A Comparative Analysis of Hazardous Waste Programs at U.C. Berkeley and Stanford University

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Introduction

In 1976 the Resource Conservation and Recovery Act (RCRA), an amendment to the Solid Waste Disposal Act , was passed by Congress to address a problem of enormous magnitude--how to dispose safely of the huge volumes of waste generated nation-wide. Within RCRA, Subtitle C was developed to ensure that mismanagement of hazardous waste does not continue. It defines a "generator" to include any facility owner or operator or person who first creates a hazardous waste (EPA, 1986). Under these laws, U.C. Berkeley becomes a hazardous waste generator. Hazardous waste is produced on campus by numerous sources. The two main contributors are teaching or research labs, and offices and maintenance facilities. The teaching and research labs contribute the majority of the waste, which consists mostly of inorganic and organic solvents. Offices and maintenance facilities produce waste items such as copier toner, liquid paper, paints, oils, fuels, cleaners, and degreasers.

In order to comply with RCRA and state and local laws, a hazardous waste management program (HWMP) at U.C. Berkeley was established under the Office of Environmental Health and Safety (EH&S). The program's main goals are to develop and carry out hazardous waste disposal procedures, provide orientation to campus personnel, monitor departmental waste operations, receive departmental waste and dispose of the waste legally, and evaluate all hazardous waste activities (Heyman, 1986).

Ever since RCRA was passed, regulations have been changing very rapidly. A chemical waste which once could be legally disposed of in a landfill may now be illegal to bury in the ground due to recent "land-ban" legislation (Armstrong, this report). Leaching chemicals that were buried legally many years ago are still the responsibility of the original generator. For this reason, "disposing of waste legally" is not enough; the environmental health impact on the future must be considered when making decisions in the area of hazardous waste. With this idea in mind, UC Berkeley should make every effort to improve its HWMP. One way to improve the UCB program is to look at other hazardous waste programs and adopt any good ideas or methods that would be applicable to the UC Berkeley HWMP.

Stanford University has recently spent a large amount of money, time, and effort renovating the Stanford EH&S (SEH&S) program. This report will look at Stanford's HWMP in an effort to find ways to improve UCB's HWMP. It will present both EH&S programs and emphasize the aspects of Stanford's program which exemplify ways to improve the HWMP at U.C. Berkeley. There have been no past studies comparing the HWMP's of the two universities.

Methodology

The data collected consist of two types: qualitative and quantitative. The majority of information is qualitative, describing the different aspects of the two hazardous waste programs; quantitative figures are included so that the magnitude of each program can be seen. Personnel and publications of Stanford University and U.C. Berkeley were the source of this information.

The hazardous waste program of each campus is described in a separate section. The data are structured so that parallels and differences between the programs can be seen. Data are presented under three sub-headings: 1) funding, 2) operational elements (staff, physical assets, educational methods), and 3) waste processing.

The discussion section compares Stanford's HWMP to Berkeley's HWMP and emphasizes certain aspects that might be applicable to the UCB program. The conclusion presents recommendations designed to improve UCB's hazardous waste management program.

The U.C. Berkeley Hazardous Waste Management Program

Funding: Funds to support the EH&S program come from the UCB's overall budget and are allocated by the Vice Chancellor of Business and Administrative Services. Funds are not directly connected by fees to the people or departments producing the hazardous waste. The Office of the Vice Chancellor has made a great effort to provide the UC Berkeley HWMP with funds during the last five years; the 1987-88 budget for the entire chemical hazardous waste program was about $330,000. This includes money for salaries, training, facility maintenance and improvement, vehicle fees, lab costs, hazcatting materials (materials used in categorizing unknown hazardous waste), waste disposal, taxes and licensing, and any additional costs. The 1987-88 funds originated as a refund from an overpayment for utilities. The budget next year will be at least as large, but the source of funds for the future is uncertain (Belk, pers. comm; 1987).

Operational elements: The hazardous waste program is managed by four full-time and one half-time employees: two have bachelor degrees (the supervisor and a technician), one has many years of experience (a technician), and one has a hazardous waste certificate from U.C. Davis (a technician). The facilities are located in three separate areas on or near the campus.

In the Berkeley Hills is the packaging and storage facility, known as the "Acid House". It consists of a room (about 750 square feet) for lab-packing hazardous waste, with a few storage cabinets for incompatible materials. Outside the Acid House are three sheds which are used to store additional waste materials. There is also a self-contained storage tank designed to collect any hazardous waste in the event of spill.

