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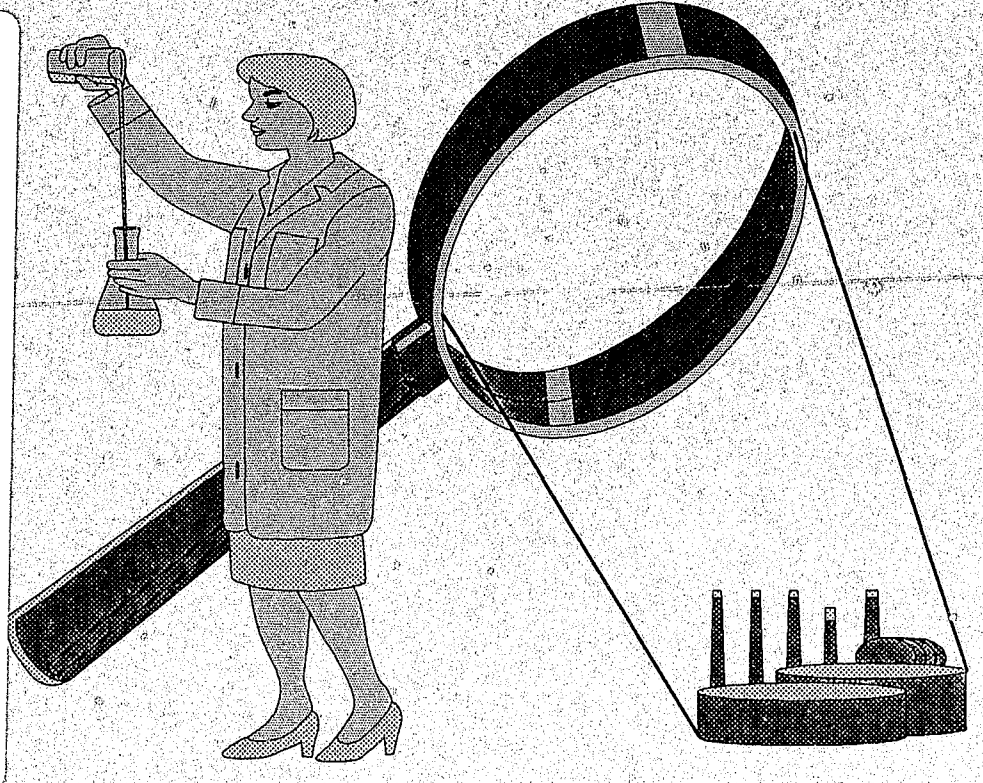
Developing a Practical Chemical Hygiene Plan

HCHEM: A Computer Program for the Inventory and Control of Hazardous Chemicals in the Laboratory



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Feature Article

Developing a Practical Chemical Hygiene Plan

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The Occupational Safety and Health Administration's (OSHA's) new *Laboratory Standard* (29 Code of Federal Regulations 1910.1450) for protecting workers from exposure to hazardous chemicals in laboratories has been in effect for over a year. This standard requires all laboratories using hazardous chemicals to develop and implement a Chemical Hygiene Plan. However, a great deal of confusion still surrounds this federal regulation. As a performance-oriented standard, it does not outline the specific health and safety issues that should be addressed by employers. Instead, it is meant to be more flexible in scope so that individual laboratories can tailor employee training to their own particular needs. This very flexibility creates difficulties, especially if the guidelines of the Chemical Hygiene Plan have not been clearly defined.

This paper will outline the reasons for developing a formal Chemical Hygiene Plan and detail elements of the *Laboratory Standard* that should be included in each laboratory's plan.

REASONS FOR DEVELOPING A CHEMICAL HYGIENE PLAN

There are two basic reasons why every laboratory needs to be covered by an effective and comprehensive Chemical Hygiene Plan. Primarily, it is mandated by law. Under the law, all laboratories using hazardous chemicals are required to develop and implement a Chemical Hygiene Plan which must include the following basic elements:

- work practices and procedures to ensure that workers are protected;
- employee training and information; and
- monitoring of exposures to certain chemicals.

Although laboratory workers are generally well educated, OSHA has found that most are lacking in safety training and that many laboratories do not have health and safety programs in place. Accordingly, OSHA proposed and enacted the *Occupational Exposure to Hazardous Chemicals in Laboratories* rule, better known as the *"Laboratory Standard,"* to provide for better safety for laboratory workers.

