Title
Supervisors Guide to Hazard Communication

Author
Bernstein, Mona

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SUPERVISORS GUIDE TO HAZARD COMMUNICATION

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DISCLAIMER

SUPERVISORS GUIDE TO HAZARD COMMUNICATION

Step-By-Step Procedures To Implement LBL's Hazard Communication Program

Environmental Health and Safety Department

Prepared by Mona Bernstein, 1988

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INTRODUCTION

This guidebook is a tool intended to assist supervisors in implementing the Hazard Communication Program at LBL. It provides information on the requirements of the OSHA Hazard Communication Standard; LBL's program, roles, and responsibilities; how to's of implementation; and resources. A short training program, supplemented with this guidebook, should thus enable supervisors to plan and provide a program that addresses the requirements of effective hazard communication for their employees.

State, Federal, and Department of Energy (DOE) regulations require that employees be informed about all workplace health hazards to which they may exposed. These regulations are commonly called "Right to Know" laws, or the Hazard Communication Standard. Although State and Federal regulations deal mainly with toxic chemicals, the DOE standards are more general in scope and include physical and biological hazards. Examples of such hazards include noise, nonionizing radiation, biohazards, and high-voltage electricity.

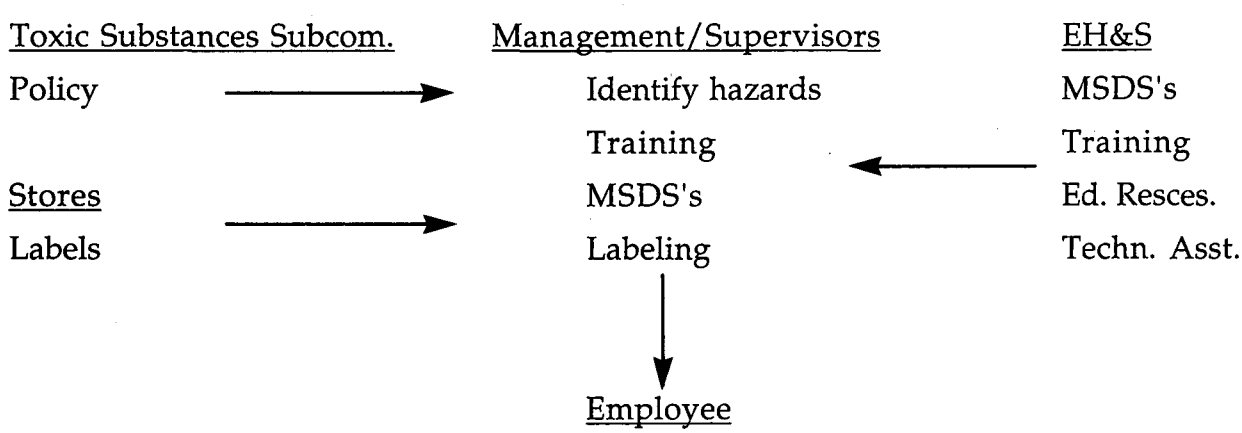
Components of the Hazard Communication Standard include the development of a written program, requirements for labeling hazards, availability of material safety data sheets (MSDS), and employee training. The intent of the Standard is to ensure that workers are informed of the identity of recognized hazardous agents, their known effects, and appropriate control measures. The result is the prevention of harmful exposures through the safe handling of hazardous agents in a variety of circumstances.

I. LBL'S PROGRAM

LBL's Hazard Communication Program is designed to follow DOE regulations. Any employee exposed to hazardous materials under normal work conditions or in forseeable emergencies must be included in the program. Although all operations must comply with the Standard, research laboratories have more limited requirements. The differences between research labs and other operations will be explained in Chapter II, "What Supervisors Must Do." Please refer to Appendix 1, a copy of LBL's written Hazard Communication Program, for more details. The written Program must be made available to all employees. Keep in mind that the written Program mainly covers chemical hazards.

Although it is line management's responsibility to implement the Hazard

Communication Program, everybody has a role to play to ensure its success. The Environmental Health and Safety Department (EH&S) provides supervisor training, educational resources, and technical assistance. The Materiel Management Department's Central Storeroom provides labels for hazardous materials. Collections of MSDS's have been distributed to Division Safety Coordinators. Additional MSDS's are available from the Industrial Hygiene Group. Employees are protected from hazardous exposures by complying with the requirements of the Standard. The responsibilities are as follows:



II. WHAT SUPERVISORS MUST DO

The following is a description of supervisory responsibilities concerning each component of the Hazard Communication Program. See the Supervisor's Check list (Appendix 2) for quick reference.

IDENTIFY HAZARDS

As a supervisor, you are responsible for identifying hazards and hazardous situations. This includes specific chemical, physical, and biological hazards located in areas that you supervise. However, you do not have to inventory areas where ionizing radiation is present since that hazard is covered by different regulations. Refer to the Hazards Inventory Check List (Appendix 3) for guidelines.

For research labs only, you may identify general hazard categories rather than each specific chemical. As an example, the following categories can be used for chemicals: corrosives, flammable liquids, reactives, carcinogens, and toxics. Hazardous materials in nonresearch lab areas should be listed individually. Refer to the section on Special Cases (Appendix 4) for help regarding questions on sealed containers, household products, office products, and outside contractors.

At the same time, you should identify all employees under your supervision who are exposed to these hazards. Make provisions for adding new hazards to your list as they are introduced into your work area.

How can I identify hazards?

First of all, be certain you understand what chemicals are hazardous. Some common household products, such as window cleaners, contain ammonia and, under certain conditions, fall under these regulations.

The following suggestions can help you develop a hazards inventory list:

- Review purchase orders. Be sure to look at the section marked "Hazard Review."
- Check any MSDS's you have received.
- Do a "walk-through" of work areas under your supervision:
  — Look for routine operations, such as welding or grinding, that produce toxic byproducts.
  — Look for containers of hazardous materials.
  — Note how much of a hazardous substance is being used, how often, how exposure may occur, and what safety controls, if any, are necessary and in place.
  — List any research apparatus containing hazardous materials.
  — Include nonroutine operations and associated hazards.
  — Identify all affected employees.
- For shop areas, check with Industrial Hygiene to determine whether any inventories or workplace monitoring to detect toxic substances have been done.
- Check job descriptions and personnel records to help you identify employees needing training.

How should I organize this information?

Use the categories from Appendix 3 as a guide. List the hazardous materials by product name, common name, and chemical name. (In research labs, you may list by general category.) List the operations that use hazardous materials and note how the products are used. List the employees who are involved with the operations and/or who are exposed. Remember—the information you gather should be useful. It will help you plan training sessions, label hazards, and obtain MSDS's.

MAKE MSDS'S AVAILABLE

An MSDS is a technical bulletin prepared by the manufacturer of a chemical product and is the primary source of information on the hazardous properties of the material. It provides information needed to work safely with the material, such as potential health hazards, proper handling procedures, and emergency procedures. The manufacturer is required to send the MSDS along with the product to any purchaser.

Where are MSDS's located at LBL?

Industrial Hygiene has distributed to each Division Safety Coordinator a set of binders containing approximately 800 MSDS's for most materials commonly found at LBL. The Division will make the MSDS's available to employees. In addition, Industrial Hygiene has copies of another 2500 MSDS's for additional substances ordered through Purchasing. Call Industrial Hygiene if you are looking for a particular MSDS (x5829).

What must supervisors do about MSDS's?

Research laboratories: You must keep all MSDS's you receive with shipments from manufacturers and make these available to employees. You are not required to have on hand the MSDS for substances that you receive without an MSDS. However, you may want to have the MSDS available as a reference for planning hazard-specific training.

