there were complaints that health hazard standards and TLV values (used to indicate maximum safe exposure) were confusing and should be oriented more towards general usage (Lewis, pers. comm.).

In the area of emergency planning and response labworkers are again less informed than the coordinator group. When labworkers were asked if their lab had a written emergency plan only one-fourth responded that they did, one-third knew that they definitely did not, while 43 percent did not know. On the other hand, 75 percent of the coordinators claimed that their labs *did* have an emergency plan. Although the safety coordinators do not necessarily manage the labs from which the labworkers responses were collected, the results imply that labworkers are not being introduced to emergency plans which do exist.

Of those labworkers and coordinators who indicated that some forms of emergency precautions were available in the lab, the most ubiquitous--and luckily one of the most effective--was the hazardous waste emergency telephone list, which was available in 85 percent of labworkers' labs. Basic personal safety precautions such as the posting of safety signs, familiarity with showers and fire extinguishers, use of correct safety wear, and the availability of a first-aid manual were also commonly adhered to. Only 40 percent of coordinators and 45 percent of labworkers, however, were familiar with chemical spill response, which is unfortunate since a spill is the most probable accident in many labs. A more ominous result is the labworkers' low familiarity with fire and evacuation procedures--62 percent and 55 percent respectively--since knowledge of escape routes during a fire or earthquake can be the key to survival.

This state of unpreparedness may stem from depatmental negligence in establishing safety coordinators in the labs. Only one-third of labworkers indicated that their labs were assigned a safety coordinator and half responded that they were unaware of such an individual in their lab. Since it is the safety coordinator's responsibility to supply labworkers with relevant safety material, his absence severely limits the ability of a labworker to protect himself in an immediate emergency. Aside from the lack of safety coordinators, the labworkers' unfamiliarity with the specifics of an available emergency plan may be due to the fact that the departmental contingency plans (usually broad descriptions of general building emergency procedures and lists of response organizations) are frequently relied on to cover all aspects of emergency response. However, these do not include advice on hazards specific to each lab (Goolsby, pers. comm.) and thus relevant emergency information is not available to workers.

However, the lack of in-the-lab training by a safety coordinator is certainly the main reason why labworkers are not familiar with safety and lab emergency procedures; that only 13 percent of labworkers were aware of on-site training is a poor result. Several respondents also gave this opinion when interviewed (Boutler; Tabron; Whittaker, pers. comm.). As this discussion indicates, pertinent safety information is often unavailable, and the information which does exist is either incomplete or too often does not reach labworkers. Evidently there is insufficient interaction between the two lowest groups in the information hierarchy.

Waste Minimization: Since waste disposal, chemical storage, and lab safety are the prime concerns of EH&S, waste minimization procedures are not stressed as strongly in the

guidelines. However, waste minimization is not only required by law but is the most direct way to reduce environmental hazards and the university's disposal costs. The most common means of minimization--recycling--is employed by 50 percent of labworkers and 40 percent of coordinators. Although these seem to be low values, they are skewed because many of the labs polled did not use recyclable materials, which are mainly composed of solvents (Merriman, pers. comm.). Eighty percent of coordinators replied that their labs participate in chemical exchange with other labs and departments, yet labworkers were once again unaware of this system as only 40 percent responded positively. This recurring imformation gap between the two lowest heirarchy levels is inhibiting the efficiency of lab waste management.

Recommendations

To reduce the problems associated with waste management in UCB labs there needs to be more interaction between labworkers and coordinators. The high turnover rate of UCB employees makes it difficult to structure a cohesive lab group since many new arrivals are never informed of lab particulars. Therefore, on-site emergency training by a safety coordinator should be conducted annually to avoid the information gaps caused by the high turnover. This, in turn, requires an increased involvement by departments in ensuring that safety coordinators are permanently established in the lab or lab group. Departmental safety committees should appoint the safety coordinators, and extra incentives should be considered for these persons as their workload may be greatly increased by the added responsibilities of safety coordination.

Training programs should include a review of chemical storage (including compatibility classes and labeling methods), spill, fire, and earthquake response, evacuation routes, the use of personal safety wear, familiarization with air circulation in the lab, and descriptions of all chemicals and waste types used in the lab. The MSDSs for these chemicals should be explained to labworkers, stressing their use as a safety measure, and their location should also be made known (it might also be possible to reduce copies of the MSDS and attach them to the chemical bottles themselves). Also, every lab should have a "kitty-litter" type absorbent kit which can inexpensively control spills (Larue, pers. comm.). The emergency plan should be available in the lab. Finally, communication between labworkers and safety coordinators should be constantly maintained by conducting group meetings when new safety information or hazardous chemicals are introduced into the lab. Most of these suggestions are already part of EH&S policy, and they are very effective and easily implemented, yet their frequent absence

in UCB labs is a great hindrance to waste management.

The waste disposal program can similarly be greatly improved by adherence to the existing requirements, with some modifications. First, a *single* waste coordinator should be assigned to each lab or lab group; group responsibility should be avoided. To reduce inefficiencies further, when possible waste and safety coordinator's responsibilities should be assumed by one individual. Second, an area for wastes should be easily accessible to labworkers. A centralized storeroom could be used to coordinate several aspects of waste management. In the case of waste disposal, labworkers could bring hazardous wastes to the storeroom where they could be consolidated until EH&S pickup. Waste coordinators could either pack the wastes in the lab as usual, or to avoid increasing the chance of accidents there they could pack them in the storeroom if space permits. This would also ease the EH&S workload by decreasing the number of pickup locations.