The following are key points of the *Standard*:

1. Laboratories must have a written Chemical Hygiene Plan.
2. Training and chemical hygiene must be specific for the hazardous chemicals each particular laboratory uses.
3. Each laboratory may customize its plan to fit its own particular circumstances.
4. The plan must include work practices, procedures and policies to ensure that workers are protected from hazardous chemicals.
5. Record keeping is required.
6. Medical examinations and employee exposure monitoring must be provided if circumstances warrant such a need.
7. Employees must be trained in proper emergency spill controls and safety.
8. Each laboratory must maintain Material Safety Data Sheets (MSDS's) in an easily accessible location.

OSHA plans to implement heavy civil penalties (fines) to enforce its regulations. For example, each willful violation (such as failing to train an employee or failing to implement a Chemical Hygiene Plan) is subject to a $7,000 penalty. The increased attention to enforcement coupled with the threat of significant financial penalties should encourage most laboratories to focus on developing and implementing a Chemical Hygiene Plan.

Aside from legal and budgetary concerns, the most important reason to finalize a chemical hygiene plan is to protect laboratory workers from exposure to chemicals which could adversely affect their health. It is easy to compile long lists of compliance measures that meet OSHA regulations for laboratory workers, but actually developing the required written plan is much more difficult. It should be understood that the requirements of the CChemical Hygiene Plan go beyond advising employees of the hazards of chemicals in the work place (as is required by OSHA's Hazard Communication Standard). The *Laboratory Standard* is intended to provide a more comprehensive approach to protecting laboratory workers through the implementation of appropriate work practices and control measures This includes practices and procedures aimed at keeping chemical exposures below the applicable exposure limits (OSHA regulations specified in 29 Code of Federal Regulations, Part 1910, Subpart Z). Since the program requires much more than simple training, it is essential that laboratory managers understand and actively support the Chemical Hygiene Plan. They must commit the necessary resources to complete and implement the plan.

A written Chemical Hygiene Plan must be developed and made readily available to all laboratory employees. The Chemical Hygiene Plan should include each of the following elements and should indicate specific measures the laboratory will take to ensure employee protection:

1. Standard operating procedures which consider safety and health factors.
2. Criteria that managers will use to implement control measures to reduce employee exposure to hazardous chemicals.
3. A means to ensure fume hoods are functioning properly.
4. Procedures to provide for employee training and dissemination of information.
5. A description of circumstances in which management review and approval must be obtained for new laboratory techniques.
6. Provisions for medical consultation and examination.
7. Provisions for environmental monitoring to ensure compliance with standards.
8. Designation of personnel responsible for implementation of the Chemical Hygiene Plan (namely, the appointment and duties of a chemical hygiene officer).
9. Provisions for additional protection for employees working with particularly hazardous substances, including select carcinogens, reproductive toxins and substances with a degree of acute toxicity.
10. Specific consideration for the following provisions, where appropriate:
    a. Establishment of designated areas for conducting particularly dangerous operations.
    b. Use of containment devices such as fume hoods and laminar flow hoods.
    c. Procedures for safe removal of contaminated or hazardous waste.
    d. Decontamination procedures.

There are a number of specific issues which administrators must address as they develop the plan. The following issues outline the decisions which need to be made. Once the decisions are made, they should be documented and, thus, become part of the written plan.

SELECTION OF A CHEMICAL HYGIENE OFFICER

Who should develop the plan, and who should serve as the required chemical hygiene officer? The responsibilities of this/these individual(s) may be time-consuming, and managers should not simply add these duties to an employee's existing work load. The chemical hygiene officer (CHO) must be qualified through training or experience to provide technical guidance in the development and implementation of the laboratory's Chemical Hygiene Plan. In addition to developing a plan, the CHO must work with employees and administrators to generate and implement required policies. Employee participation in the development of the plan and policies is an excellent means to enhance awareness. The CHO must also monitor the program, either certify or arrange for certification of protective equipment, help develop standard operating procedures, ensure that laboratory workers receive proper training, and keep appropriate records. In addition, the CHO should see that appropriate audits are conducted, help administrators develop precautions, keep up with the current legal requirements concerning regulated substances, and seek ways to improve the chemical hygiene program.