Other Areas: Supervisors must make MSDS's available to employees who request them, including employees on all work shifts. Some areas have binders of MSDS's for substances used in work operations located in those areas, such as Building 25. Divisions may choose to copy MSDS's for chemicals used in certain areas so they can be more readily available. Employees should be familiar with the hazard information on the MSDS.

LABEL HAZARDS

Supervisors must ensure that hazards are properly labeled. Labels must include the name of the material and appropriate hazard warnings. When manufacturers ship materials, they are required to provide a condensed version of health and safety information on the label. Do not remove these labels from incoming chemicals. Materials that are received, delivered, used, and disposed of in the original containers usually pose no labeling problems.

What if the material is not in the original container?

When secondary containers are used, supervisors must make sure that the appropriate health and safety information is transferred to the new container. The Central Storeroom carries warning labels for some common chemicals. See Appendix A within Appendix 1 for a list of signs and labels. Blank labels that allow you to write in the necessary information are also available.

Labels should be immediate visual warnings to alert handlers to the hazards of the material. If the label is too complicated, it won't be read. Save the details for the MSDS. If a hazardous material must be stored in small laboratory glassware (test tubes, beakers) where individual container labeling is not practical, use an area sign to identify the material. Whatever labeling system used must be explained to employees. See Appendix 1 for more information.

PROVIDE TRAINING

Training is the heart of the Hazard Communication Program. Good training will enable employees to use labels, MSDS's, and other available information effectively to protect themselves and their co-workers.

What are the training requirements?

Supervisors are required to plan and provide hazard-specific training that covers identification, control and emergency procedures. Training must cover:

- Those operations that involve hazardous materials;
- Potential chemical, physical, and biological hazards;
- Applicable health standards;
- Purpose and results of exposure monitoring;
- Purpose and use of control measures;
- Personal protective equipment;
- Detection systems—odors, monitors, alarms, symptoms;
- MSDS's—location and how to use;
- The requirements of the Standard.

See Appendix 1, "LBL's Hazard Communication Program," for more detailed information.

Training should also include a review of employee rights, such as the right to see exposure and monitoring records, the right to report unsafe work conditions, the right to information about workplace hazards, and the right to be protected from discrimination for exercising these rights.

Training should be provided initially for all exposed employees, for new employees, and, when a new hazard is introduced into the work area, for everyone concerned. Before an employee is permitted to work in your area, make sure she/he can interpret labels and MSDS's, understands proper work practices, and knows how to use personal protective equipment.

How on earth will I be able to do this?

You are probably doing some hazard communication training already. Making a plan that includes an outline of topics with a time frame will give you an organized way to address this requirement and incorporate current training. You can use existing structures, such as safety meetings, to provide brief training sessions. Hazard communication training can be accomplished most effectively by using a combination of formal presentations and on-the-job instruction, incorporating both general and specific information. EH&S will assist you in the training requirement by providing supervisor training, educational resources, and technical assistance. See Chapter IV, "How To Train," for more help.

Research laboratories: The requirement for training is slightly different. Training need only be provided by general category of hazards (e.g., carcinogens, corrosives), rather than by specific chemical, because it is assumed workers in research labs are already highly trained.

KEEP RECORDS

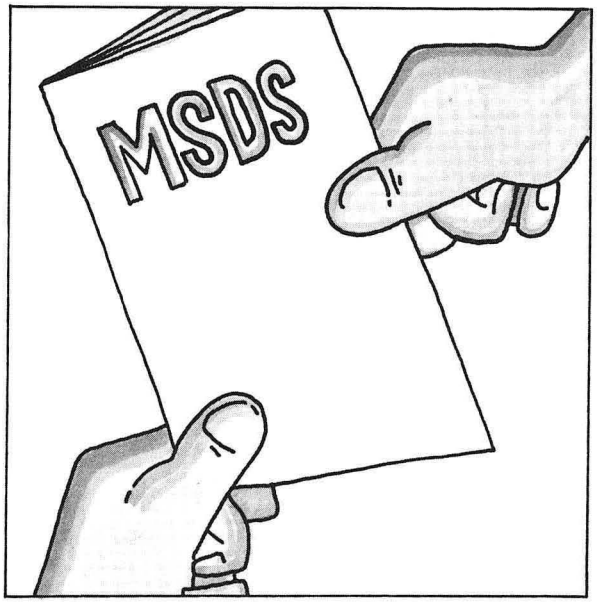
IT IS ESSENTIAL THAT ALL TRAINING BE DOCUMENTED TO SHOW THAT LBL IS COMPLYING WITH THE REGULATIONS.

DOE will be looking closely at LBL's training records. Record keeping should include:

- Names of employees and employee numbers,
- Content of training session,
- Date, and
- Who presented the training.

A special enrollment form for hazard communication training, available from EH&S, will assist you with this task (see Appendix 5). Fill out a copy each time you have a hazard communication training session. When training is completed, keep one copy of the record and send one copy to the EH&S Training Coordinator. Each Division should decide who will be responsible for maintaining its records. When EH&S receives a copy of the enrollment form, the information will be entered into the training data base for the Lab. If you would like training reports, please contact EH&S.

III. USING THE MSDS



The purpose of the MSDS is to provide vital information on health and physical hazards. This part of the guidebook will illustrate and describe each section of the MSDS to help you understand the data. You can use this information to plan training programs and to explain the MSDS to your employees. Some of the terms on the MSDS are quite technical—refer to the Glossary of Useful Terms (Appendix 8) for help.

The MSDS must include, at a minimum, all eight of the described sections. The style and layout may vary. However, every section must be filled in, even if the item is not applicable (indicated by N/A)—there should be no blank spaces! Note that some of the information, such as the chemical family, may be included, but is not required.

Remember that the information on the MSDS is prepared by the manufacturer of the product. Therefore, some data sheets contain excellent and complete information, some are adequate, and others are poor. Other sources of data on toxic and health effects should be consulted for more complete information. Call EH&S for assistance (x5251).

SECTION I: PRODUCT IDENTITY

Identity: The name of the product as it appears on the label. A product may be a mixture of two or more chemicals.

Manufacturer's Name, Address, and Phone Number: Self explanatory. If the data comes from a source other than the manufacturer, the actual source must be indicated. The date of preparation or revision must be indicated.

Emergency Telephone Numbers

Chemical Family: The general class of compounds to which the hazardous substance or mixture belongs, e.g., ethers, acids, ketones, solvents, may be listed. This term does not give you the exact content of the product.

Formula: The chemical formula for single elements and compounds, not the formulation of a mixture, may be

given, e.g., sulfur dioxide (SO_2), formaldehyde (HCHO).

SECTION II: HAZARDOUS INGREDIENTS

The identification of a hazard is based on whether the substance is flammable, reactive, or toxic or a combination of potential effects. If the product is a mixture, all hazardous ingredients must be listed. However, ingredients that are not hazardous, or make up less than 1% of the product (less than 0.1% for carcinogens), do not have to be reported. Exposure standards, i.e., Threshold Limit Value (TLV), and Permissible Exposure Limit (PEL) are included in this section, or under Health Hazards. Note—the higher the number for a TLV or PEL, the less hazardous the substance. See the Glossary for definitions of TLV and PEL.

The % column is intended to show the approximate percentage by weight or volume of each hazardous ingredient compared to the total weight or volume of the product. Normally, percentages will be listed to the nearest 5%. When the substance constitutes less than 5% of the product, this is indicated.

CAS Number: Chemical Abstract Service registry number identifies specific chemicals only, not mixtures; it is optional.

SECTION III: PHYSICAL DATA

This section contains very important data to help predict the behavior of the material in experimental situations. The information provided is for the material as a whole, rather than for each hazardous ingredient. Vapor pressure, vapor density, % volatiles, and evaporation rate all basically tell you the same thing—whether breathing the vapors will be a problem, thus indicating the need for proper ventilation.