The administrative offices for EH&S are housed on campus in the U.C. Berkeley Extension building, on the fourth floor. In addition, the HWMP has access to three labs at Cowell Hospital: an asbestos detection lab, a respiratory training lab, and a radioactive isotope detection lab. The program owns two vans for transporting waste materials on campus, which are registered with the California Highway Patrol and meet all requirements for hazardous waste transportation (Belk, pers. comm; 1987).

The education process is decentralized and is the responsibility of individual departments. At this time no consistent method is used to educate all the generators of hazardous waste on campus. Flyers and pamphlets are available through EH&S but emphasis on the importance of compliance with the recommended procedures is left to the individual departments. EH&S does offer some training programs and educational materials on chemical hazards and other safety hazards (EH&S, 1985), but training is only provided as requested and is not mandatory.

Waste processing: The actual processing of hazardous waste starts at the source of generation--usually in a lab or in an office. Once there is enough waste to package, it should be correctly labeled and placed into boxes with compatible wastes. After an inventory of the box is complete and given to the department, EH&S technicians will pick up the waste and transport it, by van, to the Acid House. This method is sometimes a problem because boxes can be hard to find and inventories cannot be labeled with chemical formulas; the chemical name must be written out. Also, packaging and transporting the waste to the department transfer location is time-consuming . Many labs have stored large quantities of hazardous waste unsafely because of the time involved to transfer their waste to EH&S (Lubelle, pers. comm; 1987).

Once at the Acid House, the chemical is stored until it can be "lab packed." Low-level radioactive material is set aside to decay for an appropriate time. After being lab-packed, approximately 60 percent of the waste is sent to landfills and 40 percent is sent out for incineration. UC Berkeley produced about 29 tons of hazardous waste in the 1986-1987 fiscal year. An average of from 35 to 47 barrels a month are sent out for disposal (Belk, pers. comm; 1987). Bulk solvents are sent to Romic Chemicals for incineration, PCBs are sent to the Kettleman City landfill, and lab-packed drums are sent to various landfills. In 1986-1987 115 five-gallon barrels and 303 fifty-five gallon barrels were sent to landfills. Currently only waste oil and some mercury are recycled.

The Stanford University Hazardous Waste Program

Funding: Each individual researcher is charged a user fee for the services provided by the SEH&S office. The user fee is part of a larger fee which each researcher pays for laboratory space and equipment. This money goes into the Stanford overall budget which, in turn, pays for the SHWMP. The budget is about $550,000 for just the chemical waste system. This covers salaries (about $150,000), waste disposal (about $250,000), and taxes, fees, and any additional costs.

Operational elements: The Stanford HWMP staff consists of 7.5 full-time equivalent positions; 2 managers, 5 technicians and a half-time secretary. All of the employees have at least a bachelors degree in a field related to their specific job. Stanford will soon be adding a chemist and two more chemical waste technicians (Chock, pers. comm; 1987). A $9,000,000 facility was recently built for SEH&S (Figure 1). The facility consists of three one-story buildings that house offices; counting, analytical, and wet-chemistry laboratories; a classroom training center; and neutralization, storage, and consolidation waste-handling systems. The facility also has separate areas for handling of biological, chemical, and low-level radioactive materials. A double-chamber, high-temperature incinerator completely oxidizes and consumes wastes that can be safely incinerated. A neutralization system