CHEMICAL HYGIENE PLAN EVALUATION AND IMPLEMENTATION

Since there are many different types of laboratories, the Chemical Hygiene Plan for each individual laboratory should include an evaluation of the physical hazards (*e.g.*, explosions and fire) and biological hazards in that particular laboratory. For instance, by dividing each laboratory procedure into its component parts, safety measures may be fully evaluated.

Protective laboratory practices and equipment should be employed to minimize potential exposures to chemicals. There are numerous references that outline these practices, including Prudent Practices for Handling Hazardous Chemicals in Laboratories (National Academy of Sciences 1983). Common sense should rule; evaluate what could go wrong and how to protect employees from exposures. Special attention should be paid to the approximately 600 chemicals that are on OSHA's list of toxic and hazardous substances which require monitoring (29 Code of Federal Regulations 1910.1000). Employee exposure must be maintained at or below the permissible exposure limits (PELs). If these materials are used and stored regularly (in large quantities, and/or outside of a fume hood), or in the event of an accident or spill, then consideration should be given to having the exposure levels monitored. A mechanism for initiating this type of monitoring (*e.g.*, hiring a commercial industrial hygienist) must be established. If there is reason to believe that exposure limits have been exceeded (or levels are high), then a schedule of monitoring, recording of results and employee notification must be developed. For instance, employees must be notified of the results of monitoring within 15 days of the receipt of results. The procedures the CHO intends to follow must be plainly listed. More importantly, future exposures should be reduced through procedural changes and equipment modifications. This precludes ongoing monitoring and medical surveillance.

Since very few laboratory chemicals and procedures are without hazards, general precautions should be adopted. There are numerous sources of basic laboratory safety rules, and it would be prudent to adopt a set of general procedures that are appropriate for each particular laboratory. These general procedures should be outlined in written format and should include policies designed to avoid unnecessary chemical exposures. Some examples include prohibition of eating in laboratory areas, safe storage practices, wearing of proper laboratory attire and regular use of safety equipment. There also should be written procedures (such as emergency phone numbers to call) to follow in case of accidents and chemical spills. In addition to general safety rules and procedures, it is advisable to have written standard operating procedures for particularly hazardous operations.

Appendix A provides a set of general laboratory procedures that could be used as the basis for a written plan. The degree of detail and the extent to which procedures should be written depends upon how valuable such procedures are for the protection of laboratory personnel. If routine procedures are used in a laboratory, they should be written and used to orient and train new employees. There also needs to be some formal system for evaluating new procedures, checking the MSDS's for any new chemicals used, and assessing possible hazards. This "safety analysis" does not need to be elaborate, but it should prompt everyone to plan ahead to avoid potential disasters.

EMPLOYEE TRAINING

Laboratory managers must provide employees with information and training to ensure that they are aware of the hazards of chemicals utilized in their work areas. Such information must be provided at the time of an employee's initial assignment to a work area involving hazardous chemicals and prior to assignments involving new exposure situations.

The *Laboratory Standard* assumes that laboratory personnel have some basic knowledge of laboratory (chemical, biological, etc.) safety. Nonetheless, there must be some formal system established to guarantee that everyone in the laboratory, including supervisors, has received information about the Chemical Hygiene Plan. Everyone needs to be aware of the hazards associated with the chemicals present in their work areas and should understand ways to minimize dangers. The *Standard* requires that this training be provided at the time of initial assignment or whenever there are new exposure situations. While the frequency of providing refresher information and training is unspecified, experience has shown that small amounts of information provided in frequent training sessions (*e.g.*, 15 minutes each month) are more effective in developing a prolonged sense of awareness. It is important to realize that as people get busy, they often become careless, especially when performing routine activities (even though there may be dangers involved).

Immediate supervisors should provide the initial training, although the CHO can furnish either written material or actual training on the general plan. Written standard operating procedures are invaluable. A new employee can be given the procedures for review, discuss them with the supervisor, and then sign a form indicating that he/she has been afforded appropriate safety instructions. As part of this training, employees need to be informed of where the Chemical Hygiene Plan and MSDS's are kept. While the CHO presumably will be the person responsible for keeping the MSDS's on file, a system must be devised to maintain a current collection for all chemicals entering the laboratory. Accordingly, those individuals purchasing chemicals should be required to forward copies of MSDS's to the CHO. Failure to have such MSDS's on file will be considered a serious violation by OSHA inspectors.