Boiling Point: The temperature at which a liquid changes to a vapor at a given pressure, usually in degrees Farenheit (°F) at the sea-level pressure of 760 millimeters of mercury (mm of Hg). For mixtures, the initial boiling point or the boiling range may be given. A low boiling point may be a special fire hazard.

Vapor Pressure: Refers to the pressure exerted by a saturated vapor above its own liquid, usually stated in mm of Hg at room temperature (68°F). The lower the boiling point, the higher the vapor pressure. A high vapor pressure indicates easy evaporation.

Vapor Density: Tells whether the material is heavier or lighter than air. This is useful information to indicate a confined-space hazard. If heavier than air, the material will concentrate in low places, such as floors, elevator shafts, sewers, or the bottom of tanks.

% Volatiles by Volume: How much of the material evaporates at room temperature. The higher the number, the faster the substance will evaporate.

Evaporation Rate: The rate at which the material will evaporate when compared to the rate of evaporation of

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)*

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name

Emergency Telephone Number

Address *(Number, Street, City, State, and ZIP Code)*

Telephone Number for Information

Date Prepared

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))

Section III — Physical/Chemical Characteristics

Boiling Point	
Vapor Pressure (mm Hg.)	
Vapor Density (AIR = 1)	

Solubility in Water

Appearance and Odor

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)

Extinguishing Media

Special Fire Fighting Procedures

Unusual Fire and Explosion Hazards

(Reproduce locally)

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable		

Incompatibility *(Materials to Avoid)*

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Skin? Ingestion?

Health Hazards *(Acute and Chronic)*

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions
Generally Aggravated by Exposure

Emergency and First Aid Procedures

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled

Waste Disposal Method

Precautions to Be Taken in Handling and Storing

Other Precautions

Section VIII — Control Measures

Respiratory Protection *(Specify Type)*

Ventilation	Local Exhaust	Special
	Mechanical *(General)*	Other

Protective Gloves

Eye Protection

Other Protective Clothing or Equipment

Work/Hygienic Practices

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a known material, usually butyl acetate. If another material is used for comparison, it should be indicated. If the number is greater than 1, the product evaporates more easily than the comparison material.

Solubility in Water: The percentage of a material (by weight) that will dissolve in distilled water at room temperature.

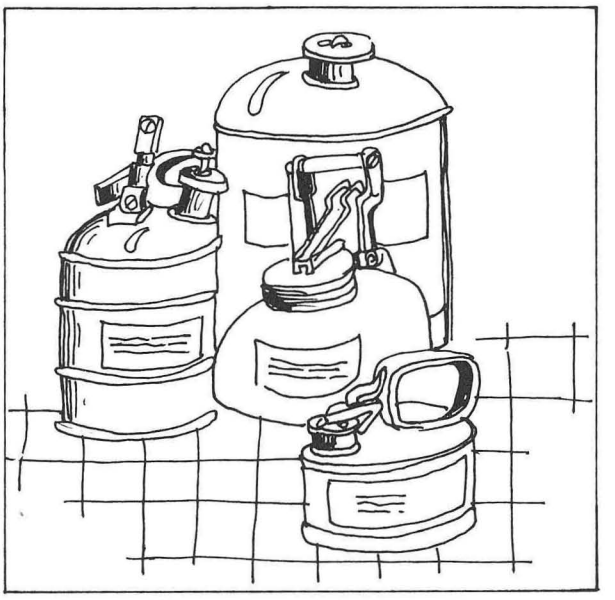
Specific Gravity: The ratio of the weight of a volume of material to the weight of an equal volume of water. For insoluble materials, a specific gravity of less than one means the material is lighter than water and will float. Greater than one means it sinks in water.

Melting Point: The temperature at which a solid becomes a liquid under normal room conditions.

Appearance and Odor: A brief description of the material at normal room temperature and atmospheric conditions. Do not rely on odor to alert you to a dangerous exposure. Some substances can reach hazardous levels and have no noticeable odor.

SECTION IV: FIRE AND EXPLOSION HAZARD DATA

This section should clearly indicate whether the material is flammable. If it is flammable, make sure you have the correct fire extinguisher on hand. If you work with solvents, peroxides, explosives, metal dusts, or other unstable substances, this section is very important.



Flash Point: The lowest temperature at which the material ignites; this will help determine storage and handling procedures. The method used to obtain this information should be stated.

Flammable or Explosive Limits: The range over which a flammable vapor, when mixed with the proper proportions of air, will flash or explode if ignited. The range is designated by lower explosive limit (LEL) and upper explosive limit (UEL), and is expressed in % of volume of vapor in the air.

Extinguishing Media: Indicates what type of fire extinguisher to use, such as water, fog, foam, alcohol foam, carbon dioxide, or dry chemical.

Special Firefighting Procedures: Special handling procedures, personal protective equipment, and unsuitable firefighting substances should be listed. For example, water should not be used

on fires involving reactive metals. General firefighting methods are not described.

Unusual Fire and Explosive Hazards: Hazards that might occur as a result of overheating or burning of the material, including any chemical reactions or change in chemical form or composition.

SECTION V: REACTIVITY DATA

This section indicates how unstable the substance is and lists conditions to avoid to prevent dangerous reactions. This information will help you handle and store the material properly.

Stability: The checked box will indicate whether the material is stable or unstable and under what conditions instability occurs.

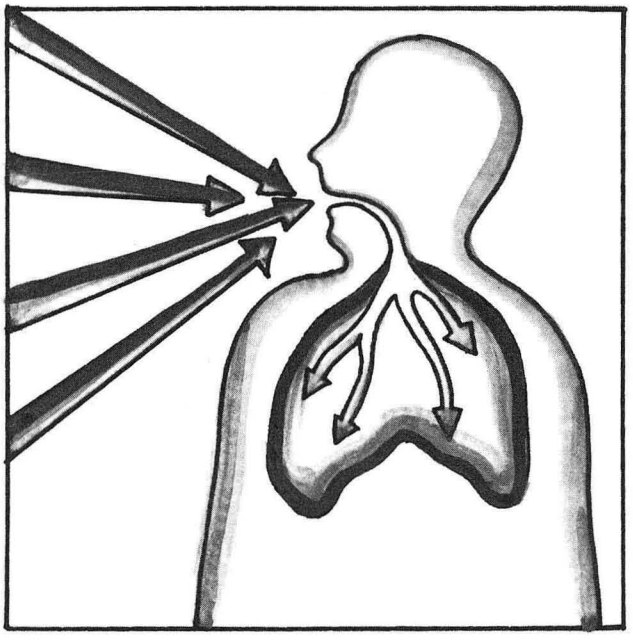
Incompatibility: Lists materials and conditions to avoid. Such conditions may include extreme temperatures, jarring, or inappropriate storage.

Hazardous Decomposition Products: A list of the hazardous materials that may be produced if the material is exposed to burning, oxidation, heating, or certain chemical reactions. The product's shelf life should be included, when applicable.

Hazardous Polymerization: Polymerization is a chemical reaction in which two or more molecules of a substance combine to form repeating structural units of the original molecule. A hazardous polymerization causes an uncontrolled release of energy (heat). If this reaction can occur, it must be indicated.