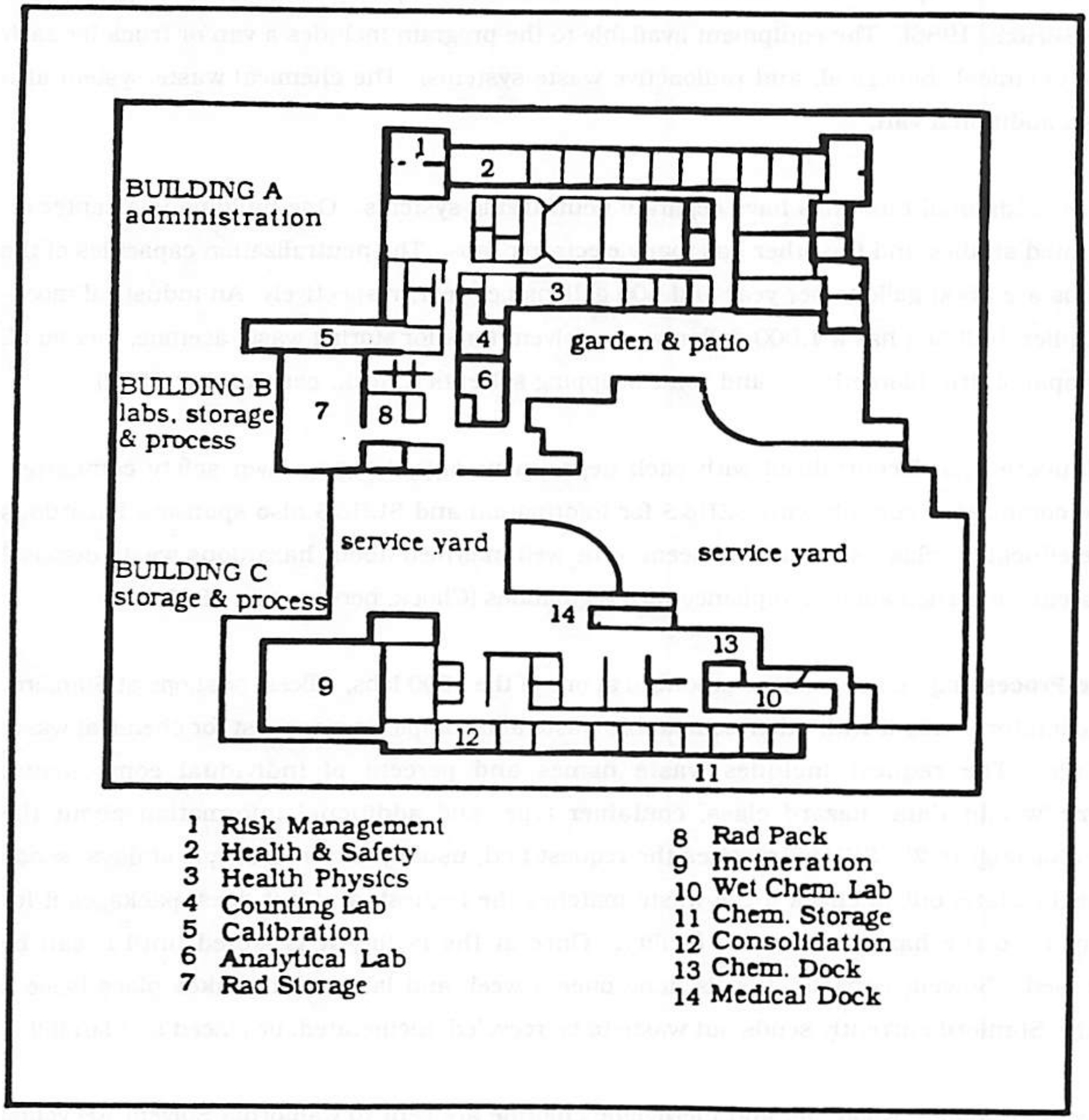

Figure 1. The Stanford Environmental Health and Safety Facility

Facility map adapted from Stanford Environmental Health and Safety ,1986.

processes and disposes of sewerable acids and bases at a capacity of about 1,000 gallons per year (SEH&S, 1986). The equipment available to the program includes a van or truck for each of the chemical, biological, and radioactive waste systems. The chemical waste system also has an additional van.

Two additional buildings have separate neutralizing systems. One building is a center for integrated studies and the other has many electronic labs. The neutralization capacities of the systems are 3600 gallons per year and 600 gallons per year, respectively. An industrial mock-up studies' building has a 1,000-gallon waste solvent tank for storing waste acetone, methanol, iso-propanol, tri-chloroethane, and some stripping solvents (Chock, pers. comm; 1987).

Education is decentralized with each department organizing its own safety committee. These committees consult with SEH&S for information and SEH&S also sponsors hazardous waste education classes. Students seem to be well informed about hazardous waste disposal and seem concerned about compliance with regulations (Chock, pers. comm; 1987).

Waste Processing: Once waste is produced at one of the 1500 labs, offices, or shops at Stanford, the generator stores it with other compatible waste and completes a request for chemical waste pick-up. The request includes waste names and percent of individual components, volume/weight data, hazard class, container type, and additional information about the generator (Figure 2). SEH&S receives the request and, usually within a couple of days, sends two technicians out to check if the waste matches the request, and if it does, packages it for transport to the hazardous waste facility. Once at the facility it is stored until it can be processed. Solvent consolidation is done once a week and lab-packing takes place twice a month. Stanford currently sends out waste to be recycled, incinerated, or placed in a landfill.

