Inventory and Storage of Hazardous Substances in Shops and Photolabs

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Introduction

Accurate inventory of hazardous substances is important to maintaining a safe working environment. Most obviously, an inventory provides a record of stock so that one knows when to order and when not to order to keep stock at a minimal level. Also, U. C. Berkeley's Office of Environmental Health and Safety (EH&S) needs to know inventories in order to monitor disposal practices properly (see Fleming, this report). Lastly, inventories help emergency responders know the contents of each room so that they can respond in the best way to an emergency. For these reasons, many other schools and businesses are required to maintain inventories, and it is only a matter of time before the U.C. campuses will need to keep inventories as well.

Inventory of shops and photolabs is different from the inventory of most other laboratories because the substances used, stored, and disposed of are not pure chemical reagents but commercial products. However, they are still potentially dangerous and should be inventoried and stored as such. This report presents the classes and amounts of hazardous substances in various types of shops and photolabs in two departments on the U.C. Berkeley campus and addresses the problems of inventory and storage in these environments.

Past Studies

Two useful pamphlets, *A Guide to the Safe Storage of Laboratory Chemicals* (EH&S, 1986), and *Working Safely with Hazardous Substances: A Handbook for Employees* (EH&S, 1985) give storage guidelines, chemical compatibilities, inventory guidelines, first aid advice, and references to more specific publications, laws and regulations. A good book that contains this kind of general information has been published by the National Research Council (NRC,1983). A good safety guide for school laboratories is *School Science Laboratories: A guide to Some Hazardous Substances* (CSSS, 1984), which provides storage guidelines, chemical properties

and compatibilities, and inventory guidelines. *Health Hazards Manual for Artists* (McCann, 1985) addresses some of the hazards of photography and metalworking. Although I have found no studies specifically of inventory and storage of hazardous substances on the U.C. Berkeley campus, Jolly (1983) includes data on chemicals commonly used in laboratories.

Hazard Classes

The substances inventoried in this study are grouped according to the following hazard classes defined in the Introduction to the Inventory Section: flammables, oxidizers, corrosives, and toxics. In addition to these, four others are relevant to my study:

1. Carcinogens - substances that are possible or probable causes of human cancer.
2. Irritants - materials which irritate the skin, eyes, membranes, or lungs. May be slightly toxic or corrosive.
3. Other - materials that do not adequately fit in any other class but are still hazardous according to the Department of Transportation (CFR 49).
4. Unidentified - materials whose hazard classes could not be easily identified.

Methodology

An inventory sheet, questionnaire, checklist and basic methodology were designed in collaboration with other class members doing inventories. The basic methodology was to contact people in charge of shops and photolabs who were interested in having an inventory, ask them a few questions, and then inventory the hazardous substances using the inventory sheet. Most labs and shops took about half an hour to inventory, but those with a lot of commercial products took up to one and one half hour because I had to inspect the labels for ingredients. Later, approximately twenty hours were spent using CFR 49, Sax (1975), and CSSS (1984) to identify the hazard classes of the substances inventoried. The introduction to the inventory section and the Appendix give a more detailed description of each of these steps.

Although ideally two people should do the inventory, I did not always have another person help me. The shops and photolabs that I inventoried alone did not contain many chemicals, and people working in the labs could have helped me had an emergency occurred.

Sometimes I had to guess at the amount of a substance because it was not given on the container. However, small errors in judgement are insignificant considering the error

introduced in converting all quantities to gallons and pounds for data presentation. I chose to convert to English units because most labels still used these.

I usually did not record the manufacturer of chemical reagents because it was time-consuming and pointless for my purposes, but I did record it for commercial products. Whereas reagents are basically the same regardless of the manufacturer, different manufacturers have different formulations for similar commercial products.

Data

Some problems are common to all shops and photolabs I investigated. None of the shops or labs have an inventory system. None of the shelves have rim guards. There are no posted guides to chemical incompatibilities or chemical disposal. There are very few dates on the labels. None of the shops and labs have a systematic approach to separating chemicals of different hazard classes. None of the shops and labs have spill clean-up material or fire extinguishers, although extinguishers are in the hallways. None of the photolabs recover the silver waste because of the low volume use.

Shop #1: The shop contains moderate amounts of flammables, compressed gasses, corrosives, irritants, toxics, and carcinogens (Table 1). Most of the substances are products such as soldering fluxes, adhesives, sealants, cleaners and lubricants that contain a mixture of chemicals. Sometimes the labels specify precautions and list hazardous ingredients.