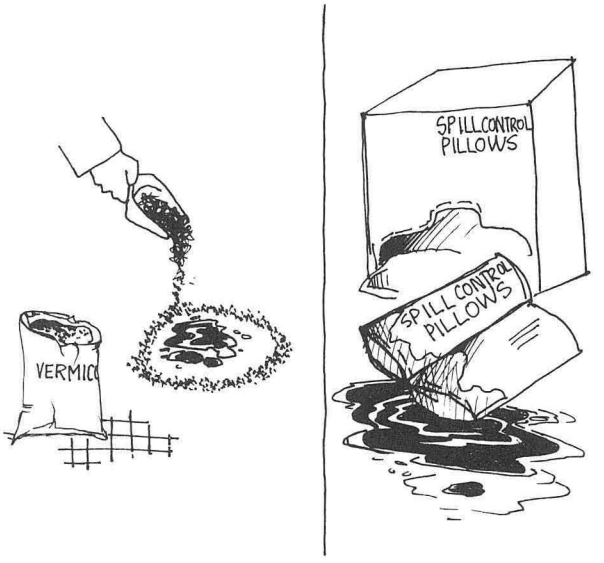
SECTION VI: HEALTH HAZARD DATA

This section lists routes of entry (inhalation, skin absorption, ingestion), and gives signs and symptoms of overexposure, such as skin rash, tremors or dizziness. Short-term (acute) and long-term (chronic) health hazards, such as the ability to cause cancer (carcinogenicity), birth defects (teratogenicity), or nervous-system damage, should be listed. Some products cause both types of effects. Unfortunately, this important section often lacks adequate information, especially on the health effects of long-term exposure.



Instructions for first aid and emergency procedures for victims of acute inhalation, ingestion, or skin or eye contact must be included. Medical conditions that can be aggravated by exposure must also be stated.

Information on exposure standards, such as TLV, PEL, or STEL, and toxicity data (indicated by an LD_{50} number), may be included here. Toxicity data is only an estimate of the degree of toxicity, based on experiments with test animals.



SECTION VII: PRECAUTIONS FOR HANDLING

This information will help you prepare for emergencies by having the proper materials and equipment on hand. The section lists methods, special equipment, and precautions necessary to control and clean up spills, leaks, and other releases. For example, if respirators are required to clean up a spill, that fact should be shown.

Acceptable waste-disposal methods, as well as prohibited methods, are described. The user will also be alerted to any potential environmental danger to the general population, crops, water supplies, etc.

Instructions for safe handling and storage, such as the warning not to store acids and bases together, may be given. Any additional special precautions not addressed elsewhere in the MSDS should also be listed here. These may include instructions for storage life or transportation, such as special packaging or temperature control.

SECTION VIII: CONTROL MEASURES

This section is essential for protecting employees from overexposure. It lists personal protective equipment, such as proper gloves, safety glasses, or respirators, ventilation necessary to work safely with the material, and work/hygienic practices. Types and descriptions of necessary equipment should be specified (e.g., organic vapor cartridge, neoprene gloves). If the material has a low TLV, indicating a dangerous health hazard, local ventilation is recommended, not general or dilution ventilation. Remember, engineering controls, such as the right kind of ventilation, are always preferable to relying on respirators.

IV. HOW TO TRAIN

The goal of employee health and safety training is to influence behavior to either improve safe work practices or support existing good ones. Hazard communication training should provide an understanding of the health risks from dangerous exposures as one motivating factor in the total picture of a safe workplace. The purpose of such training is not to frighten employees but rather to strike a balance between fear and respect for the hazard, so employees are fully informed and know that it is possible to do the job safely. Full disclosure of health risks is a recognized right of all workers exposed to hazardous materials.

WARNING!

One of the most common attitudes you will encounter when providing training is complacency. Employees may feel that they have been on the job so long they know everything there is to know about safety and health. They may think that, because they have been doing the job for years without adverse consequences, the hazards of exposure have been overemphasized. Changing this attitude is a challenge.

If you see someone working unsafely, you might first approach the employee with friendly concern. For example, you might say, "I noticed that you don't wear safety goggles when using the grinder. I'm concerned that you might damage your eyes from flying pieces of metal. Is something wrong with the goggles or are they uncomfortable?" This way does not accuse the employee. If this doesn't work, other approaches can then be tried—appealing to regulations, authority, or self-interest. Supervisors may find it useful to remind employees that, since safety is part of the job, safety performance is properly included on a performance evaluation.

Employees may also feel negatively about past experiences with inappropriate safety training. Being forced to attend lectures that do not concern them, are below their level of comprehension, blame them, or are boring is one reason why employees might feel safety training is trivial, unimportant, or sometimes demeaning. Training that relies on general lectures or audio-visual programs only takes the path of least resistance, and may actually have a negative effect. Employees see that little effort has been made to prepare an individualized program.

Supervisors should spend sufficient time planning a training program. Actively solicit involvement and feedback from employees. Use their comments as much as possible when designing your safety training. Active involvement will also help overcome complacent or apathetic attitudes.

MAKE A PLAN

Making a formal plan may seem like a lot of work, but it will give you an organized way to approach training. In the end it will make your job easier and the training more effective. See "Training Tips" in this section for additional help.

1. The first step is to identify the needs your training program will address. You will need answers to the following questions: What problem is training trying to solve? What changes are necessary to solve the problem? Who or what needs to change? This requires gathering two types of information—information about the hazards and information about the trainees. You will use this information in the next step of the planning process—identifying what you want to accomplish.

To select the topics for training, consult the list of hazards from your work area(s) and the requirements of the DOE Order as spelled out in LBL's written Program (Appendix 1). See the Training Check List (Appendix 6) for additional help. Make sure you identify any operation requiring the use of personal protective equipment and/or engineering controls, such as a fume hood, or a process requiring enclosure or isolation. Look at accident rates, labels, MSDS's, monitoring records, fact sheets, and reference materials. This should give you adequate information about the subject matter.

Next, consider your audience. How do they learn best? What is their attitude about health and safety? Are they interested in the topic? Observe

how people work; note "near misses" and anyone working unsafely. Solicit input from employees concerning the hazards in their work areas. Ask employees to help you by describing their jobs. This also creates interest in the training program. Listen to complaints, questions, fears, and suggestions. Know who your audience is so you can reach it most effectively.

2. Your completed "needs assessment" will then be used to identify your objectives, which spell out what training will achieve. Objectives describe behavior that the trainee is expected to demonstrate, not what the trainer will do. Objectives describe changes in knowledge, behavior, and/or attitude. They should be realistic and specific. One example of an objective is "Participants will understand the relevant information on the MSDS for trichloroethane." Reviewing the objectives after training has been completed will also help you evaluate the training.

3. From the objectives, make an outline of activities that you will use to convey the necessary information. Remember to include a "time frame," a schedule to make sure all the issues have been addressed. In your outline include materials you will use, such as pamphlets or videotapes. See the list of training methods for help with this section. EH&S also has fact sheets and other written materials for you to use.

4. The final part of the training plan is evaluation; this will provide you with feedback to improve your program. You want to find out if the material has been understood, if it was relevant, and if there has been any subsequent change in behavior and/or attitude. Ask yourself if your training objectives have been met. Does any training need to be repeated? Is further training needed?

Evaluation can be done formally, by using a questionnaire, or informally. Informal evaluation can include asking a few questions at the end of a training session that highlight the main points, observing any differences in work practices, noting employee requests for MSDS's and other information, and employee reports of hazardous conditions. See the Safety Performance Check List (Appendix 7) for a list of observations you may make to help assess the effectiveness of your training program.

Determining the contribution of training to employee safety performance is very difficult due to the many other factors that influence workplace safety. Some of these factors are management-employee relations, work-area design, fatigue, work pressure, peer pressure, and personal problems. Good training, however, can influence some of these factors for the better.

Sample Training Session:

- Introduction to program.
- Audio-visual program for general information (15 min).
- Hazard-specific information—review one hazard using the MSDS, label, and relevant personal protective equipment (15 min).
- Structured questions, discussion, feedback (15 min).