As a means to facilitate waste exchange the storeroom could post a bulletin board listing available chemicals, in addition to serving as a storage area for these chemicals if space allows. In order for the exchange program to be effective, however, *waste coordinators must let the labworkers know that it exists during lab meetings.* Also pertaining to waste minimization is the review of large-quantity chemical purchasing by labs. Often 5-gallon drums are stored in labs without ever being used; it would be more practical to locate these drums in the storeroom and collect smaller quantities when needed. The problem of drain disposal needs to be addressed also (see Janine Young's paper in this report).

Although not a direct concern of labworkers, a computer program similar to NOAA'S (National Oceanic and Atmospheric Administration) CAMEO system could be useful in implementing a comprehensive campus-wide inventory and emergency response system. CAMEO (Computer Assisted Model for Emergency Operations) is a computer program which contains emergency response information such as diagrams of facilities indicating the locations and quantities of chemicals, and dispersion models for spill control (D. Chan, pers. comm.). This system could be acquired by EH&S to increase emergency response efficiency. Each coordinator could prepare a computer diskette which lists the hazardous chemicals in the lab and the usual quantities. For the purpose of an inventory system, which it is imperative that the university develop in order to cope with its own costs and the enforcement of applicable legislation (Bild, 1987), a list of all chemicals should be included. The inventory

itself could be conducted by the coordinators, though it is a lengthy process and might require a special inventory team which travels from lab to lab (see Inventory papers in this report). Emergency features specific to labs would also be detailed, and then the disk given to the departmental office where it is entered as a file with the other departmental--or building--labs. A great advantage of the computer file system is that it can be easily updated. Also, having this information on a computer system similar to CAMEO would allow outside agencies such as the fire department easier access to critical information and thus a faster response time in controlling emergencies. After having compiled this disk future safety coordinators and labworkers would have access to a clear, comprehensive overview of the lab safety situation.

In conclusion, UCB's waste management policy can be noticeably improved if the simple recommendations and requirements of EH&S are more strictly implemented by the coordinator group in the lab hierarchy. In addition, the more specific suggestions pertaining to emergency orientation, waste disposal and storage should be considered. It was not the intention of this report to analyze the interactions between EH&S and the campus departments because it appears that the transfer of information between these hierarchy levels is not nearly as great a problem as the implementation of this information in the labs. Though the departmental level is not as physically involved in waste management, it should not adopt the bureaucratic attitude of "passing the buck" to the lab, but should assume the responsibility designated to it by Chancellor Heyman (1986) and make stronger efforts to establish a thorough waste management policy.

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Appendix

Lab Questionnaire

Please indicate your lab, department and job title. Please check the pertinent answer to each question, and if there is any doubt answer DON'T KNOW. Any written response is appreciated.

Lab:_____Department:_____

JobTitle:_____

	YES	NO	DONT KNOW
1) Do you know what a Material Safety Data Sheet is?			

2) Are the following sections of an MSDS usually filled out:
   a. chemical name and family?
   b. health hazards?
   c. spill leak and disposal procedures?

3) Does the lab have the following written materials pertaining to hazardous wastes on-site:
   a. Material Safety Data Sheets?
   b. chemical compatibility guides?
   c. hazardous waste emergency telephone list?
   d. EH&S chemical waste packaging requirements?
   e. EH&S chemical waste compatibility guide?
   f. EH&S waste packing lists?
   g. first-aid manual?

4) Is there a designated employee in charge of waste packaging?

5) Is there a designated area in the lab or its close vicinity for wastes awaiting packaging or pickup?

6) Does the lab have a written emergency plan?

7) If an emergency plan of any form exists, does it include the following:
   a. designation of an emergency plan coordinator?
   b. lab evacuation procedures?
   c. familiarization with use and location of safety devices? (showers, fire extinguishers, vents, etc.)
   d. chemical spill response?
   e. fire response?
   f. use of correct safety wear?
   g. posting of safety signs? (No Smoking, Flammable Gas, Radioactive, etc.)

8) Does the emergency coordinator provide on-site training in any of the categories listed above? (Circle applicable categories)

9) Does the lab employ any waste-minimization procedures?

10) If so, do waste-minimization procedures include the following:
   a. chemical exchange between labs and other departments?
   b. chemical recycling? (solvents, metals, etc. Please specify)

	YES	NO	DONT KNOW
c. review and control of large-quantitiy chemical purchasing?			
d. use of waste-minimization devices? (Please specify)			
e. proper storage techniques?			
f. drain disposal of very dilute solutions? (Please specify)			

11) If an unknown substance is found in the lab are efforts made to identify it?

12) Does the lab have any system for keeping track of the following:*
   a. the type and annual quantity of all hazardous substances on-site?
   b. the general location of any hazardous substance on-site?
   c. who worked with a hazardous substance at any time?

13) Please approximate the monthly amounts of chemicals often disposed of through the drain:

* Question 12 is not applicable to the report because of vague wording.