The shop normally would have many more flammable solvents, but because it had just been inspected by the Fire Marshall, the excess solvents were disposed of through Environmental Health and Safety (EH&S). In the future the shop will have a special cabinet for the storage of flammables.

Most materials are stored in cabinets with doors, although one shelf has no doors or rim guards. The fume hood has a sign stating that no hazardous materials are to be stored there, but contained one small cylinder of a nonflammable gas.

The aisles are clear, and there is an eyewash and shower. Since many items are stored near the area of use, the lead solder and fluxes are near a heat source. This is far away from the flammable liquids.

	SHOP #1		SHOP #2		SHOP #3		SHOP #4	
	GAL.	LBS.	GAL.	LBS.	GAL.	LBS.	GAL.	LBS.
FLAMMABLES	2.25	3	3.5	4	–	4	16.5	1.25
OXIDIZERS	–	–	0.13	–	–	–	–	6.25
CORROSIVES	0.75	6	0.5	3	–	–	0.25	12.75
TOXICS	1.75	–	0.5	–	–	–	0.75	4
CARCINOGENS	3	–	–	–	–	–	0.25	1.25
IRRITANTS	0.5	5	trace	–	–	–	–	–
OTHERS	–	–	–	–	–	–	–	4
UNIDENTIFIED	3.7	8.6	0.65	–	5.2	0.25	1.5	6.7

Table 1. Amounts of hazardous substances in the shops by hazard class.

Shop #2: The products in this shop are for cleaning and preparing samples. Chemical reagents, immersion oils, and commercial products such as lacquers, adhesives, and cleaners are stored. These are flammables, oxidizers, corrosives, irritants and toxics (Table 1).

The shop/office is extremely small, and not everything is stored in a cabinet. The flammables are stored in a box under a shelf and lacquers and adhesive aerosols are stored precariously atop cabinets and piles of papers. The aisles are crowded, there is no eyewash or shower, and there is no fume hood.

The majority of the immersion oils have no contents on the label, only an index number. I inventoried the only box that had the contents on the bottles. The others are probably mixtures of these and other substances that remain unknown.

Shop #3: This shop has only a small amount of flammable material and a container of high voltage transformer oil, possibly containing polychlorinated biphenyls (PCBs, Table 1). Most of the materials are commercial aerosol paints and adhesives. These are stored in a cabinet with doors. The aisles are clear and the shelves are tidy. There is no eyewash or shower.

Shop #4: In contrast with the other shops, this shop has a lot of chemical reagents, mostly inorganic solids. There is also a large quantity of flammable liquids, as well as oxidizers, corrosives, toxics, irritants, carcinogens, and other materials (Table 1).

The storage areas are not labelled but are partially organized by hazard class. There are still some incompatible chemicals stored near each other. The shelves are stable and tidy with doors. Some items are stored in the fume hood. Many chemicals appear to be old. One is dated 1964.

The chemicals are stored away from heat sources, the aisles are clear, and there is an eyewash and shower.

Photolab #1: This darkroom has mixed solutions of developer and fixer. These are in bottles with labels that may mean something to the people who use the lab, but gave me no indication

of the contents or the type or brand of developer and fixer. Because such substances are generally corrosive, I classed them as such (Table 2), but they may be toxic as well.

Although I did not inventory wastes, waste chemicals stored on the floor under the counter awaiting pick-up by EH&S were pointed out. I was told that nothing goes down the drain. Smoking is permitted in the lab. There is no eyewash or shower.

Photolab #2: This photolab has a variety of developers, fixers, stop baths, and other photochemicals that are mostly corrosive, with small amounts of flammables and oxidizers (Table 2). There are some well-labelled bottles of solutions already made up, but most of the chemicals are still in their packages in concentrate. These are all in a low cabinet with doors. There is a flammable substance in this same cabinet with an oxidizer. There is no eyewash or shower.

Photolab #3: The chemicals for this copy camera lab are activators and developers that are corrosive (Table 2). These are still in the manufacturers' containers and most have good labels with hazardous ingredients listed. I found two bottles without labels. Two items are stored on an open shelf, and everything else is in a cabinet with doors. There is no eyewash or shower.

	PHOTOLAB #1		PHOTOLAB #2		PHOTOLAB #3	
	GAL.	LBS.	GAL.	LBS.	GAL.	LBS.
FLAMMABLES	–	–	trace	–	–	–
OXIDIZERS	–	–	–	0.25	–	–
CORROSIVES	6	–	1	7.5	3.5	–
UNIDENTIFIED	–	–	0.13	5.13	7	–

Table 2. Amounts of hazardous substances in the photolabs by hazard class.