Total time: 45 minutes

Sample Training Activity:

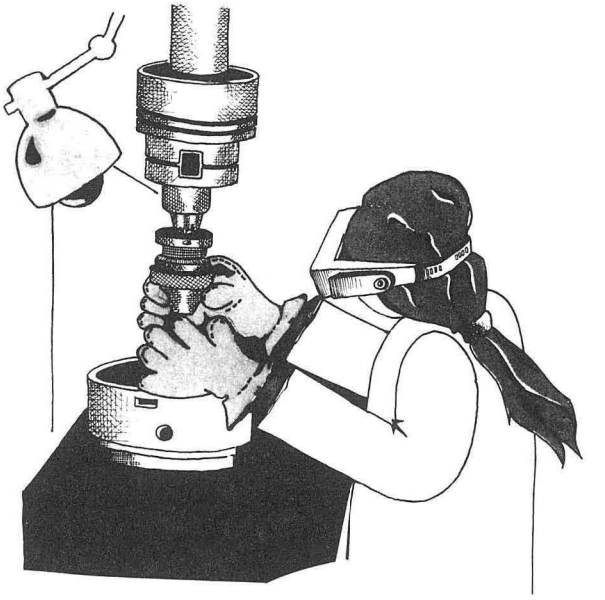
- Distribute sample copies of one MSDS on a material used in your work area.
- Ask the group a series of questions to obtain their active participation.
  —What are the main hazardous ingredients?
  —What kind of hazards does exposure cause?
  —Are there any long-term health effects?
  —Are there any special procedures you should use to work with the substance?
  —Where should you store the chemical?
  —What would you do if you spilled it?
  —Do you think the information on the MSDS is adequate? Why or why not?

A different version of this exercise can be done by having employees take turns presenting pertinent information from the MSDS to the work group. At each safety meeting, have a different employee review one hazardous material in this manner.

TRAINING METHODS

CAUTION!

A combination of training methods works best. When deciding which approaches to use, the supervisor must keep the information and the audience in mind and choose her/his methods accordingly. For instance, lecture style would not be suitable for training on the safe operation of a centrifuge. Demonstration with a small group or one-to-one hands-on training is a better method. Audio-visual materials can depict hazardous situations that cannot be demonstrated, but they are often very general and boring. Remember, adults learn best when the training draws on their own experience and is participatory and practical. Small groups allow for the most participation.



The following is a list of training methods with comments:

Lecture: enables you to reach large audiences but is one of the least effective means of conveying information. To be effective a lecture must be well organized, informative, and lively.

Walk-through: draws on the audience's experience, very effective if planned well. Go through the work area(s) with the group, or use photographs or slides to point out hazards and how to avoid exposure. You can also use photos to ask, "What is wrong with this picture?"

Audio-visual material: effective for large groups but is a passive way of learning, entertaining only if done well. Unfortunately, many shows are tedious and sometimes condescending. Review any materials before using them for training and prepare pertinent follow-up information.

Written materials: pamphlets and fact sheets can present hazard-specific information to supplement and support training. Do not, however, rely on them exclusively.

Discussion: best for changing attitudes and sharing ideas, experiences, and feelings. Requires careful planning and some structuring but should always be encouraged.

Practice drill: good for preparing for emergency situations.

Role play: introduces problem situations dramatically by having the participants enact situations similar to work conditions; enables participants to find solutions. Situation and instructions must be clearly presented. Can frighten people if they are self-conscious.

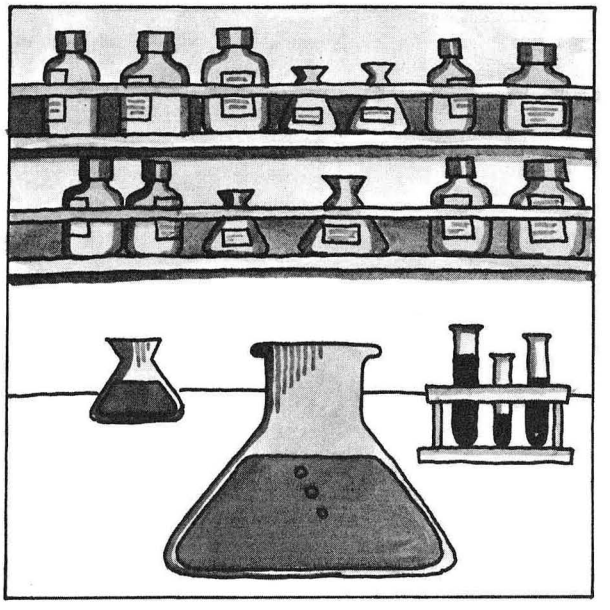
Case study: develops problem-solving skills, draws on experience, encourages discussion and exchange of information, allows trainees to practice new knowledge and skills.

Role play and case study are excellent means by which to practice new skills and incorporate new information. The EH&S Training Coordinator can help you design any of these activities.

TRAINING TIPS

The following advice can help make your task easier and more successful.

1. Rate the hazards and then rank your training topics accordingly. Train first on the most hazardous materials and the skills needed most often.



2. Make sure the information is appropriate, understandable, and practical. Avoid jargon if possible, and explain all jargon used. Use common examples that everyone can understand. For example, to illustrate reactivity, describe what happens when you mix bleach and ammonia, ordinary household products. (The reaction releases toxic chlorine gas!)

3. Incorporate hazard communication training into already existing safety and other job-related training. For example, spend several

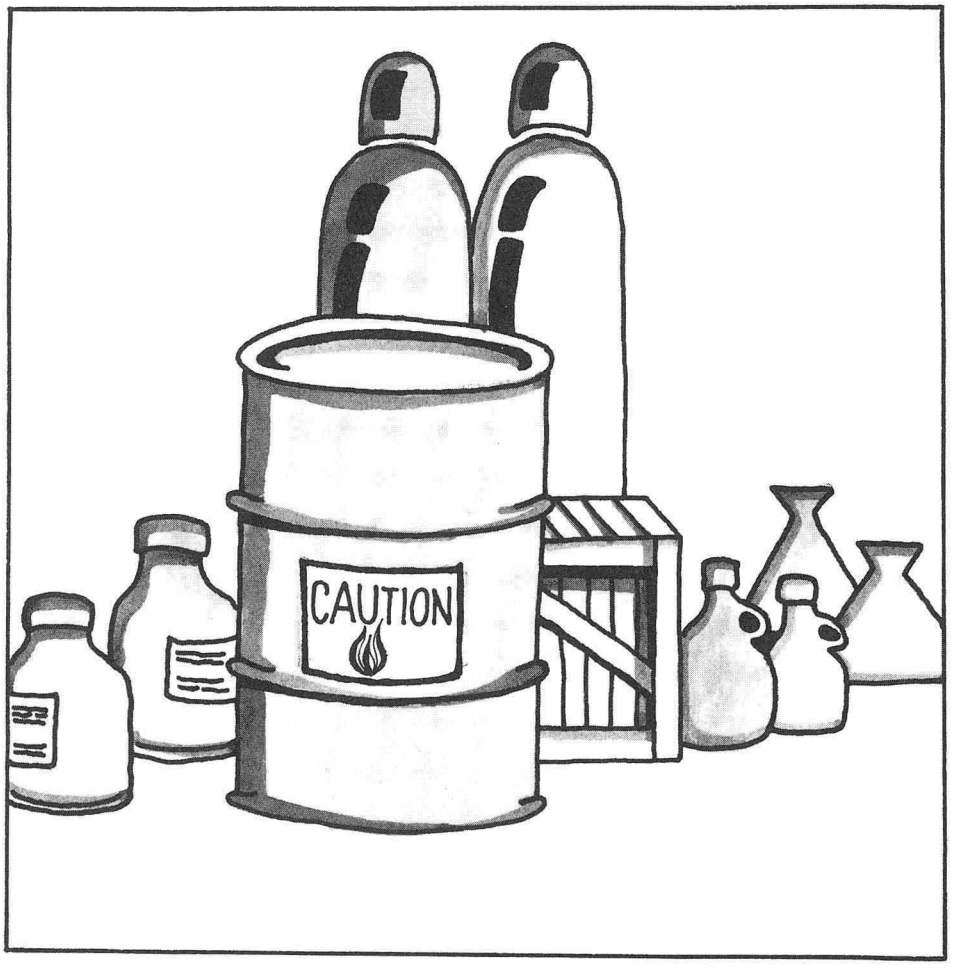
minutes at each safety meeting discussing a different hazard. If no current mechanism for safety meetings exists, create one.