Other information which should be provided in employee training includes:

1. A discussion of PELs for OSHA-regulated substances or recommended maximum exposure limits for other hazardous chemicals where PELs do not exist (including instructions for what an employee should do in case of a suspected exposure).
2. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
3. The location and availability of known reference materials, including MSDS's.
4. Methods and observations that may be used to detect the presence or release of a hazardous chemical, such as monitoring devices, visual appearance and/or odor.
5. The physical and health hazards of chemicals in the work area.

CHEMICAL EXPOSURE CONTROL MEASURES

Each laboratory must have an appropriate method for controlling chemical exposures. Managers should work with the CHO to determine how exposures can be reduced through work practices (*e.g.*, decreasing amounts of chemicals used in the laboratory or using less hazardous chemicals to create fewer potential health problems). Developing standard operating procedures (see Appendix A) enables chemicals used in different procedures to be evaluated and ensures that the appropriate MSDS's are available, as required. Engineering controls also must be employed; most notable are chemical fume hoods or biosafety cabinets.

Chemical fume hoods prevent toxic or flammable vapors from entering the laboratory atmosphere, provide a physical barrier between the employee and the chemical reactions, and contain accidental spills and splashes. Hoods should be operated with face velocities of between 60 and 100 linear feet per minute. The face velocity of the hood increases significantly when the sash is all the way down or partly down.

To ensure the safest possible work environment, there must be a mechanism in place to establish that fume hoods are being used and are working properly. The CHO may want to arrange for an annual inspection of all hoods, and records of these inspections should be maintained. The daily operation of a fume hood could be checked by a simple method such as holding a chemwipe in front of its face to check for air flow. It is also important to remind employees to use fume hoods for work rather than for storage.

Good laboratory practices involve regular use of personal safety equipment. Safety glasses must be provided for employees, and the CHO (and/or supervisors) should discipline employees who fail to use them. If sophisticated personal safety equipment (such as a respirator) is required, a change in existing laboratory procedures should be considered. Since respirator use requires another complete program under OSHA regulations, respirators should be used as a "last resort" to reduce chemical exposures.

The standards for working with carcinogens are more stringent than for other toxic chemicals. Specific regulations apply to training, working conditions, record keeping and medical surveillance. When working with these substances, employees must receive specific training for each chemical, and standard operating procedures should be employed. The legal definitions for carcinogens are somewhat complex; if the MSDS indicates a potential carcinogen, an effort should be made to replace the material with a substitute.

In forensic laboratories, working with potential biological hazards is a particular concern. Viruses such as Hepatitis and Human Immunodeficiency Virus (HIV) are infectious in both the dry and liquid states. Viruses can be found in body fluids such as blood, semen, saliva and vaginal secretions. Specific precautions and procedures must be followed when working with these types of evidence, especially liquid blood samples.[1]

[1] Although the Hepatitis B virus is most often transmitted by blood and blood products, the virus reportedly has been found in saliva, breast milk, semen and vaginal secretions. Also, Hepatitis B is present in much higher concentrations than HIV).

MEDICAL ATTENTION

Any laboratory employee who believes he/she may have been exposed to hazardous materials must be given the opportunity to seek medical attention. Therefore, under the *Laboratory Standard*, a mechanism for medical care must be provided. Usually, employers offer health plans for employees, but each laboratory's Chemical Hygiene Plan must clearly specify how an employee should proceed in obtaining medical attention. The initial examination and any follow-up examination(s) must be provided under the supervision of a licensed physician, at no cost to the employee.

The circumstances under which an employee should seek a medical examination should be clearly stated in the written plan. They are as follows:

- when the employee exhibits signs or symptoms associated with exposure to a hazardous chemical;
- when air monitoring reveals an exposure above the PEL; and
- when an event such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure takes place in the work area.

In cases of exposure, the attending physician will need information about the types of chemicals used by the injured party. The supervisor or CHO should be prepared to provide this information. While these procedures are described in the regulations, each laboratory must either adopt procedures already in place (as part of Workers' Compensation/health care benefits), or specifically negotiate procedures with appropriate health care providers. In addition, the CHO should document all accidents, spills, or complaints of exposures, including the results of medical examinations.