Discussion

The shops and photolabs inventoried for this report are basically safe, much more so than the other labs and storage areas I helped to inventory. However, hazards are not always obvious. They may be sitting in unlabelled bottles, or hidden behind the secure front of a famous brand name. The biggest hazard I saw was the lack of preparedness for an accident or disaster. Some rooms did not have eyewashes and none had spill clean-up supplies. When one is storing chemicals, there should be concern for seismic safety. Shelves should have raised guards to reduce the possibility of chemicals falling off of shelves. It would be disastrous if an earthquake knocked the chemicals off their shelves and the incompatible chemicals mixed.

Except for the 16.5 gallons of flammable liquid in Shop #4 (Table 1), no large quantities of hazardous substances are stored in the shops and photolabs. However, this does not accurately reflect the potential hazards of different chemicals. Some may be extremely dangerous even in small quantities. Others may not be hazardous when stored, but only when in use. For example, when heated, fluoride soldering fluxes emit fluoride fumes that form hydrofluoric acid in the lungs (McCann, 1985). These differences in toxicity make it difficult to assess hazards solely in terms of the quantities listed on the tables.

The labels on many of the chemicals could be improved. Items that are highly hazardous or carcinogenic should always be labelled as such. If these also had dates on the label, it might become apparent that they are seldom used and should be disposed of or purchased in smaller quantities.

Although most of the storage areas were neat, the disorder in one shop made the inventory process difficult and increased the chance of an accidental spill. It was hard to find all of the hazardous chemicals when they were crowded in with other items in the cabinets or spread throughout the room among papers and samples.

It is not advisable to smoke cigarettes in the same room where chemicals are stored. This is not only because there is a danger of igniting flammable materials, but because there is a danger of ingesting toxic chemicals passed from the hands to the cigarette.

The inventory system worked well, but I recommend some changes to the inventory sheet used (see Appendix B). The type of container is not usually important information, and if it is, such as an aerosol or compressed gas cylinder, it can be specified in the notes. This would leave

more room to write the container size. For use in the shops and photolabs or other labs that use a lot of commercial products, I would keep the manufacturer column in case information or a Material Safety Data Sheet (MSDS), which provides the properties of hazardous materials, needs to be obtained. It would be better if the manufacturer column came before the chemical name so that the product name could be listed before each constituent (Figure 1).

MANUFACTURER	CHEMICAL
Kodak Rapid Fixer	sulfuric acid boric acid
Kodak Stop Bath	acetic acid

Figure 1. An example of how to list the constituents of a product showing that it is better to list the manufacturer first (see text).

Unless the University can make the process of looking up hazard classes less time-consuming, there will probably be little compliance with an inventory policy. The University has several approaches it could take to solve this problem. One would be to hire a team of people to do the initial inventories. With each inventory, experience would be gained that could reduce the time spent on subsequent inventories. This would also minimize the inconvenience to the heads of labs. It would also be helpful to have a library room at EH&S where all necessary references and a collection of MSDS's were available. The University could also look into purchasing or creating a computer program like the National Oceanic and Atmospheric Administration's (NOAA) CAMEO program. This was developed by the Hazardous Materials Response Branch (HAZMAT) and has a database of chemical names , synonyms, and hazard classes (Chan, 1988, pers. comm.).

Conclusions

Inventories of hazardous chemicals would make the people working in the shops and photolabs more aware of the hazards of the substances they use. They could easily check that they have MSDS's for all the chemical products. An inventory of hazards would make it easier to dispose of chemicals through EH&S because if the hazard class is not obvious, it can be

identified from the inventory record, and the material can be packaged for disposal accordingly. Access to hazard class information could be valuable for emergency response as well, because the inventory shows where the hazards are located in the labs. The hazard class information could also illuminate chemical incompatibilities and a safer storage plan could be devised.

Requiring shops and photolabs to keep inventories would create a few hours of work to begin with, but, as noted in the Discussion, there are ways to minimize the time and inconvenience to laboratory personnel. Once the initial inventory is completed, keeping the inventory updated would take little effort. I noticed computers in most of the shops, which would make record-keeping fast and simple.

The main obstacle to having a good storage system in which chemicals are separated by hazard classes is the lack of space in many shops and photolabs, and the necessity of some materials to be near the area where they are used. However, even if there is only one cabinet in the shop or in the area of use, it can be divided into sections so that the chance of incompatible chemicals is reduced.

Adopting safer storage and inventory practices would not be very difficult in the shops and photolabs. It would take a little time and money, but would greatly reduce the risks of damages to property and people.

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