4. Take one topic at a time. Set a time limit and stick to it. Do the required training in short doses. For example, do the following training activities one at a time: analyze one MSDS, stage a spill drill, highlight one safe work practice, review proper maintenance of respirators.

5. Try to make it interesting. Use a variety of methods. Choose an exercise to convey information, rather than relying solely on lecture or videotapes. Make it active. For example, ask the trainees to compare the label and MSDS for the same product.

6. Ask employees to help you. Have knowledgeable employees train others; use their valuable experience. Reward employees for helping with the safety program by noting it on their performance evaluations.

7. Go from the general to the specific, from the familiar to the unknown. Address high-interest material first, moving from the concrete to the abstract.



V. RESOURCES

EH&S will provide support, resources, and technical assistance to line management to help you develop and implement the Hazard Communication Program for your employees.

TRAINING

EH&S offers hazard communication training for supervisors, tailored to address the hazards within specific divisions and work areas (lab, shop, office) to discuss the "how to's" of implementation.

MATERIALS

This guidebook provides guidelines and ideas as the first step in helping you implement the Program. EH&S has visual aides (films, slide shows, videos) you may borrow to supplement training sessions. These materials are good for providing general information, rather than the specifics of your operation.

The slide/tape show "Hazard Communication Solutions: Right to Know," available from EH&S, provides a basic introduction to the Program and to health hazards and chemical safety. The EH&S Training Coordinator can also help provide written materials, such as pamphlets, fact sheets, and posters, on specific hazards (e.g., solvents).

TECHNICAL ASSISTANCE

Industrial Hygiene and the EH&S Training Coordinator can help you with the following:

- Provide any inventories of hazards that have been done;
- Assess hazards after you have completed the inventory;
- Provide information about any workplace monitoring that has been done;
- Identify necessary control measures, work practices, and/or personal protective equipment;
- Provide resources to determine detrimental effects from hazardous exposures;
- Help design your training program;
- Provide limited training; and
- Provide training reports and data from the training data base.

Appendix 1.

HAZARD COMMUNICATION PROGRAM LAWRENCE BERKELEY LABORATORY

INTRODUCTION

On May 25, 1986, the Occupational Safety and Health Administration placed into effect the requirements of a new standard called "Hazard Communication" (29 CFR 1910.1200). This standard establishes requirements to ensure that chemical hazards in the workplace are identified and that this information, along with information on protective measures, is transmitted to affected employees. The Department of Energy has made the Hazard Communication Standard mandatory for all of its contractors.

This document describes how LBL employees are informed about the potential chemical hazards in their work area so they can avoid harmful exposures and safeguard their health. Components of this program include labeling, material safety data sheets (MSDS) and training.

POLICY

It is LBL policy that every supervisor is responsible for ensuring that hazardous materials are labeled properly, that MSDS's are available, and that the necessary training is provided to his/her employees.

SCOPE

This program applies to all LBL activities in which employees may be exposed to hazardous materials under normal conditions of use, or in a foreseeable emergency.

With regard to MSDS's, individual research laboratories within LBL have limited coverage under the OSHA Hazard Communication Standard. They are required to maintain only those sheets which are received with incoming shipments, and are not required to obtain an MSDS for every hazardous material found in each laboratory. The Standard treats research laboratories differently from industrial, commercial or agricultural facilities for the following reasons: these laboratories commonly use small quantities of many different hazardous materials for short periods of time; the

conditions and uses of the hazardous materials frequently change, often unpredictably; many materials are of unknown toxicity; and in addition, most workers are highly trained.

RESPONSIBILITIES

Supervisors/Management:

- Identify hazards for respective work areas.
- Ensure hazards are properly labeled.
- Obtain/maintain copies of material safety data sheets, as required, of each hazardous material used in the work area and make them accessible to employees during each work shift.
- Have the written Hazard Communication Program available to all employees.
- Provide hazard specific training for employees.
- Identify hazardous materials in the hazard review section of the LBL purchase requisition form.

Employee:

- Attend safety training meetings.
- Perform operations in a safe manner.
- Notify management immediately of any safety hazards or injuries.
- When ordering materials, identify hazardous chemicals in the hazard review section of the LBL purchase requisition form.

Environmental Health and Safety Department:

- Assist the Toxic Substances Safety Subcommittee in developing the written Hazard Communication Program.
- Maintain a central file of material safety data sheets.
- Review and update LBL stock safety labels.
- Provide generic training programs.
- Assist supervisors in developing hazard specific training programs.

Toxic Substances Safety Subcommittee:

- Oversee the Hazard Communication Standard written policy and implementation plans.

Plant Engineering Department:

- Alert on-site contractors to hazardous materials in work areas.
- Alert on-site contractors that they must provide to their employees information on hazardous materials that they bring to the worksite.

Purchasing Department:

- Submit copies of all requests for hazardous materials to the EH&S Department.
- Designate controlled items (e.g., carcinogens) for "A" distribution as defined in the LBL Procurement Guide.

Materiel Management Department:

- Submit copies of all stockroom additions of hazardous materials to the EH&S Department.
- Notify EH&S when items designated for "A" distribution are received.

LABELING

Hazard warning labels are required on the original shipping container and any containers subsequently used for storage. The label must show the name of the material and provide hazard warnings appropriate for employee protection. The labels must be legible and prominently displayed. Labels on shipped containers must also include the name and address of the chemical manufacturer, importer, or other responsible party. * Other forms of warning (e.g., tags) are also acceptable, provided that the above requirements are met.

Labels on containers which an employee fills for his (sic) personal use during a single work day are not required to show hazard warnings; however, the identity of the material must be shown.

Labels for chemicals commonly used at LBL are available at the Central Storeroom, Building 7. See Appendix A for a list of stocked labels.

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* Labels on shipping containers provided by the manufacturer provide all the appropriate information. Do not remove them.

MATERIAL SAFETY DATA SHEETS

Manufacturers and distributors are required to develop material safety data sheets (MSDS's) for each hazardous material they produce or import. All MSDS's provide information regarding the specific chemical identity of the material(s) involved and the common names; information on its physical and chemical characteristics; known acute and chronic health effects and related health information; exposure limits; precautionary measures; emergency and first aid procedures; and the identification of the organization responsible for preparing the sheet.

Every work area at LBL, with the exception of individual research laboratories, must have readily accessible to the employees an MSDS for every hazardous material used in the area. If an MSDS is inadvertently not received at the time of the first shipment, a copy may be obtained through the files in the industrial hygiene office (extension 5829). If the MSDS is not on file, the Industrial Hygiene Group will contact the manufacturer and obtain one.

Individual laboratories must only maintain those MSDS's which are received with their shipments, and need not obtain an MSDS for every hazardous material in their work areas.

A list of hazardous materials is on file in the industrial hygiene office and in the binders, distributed to all program divisions, which contain MSDS's for LBL stocked materials.

TRAINING

Employees must be provided training on the hazards to which they may be exposed and the means to avoid those hazards. Training must be updated when a new hazard is introduced into the workplace. New employees must be trained at the time of their initial assignment to work with a hazardous material.

The training must include:

- which operations involve hazardous materials;
- potential chemical, physical, and biological hazards;
- applicable health standards;
- purpose and results of exposure monitoring;
- purpose and use of control measures;
- personal protection equipment;
- detection systems—odors, monitors, alarms, symptoms, etc.;
- material safety data sheets—location and how to use;
- the requirements of the Standard.