Xylene/alcohol, waste oil, and methylene chloride are sent to California Solvent Recycling Corporation for recycling. Recycling costs $120/drum (plus the drum and DOT stickers). A recycling facility is in the process of being designed at Stanford and will help recycle solvents and also reduce toxicity of certain chemicals. Some recycled solvents will be used as cleaners and degreasers.

In-state incineration starts at $145/drum (plus the drum and DOT stickers) for solvents with less than 15 percent halogenation; prices increase with the percentage of halogenation. Aeromatics are sent to Arkansas for incineration and other wastes are incinerated where

* REQUEST FOR CHEMICAL WASTE PICKUP *

Requested By: John Doe Phone: 3-9876

Department: Chemistry

Building: Stauffer II Room: 567

Account No: 7-ABC-123-45678 Date: 1/15/87

Send To:
Chemical Waste Program
ESF, Mailstop 8007

Phone: 723-4767 ,-5075

* Container Type
C = Paper Carton, Box
P = Plastic Bottle
G = Glass Bottle
M = Metal Can
B = Plastic bag (must be double-bagged)

Volume/weight
Ml.
Liter
Gal.
Gm.
Kg.
Lb. , etc.

\+ Hazard Class
C = Corrosive
F = Flammable
W = Water-Reactive
T = Toxic
O = Oxidizer

Item No.	Contents Use full chemical name(s). List **all** components (and their %'s) of mixtures.	* Container Type C	P	G	M	B	# Volume/ Weight	+ Hazard Class C	F	W	T	O
1.	Nitric Acid			X			1 x 5 pt.	X				X
2.	alpha-Naphthylamine			X			1 x 1 pt.				X	
3.	Xylene			X			5 x 1 gal		X			
4.	Non-chlorinated mixed waste solvents (Benzene 25% + Acetone 75%)				X		1 x 55 gal		X			
5.	Labware (wipes, gloves, etc.) contaminated with Acrylonitrile	X					3 Ft.^{3}				X	
6.	Asbestos					X	100 gm.				X	
7.												
8.												
9.												
10.												
11.												
12.												

(Form BHS-101) (07/87)

Figure 2. Request For Chemical Waste Pickup .

This is Stanford's form to request chemical waste pickup.

possible. Out-of-state incineration is about $380 per barrel of bulk solvent (mostly heavy halogenated liquids and some toxic materials) and $1,000 per barrel of lab-packed material (mostly flammables and some corrosives). These prices do not include the cost of the drum, DOT stickers, or transportation. The incinerator at Stanford currently incinerates only biological and some low-level radioactive hazardous waste; however, they hope to be able to incinerate chemical hazardous waste in the future if a permit is issued to the Stanford facility. Unfortunately, the state permitting process is not well defined and before a permit is issued many tests are required. Stanford expects testing to cost between $100,000 and 200,000.

Stanford's HWMP landfills only solids: asbestos, spill cleanup absorbent, organic/inorganic solids, some heavy metals, and dry materials contaminated with chemicals (crushed empty bottles, etc). Stanford ships approximately 60 barrels per month for disposal (15 for bulk recycling and bulk incineration, 30 for lab pack incineration, and 15 for landfill). According to Harvey Chock, Stanford's chemical and hazardous waste disposal manager, illegal disposal of wastes, by dumping, is believed to be at most one to five percent of the total produced. Local water and sewer companies have never complained to Stanford about any problems associated with hazardous waste in the University's effluent (Chock, pers. comm; 1987).

Discussion

There are many similarities and some differences between the Stanford and Berkeley hazardous waste management programs. By analyzing some of these similarities and differences, ideas and methods may be seen that could improve the Berkeley HWMP.

The funding for each EH&S program comes from its respective university's overall budget. However, Stanford charges generators of hazardous waste a fee to support their HWMP. This fee seems to be an incentive for researchers to become more aware of services offered by the program and to use the SHWMP since they are already paying for the service. Berkeley researchers are not directly connected to the BHWMP by any fee structure, and may have less incentive to become fully aware of the services offered because of the time commitment needed to be well informed.