CONCLUSION

The *Laboratory Standard* is a performance standard and therefore does not prescribe specific procedures that must be followed to reduce exposures. It emphasizes safe handling of hazardous chemicals through practices and procedures set up by the employers as described in the Chemical Hygiene Plan. The plan itself may have little real value except for regulatory and legal purposes, but the process of developing this plan should be significant for everyone involved because it will provide an opportunity for all laboratory employees to consider the safety aspects of their jobs. Increased awareness will certainly benefit each employee, and that is ultimately the purpose of the OSHA regulations.

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Appendix A. Standard Operating Procedures

I. General Procedures

A. Each employee is to determine the potential laboratory hazards and take appropriate safety precautions, such as the wearing of protective equipment and the use of fume hoods. If the safety of a particular operation is unknown to an employee, he/she is to discuss the matter with the supervisor, laboratory director, or chemical hygiene officer before proceeding.

B. Any substance can be lethal when ingested in a sufficient quantity. It is the dose that determines whether or not a substance is a poison. There are four main routes by which chemicals enter the body:
   1. Absorption through the respiratory tract (lungs)
   2. Absorption through the digestive tract
   3. Absorption through the skin
   4. Percutaneous injection through the skin

C. When working at the laboratory bench, all employees are to do the following:
   1. Wear appropriate eye protection. This may consists of goggles or safety glasses meeting OSHA standards. If prescription glasses are necessary, the glasses — but not the prescription — will be provided by the employer.
   2. Wear appropriate clothing. Clothing should offer protection from splashes and spills. Laboratory coats will usually suffice for this protection.
   3. Wear gloves when necessary. Gloves are necessary during certain types of laboratory operations. They may be reused, cleaned or discarded depending on their prior use and type of contamination.

D. The following protective clothing is ***specifically*** to be worn in the laboratory when handling liquid blood samples:
   1. Safety glasses
   2. Laboratory coat
   3. Surgical gloves
   4. Surgical mask

II. Good health and personal hygiene standards should be maintained.

A. Never pipette by mouth; instead, use a pipette aid.
B. Do not smoke in the laboratory work area.
C. Wash hands and arms before leaving the laboratory.
D. Do not consume food or beverages at the workbench.

III. Housekeeping

A. Good housekeeping leads to a safer environment. Keep things neat and clean. Aisles and corridors should be kept clear of boxes and surplus furniture and instruments. Fume hoods should ***not*** be used to store chemicals.

B. Accepted waste disposal procedures must be followed. Chemicals that cannot be poured down the sink drain should be labeled and taken to the appropriate location for proper disposal. Glass is to be disposed of in specially marked boxes.

IV. Incompatible Chemicals

Chemicals must be physically arranged such that accidental mixing does not create a fire hazard. Fire is the most acute hazard in the storage of incompatible chemicals.

V. Flammable Chemicals

A *flammable* substance is a chemical with a flash point below 100° F. A *combustible* substance is a chemical with a flash point between 100° F and 200° F. Generally, any chemical with a flash point below 200° F is considered a fire hazard and will be stored in a flammable storage cabinet.

VI. Compressed gas cylinders are potential rockets. Accordingly, they should be handled and stored with due respect.

A. Full cylinders and empty cylinders should be stored separately and labeled appropriately, as full or empty.
B. Cylinders must be stored in an upright position and secured to prevent falling.
C. Cylinder caps must be in place at all times during storage and transport.
D. Cylinder color should not be used for identification purposes. Rely strictly on the label.

VII. Spill Control Measures

A. Chemical spills should be cleaned up immediately.
B. Coworkers shall be advised of the spill and the risk factor.
C. Supervisors and emergency personnel shall be advised immediately.
D. Generally, small quantities of chemicals may be cleaned up with paper towels or with absorbents in spill control kits available at designated locations.
E. If a flammable liquid is spilled, special precautions must be taken to ensure that no electrical devices or open flames are being operated nearby.
F. If an individual has been splashed with a chemical, he/she should wash with plenty of water, remove contaminated clothing, and seek appropriate medical attention.