The hazards associated with both routine and non-routine tasks should be addressed in the training, including the hazards presented by hazardous materials in unlabeled pipes.

Supervisors should keep records on the subjects covered and training methods used. Attendance should also be taken at training meetings, and a copy of the list sent to the EH&S training office at Building B75B.

Assistance in developing a training program is available through Environmental Health and Safety. Audio-visual aids may be borrowed from the training office at Building B75B.

Appendix A

SAFETY LABELS, SIGNS AND TAGS AVAILABLE THROUGH STOREROOM

Description	Size Inches	LBL Stock #4280	Site*
A-9 Aluminum Cutting Tool Fluid — CAUTION	4 x 7	69388	2
Acetone — DANGER	2 x 3	45113	1,2,3
	4 x 7	45114	1,2,3
Acid Waste Only — CAUTION	4 x 7	67081	2
Acids, General (write-in name) — DANGER	2 x 3	46521	2
	4 x 7	46522	2
Asbestos Fibers, Contains — DANGER	3 x 5	65094	2
Benzene — DANGER	2 x 3	45117	1,2
Beryllium — DANGER	2 x 3	45118	1,2,3
Beryllium, Contains	3/4 x 1-1/2	34846	2
Cancer Suspect Agent, Authorized Personnel Only — CAUTION	10 x 14	67345	2
Cancer Suspect Agent — DANGER (write-in name)	1 x 3	67347	2
Carbon Tetrachloride — DANGER	2 x 3	45119	2
Chemical Carcinogen — DANGER	1 x 3	64462	1,2
Caustic (Base) Waste Only — CAUTION	4 x 7	67080	2
Caution Blank	3 x 5	64646	2
	7 x 10	64647	2

* Site: 1 - Lawrence Berkeley Laboratory
2 - Lawrence Livermore National Laboratory
3 - Site 300 (LLNL)

Description	Size Inches	LBL Stock #4280	Site*
Cool-Tool Cutting Oil — CAUTION	4 x 7	69389	2
Danger Blank (metal)	7 x 10	64618	2
	10 x 14	64624	2
Danger Blank (plastic)	7 x 10	64643	2
Ethyl Alcohol — WARNING	3 x 5	51249	1
	4 x 7	51250	1
Ethyl Alcohol, 190 Proof — WARNING	2 x 3	53190	1,2
Ethyl Alcohol, 200 Proof — WARNING	2 x 3	53191	1,2
Eye Hazard Area — CAUTION	10 x 14	64634	2
Eye Protection Required — CAUTION	7 x 10	34841	2,3
Eye Wash	7 x 17	69370	2
Flammable Solvents — DANGER (write-in name)	2 x 3	46525	1,2,3
— WARNING (write-in name)	4 x 7	46526	2,3
Fluorocarbon TF Solvent	3 x 3	67676	2
	4 x 7	67677	2
Gasoline — DANGER	4 x 7	45120	1,2,3
Isopropyl Alcohol — WARNING	2 x 3	45133	1,2,3
	5 x 7	46518	1,2
Kerosene — CAUTION	2 x 3	46519	1,2,3
— WARNING	4 x 7	45122	1
Lacquer Thinner — WARNING	4 x 7	51256	1
Laser — DANGER	10 x 14	67821	2
Laser Beam, Avoid — CAUTION	10 x 14	67822	2
Mercury — DANGER	2 x 3	45123	1,2
	4 x 7	45124	2
Methanol — DANGER	4 x 7	51251	1
Methyl Ethyl Ketone — WARNING	2 x 3	45125	1,2,3
	4 x 7	45126	1,2,3
Notice Blank	3 x 5	64649	2
	7 x 10	64652	2
Organic Waste Solvents — CAUTION	4 x 7	67079	2
Oxygen Gas — CAUTION	10 x 14	67035	2
PCB, Equipment Contains — CAUTION	3 x 5	67091	2
Perchloroethylene — WARNING	2 x 3	45127	2
	4 x 7	51257	1
Peroxides, Organic — WARNING	2 x 3	48051	2
Poisons — DANGER (write-in name)	2 x 3	46523	1,2
Polychlorinated Biphenyls (PCB) — CAUTION	1 x 2	64776	1
	6 x 6	64775	1
Safety Shower	7 x 17	69371	2
Toluene — WARNING	4 x 7	51258	1
1,1,1-Trichloroethane — CAUTION	2 x 3	45131	1,2
— WARNING	4 x 7	45132	1,2
Trichloroethylene — WARNING	2 x 3	45130	1,2,3
	4 x 7	46520	2

* Site:
1 - Lawrence Berkeley Laboratory
2 - Lawrence Livermore National Laboratory
3 - Site 300 (LLNL)

Appendix 2.

SUPERVISOR'S CHECK LIST

A. Identify hazardous substances.

- Do a walk-through survey of your work area, and make a list of the chemical products, physical and biological hazards, and operations involving potential exposure. Note chemical name, manufacturer, and manufacturer's address.
- Check purchase orders.
- Check with Industrial Hygiene for any existing inventories for shop areas.
- Update inventory list when new hazardous materials are used.

B. Request MSDS's and make them accessible to employees.

- Make arrangements for having MSDS's accessible (e.g., in centrally located binders).
- Let employees know where/how to get copies of, or see, MSDS's.
- Call Industrial Hygiene for assistance in obtaining MSDS's you do not have.

C. Inspect hazardous materials to make sure they are properly labeled.

- Check original containers.
- Check secondary storage containers—name and hazard warnings required.
- Check immediate-use containers—name of material only required.
- Check laboratory glassware—individual labels or area signs required.

D. Train your employees to work safely with hazardous substances.

- Provide general training, which can be covered by using the "Right To Know" slide show and booklet. Call EH&S to make arrangements. Topics covered include: an overview of toxic materials, health effects, basic protective measures, how to use an MSDS, and chemical labels.

- Provide specific training on hazardous effects, handling, storage, disposal, etc., for the hazardous materials involved. Consult with Industrial Hygiene if you need additional health information.

- Make provisions for hazard communication training for new employees.

- Provide safety training when a new hazard is introduced.

- Keep accurate records.

Appendix 3.

HAZARDS INVENTORY CHECK LIST

The following list of categories and subcategories is a guideline to help you identify, list, and label hazards in your work area(s).

CHEMICAL HAZARDS

flammable liquids
reactives (oxidizers, water reactives, light sensitives, peroxide formers, pyrophorics)
corrosives (acids, bases)
carcinogens/teratogens/mutagens
other toxic substances

PHYSICAL HAZARDS

microwave generators
equipment producing high levels of noise
lasers
high-voltage electricity
magnetic fields
radiofrequency sources
extreme temperatures (hot/cold)
ultraviolet light sources
high-pressure systems

BIOLOGICAL HAZARDS

infectious agents

Appendix 4.

SPECIAL CASES

You may have many questions about how this standard applies to certain situations that are not covered in the general requirements. The following information provides some answers.

Warehouse and Transportation: If normal work conditions and operations involve handling sealed containers, you do not have to provide information, training, and MSDS's on every material that is stored and transported. Do not remove labels from incoming materials. Maintain and provide access to any MSDS's that are received. Again—you do not have to have an MSDS for every material. Training need only cover general information on hazardous exposures, the Hazard Communication Program, emergency procedures in the event of a spill or leak, and where and how to acquire information when needed.

Household Products: Many common household products contain toxic chemicals. If a common household product is used in the workplace, and the exposure is no greater than occasional ordinary household use, the product does not have to be included in the activities of the Hazard Communication Program. However, if an employee is working with the substance more often, then the exposure is great enough to warrant inclusion in hazard communication. If you are uncertain about the type and amount of exposure, ask Industrial Hygiene and/or obtain the MSDS.