The SHWMP is larger than the BHWMP even though UC Berkeley has a much larger student body and produces more hazardous waste than Stanford. The SHWMP has three more full-time employees than does the BHWMP. The SHWMP also has a facility that is much more extensive than the UC Berkeley facility: a $9,000,000 facility compared to the small Acid House. The Stanford facility meets legal requirements for storage of hazardous waste, is permitted to do neutralization, and is in the process of getting a permit to recycle bulk solvents. Stanford also has three buildings with additional neutralization or storage capabilities. The Berkeley facility is inadequate because it is too small to handle the current volume of hazardous waste legally. The Acid House is cramped for room and chemical and radioactive wastes are not separated by a wall. UCB currently is not a permitted waste treatment facility.

There are two main differences in waste processing between the two campuses. The first is the method of waste pick-up and the second is the methods of waste disposal. Waste pick-up at Stanford is done completely by SEH&S. They come into the lab within a couple of days after receiving a waste pick-up request and check labeling and the inventory, package the waste in compatible groups, and then transport the waste to the facility for disposal preparation. The process at UCB is similar except that lab personnel must package the waste themselves into compatible groups and store it until they can transfer it to a departmental storage area. This sometimes causes problems because of the time needed by the researcher to package and transport the waste. Department waste storage areas sometimes accumulate improperly labelled wastes whose origin may be difficult to determine.

The second difference in waste processing between the two universities is waste disposal methods. Both campuses use three methods of disposal: recycling, incineration, and landfill. Berkeley currently produces about 25 tons per year more of hazardous waste than does Stanford. The difference in waste disposal methods lies in the percentage of hazardous waste placed in landfills. Berkeley sends about 40 percent of its chemical hazardous waste to landfills while Stanford only sends about 20 percent of its chemical hazardous waste to a landfill. Stanford has committed itself to using a wider array of techniques to reduce its waste disposal requirements, including recycling and neutralization.

Conclusion

The UC Berkeley Administration has improved its hazardous waste management program in the past few years. The Office of EH&S, the hazardous waste management Committee, many members of the faculty, and students are actively trying to develop new approaches to waste treatment and disposal which will lead to safe working conditions on campus and an unpolluted environment. The administration should encourage these efforts and support their implementation financially. UCB can improve its HWMP by adopting some of the procedures used by Stanford in the area of hazardous waste management.

A direct or indirect connection between the generators of hazardous waste and the funds to support the UCB HWMP should be implemented. Researchers will take the time to be more aware of the program if they are financially connected to it.

A financial commitment needs to be made by the University to build a new hazardous waste facility that can legally handle the amount of waste produced by the campus. The problems associated with locating a new facility need to be overcome and permitting for treatment of certain wastes should be acquired (neutralization and recycling). UCB also needs to consider the possibility of on-site incineration. The University also should make a financial commitment to increase the HWMP staff. This would permit researchers to spend more time doing research instead of packaging and transporting wastes.

The most significant improvement UC Berkeley can make is to send less waste to landfills. Until alternative methods of disposal are feasible, off-site incineration or recycling should be used as much as possible, while waste sent landfills is decreased. Under the Superfund program, UC Berkeley is responsible for any landfill site that they have contributed to that releases or threatens to release hazardous substances. Every time it puts a barrel in a landfill, UCB increases the amount of material it is liable for. This could be very expensive for the University in years to come. Not only is the financial responsibility a problem, but the environmental impact of burying barrels (that will eventually leak) in the ground is enormous: it threatens the environment and human health.

References

Belk, David, Hazardous Waste Manager, Office of Environmental Health and Safety, U.C. Berkeley. Personal communication, 26 September,1987.

Chock, Harvey, Health and Safety Specialist, Environmental Health and Safety, Stanford University. Personal communication, 23 November, 1987.

Environmental Protection Agency, 1986. *RCRA orientation manual.* Washington D.C., U.S. Government printing Office,168p.

Heyman, Ira Michael, Chancellor, University of California Berkeley. Letter to deans, directors, department chairs, and administration officers, 17 March,1986.

Lubelle, Bill, Graduate Student, Chemistry Department, U.C. Berkeley. Personal communication, November, 1987.

Office of Environmental Health and Safety,UCB 1985. *Working safely with hazardous substances*, pamphlet, 42p.

_____, 1986. *A guide to the safe storage of laboratory chemicals*, pamphlet, 31p.

Stanford Environmental Health and Safety, 1986. *Managing risk at Stanford*, pamphlet, 7p.