Office Products: Office products containing toxic chemicals must be included in the Hazard Communication Program if the exposure is frequent or significant. For example, the person(s) responsible for replenishing the toner in the copy machine should receive information and training about the toner. Other office staff do not need this training. Office workers who may encounter hazardous materials in isolated and unexpected situations are not required to be included in the Hazard Communication Program.

Outside Contractors: Outside contractors are responsible for their own compliance with the components of the Hazard Communication Standard, i.e., the availability of MSDS's, proper labeling, and training for their own employees concerning hazardous materials.

Appendix 5.

TRAINING CLASS ENROLLMENT FORM

LAWRENCE BERKELEY LABORATORY
HAZARD COMMUNICATION TRAINING
CLASS ENROLLMENT LIST

Division_____ Department_____

Course length_____ One copy to EH&S, Mail Stop B75B-101
One copy for your files

Topic(s):

Instructor(s)_____
_____
_____

Date	Employee No.	Name	Phone

Appendix 6.

TRAINING CHECK LIST

The following list describes the topics that must be included in hazard communication training.

- The purpose of training;
- Relevant orders and standards;
- Employee rights under the law;
- Location of written Hazard Communication Program;
- Where to find MSDS's;
- How to use an MSDS;
- Review of labeling system;
- Operations in work area where hazardous materials are present or produced, e.g., welding;
- Physical and other health hazards of hazardous materials;
- Methods used to detect the presence of hazardous materials, including any monitoring;
- Protective measures provided by employer;
- Protective methods that must be used by employees;
- How to see medical and exposure records.

Appendix 7.

SAFETY PERFORMANCE CHECK LIST

You may use the following list to help you assess safe work practices and the effectiveness of safety training.

Do employees:

- Leave food, drinks, and cigarettes outside work areas where hazardous materials are present?
- Know what flammable, toxic, and reactive materials are in the work area?
- Check for potential ignition sources around flammable materials?
- Know when to remove flammables before work begins?
- Know what incompatible materials cannot be stored together?
- Know what to do in an emergency?
- Request to see hazard information and/or MSDS's?
- Always work with a partner when doing hazardous jobs?
- Regularly inspect and maintain protective equipment?
- Always use appropriate personal protective equipment?
- Check ventilation systems as needed?
- Read the container labels?
- Dispose of chemicals and hazardous waste properly?

Appendix 8.

GLOSSARY OF USEFUL TERMS

-A-

Acute effect - Symptom of exposure to a hazardous material that soon appears after a short-term exposure, coming quickly to a crisis.
Acute exposure - A single, brief exposure to a large dose of a toxic substance. Adverse health effects are evident soon after exposure.
Acute toxicity - Adverse biological effects of a single dose of a toxic agent.
Aerosol - A suspension of fine solid or liquid particles in air (e.g., paint spray, mist, fog).
Anesthetic - A chemical that causes drowsiness. Large doses of anesthetic chemicals can cause unconsciousness, coma, and death.
ANSI - American National Standards Institute. This privately funded, voluntary organization develops standards for the safe design and operation of equipment and safe practices or procedures for industry.
Asphyxiant - A chemical vapor or gas that replaces air and can, thereby, cause death by suffocation. Asphyxiants are especially hazardous in confined spaces.

- C -

Carcinogen - A chemical or physical agent that is known to cause cancer in humans or is thought possibly to cause cancer, based on evidence from experimental animals.
Cardiac - Term used to refer to the heart.
CAS Number - Chemical Abstract Service registry number, which is used to identify a specific chemical.
cc - Cubic centimeter. A metric-system volume measurement equal to a milliliter (ml). One quart is about 946 cc (946 ml).
Ceiling Limit - The maximum allowable exposure limit for an airborne chemical, which is not to be exceeded even momentarily. See also PEL and TLV.
Central nervous system - The part of the body made up of the brain, spinal cord, and nerves.
Chemical family - Chemicals with similar structural characteristics are grouped into a chemical family (e.g., ketones, alcohols, hydrocarbons).
Chronic exposure - Repeated exposure or contact with a toxic substance over a long period. Adverse biological effects from chronic exposure develop slowly, last a long time, and frequently recur.
Chronic effect - Symptom of exposure to a hazardous material that develops slowly after many exposures or that recurs often.

Chronic toxicity - Adverse biological effect of repeated doses or long-term exposure to a toxic agent.
Combustible - Able to catch on fire and burn. A liquid that will burn is called a "combustible liquid." Nonliquid substances that will burn, such as wood and paper, are called "ordinary combustibles." (See flammables.)
Concentration - The relative amount of a given substance present when mixed with another substance(s). Concentration is often expressed as parts per million (ppm), percent, or weight per unit volume, e.g., milligrams/cubic meter (mg/m^3).
Corrosive - A chemical that causes visible destruction of, or irreversible changes in living tissue by chemical action at the site of contact, or that has a severe corrosion rate on structural materials.

- D -

Decomposition - The breakdown of a material into a simpler compound by chemical reaction, decay, heat, or other process.
Density - The mass of a solid per unit volume. The density of a substance is usually compared to water, which has a density of 1. Substances that float on water have densities of less than 1; substances that sink in water have densities greater than 1.
Dermal - Term used to refer to skin.
Dermatitis - An inflammation of the skin, which can be caused by irritation (chemical, physical, or mechanical) or allergic reaction.
Dose - The amount of a substance received during exposure.

- E -

Epidemiology - The branch of medical science that deals with the incidence, distribution, and control of disease in a population.

- F -

Flammable - A flammable substance is one that will catch on fire and burn rapidly under ordinary conditions; for example, liquids with a flash point below 100°F and solids that ignite readily.
Formula - The molecular composition of a chemical compound written in scientific symbols. Water is H_2O; hydrochloric acid is HCl.

- G -

g/kg - Grams per kilogram. A term used in experimental testing to indicate the dose of a test substance, in grams, given for each kilogram of the test subject's body weight.

- H -

Hazard warning - The words, pictures, and symbols, or combination thereof, that appear on a label and indicate the hazards of the substance in the container.
Hazardous chemical - A chemical or mixture of chemicals that can produce adverse physical effects (e.g., fire, explosion) or health effects (e.g., dermatitis, cancer).
Health hazards - Substances for which there is evidence, from at least one scientific study, that acute or chronic health effects may occur in exposed persons. These chemicals include carcinogens, toxic agents, reproductive toxins (mutagens and teratogens), irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents that damage the lungs, skin, eyes, or mucous membranes.
Hematopoietic system - The blood-forming organs of the body, including bone marrow and the spleen.
Hepatotoxin - A chemical that can cause liver damage (e.g., carbon tetrachloride).

- I -

IARC - International Agency for Research on Cancer. IARC publishes "Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man," one of the publications used to determine the cancer risk of a chemical.
Ignition temperature - The lowest temperature at which a substance will ignite and continue to burn. The lower the ignition temperature, the more likely the substance is to be a fire hazard.
Ingestion - Taking a material into the body through the mouth and swallowing it.
Inhalation - Taking a material in the form of a vapor, gas, dust, fume, or mist into the body by breathing it.
Inhibitor - A chemical added to a substance to prevent the occurrence of an undesirable chemical reaction.
Irritant - A substance that may not be corrosive but that can, with direct contact, cause a reversible effect on the skin, eyes, or respiratory system.

- L -

Lacrimation - Abnormal or excessive production of tears as a result of exposure of the eyes to an irritant.
LC_{50} - The concentration of a substance in air that will kill half (50%) of the exposed test animals. A measure of acute toxicity.
LD_{50} - The dose of a substance that will kill half (50%) of the treated test animals when given as a single dose. A measure of acute toxicity.
LEL or LFL - Lower Explosive Limit or Lower Flammable Limit.
Local exhaust - A ventilation method for removing contaminated air at the point where the contaminants are generated (e.g., a fume hood).

- M -

m^3 - Cubic meter. A volume measurement in the metric system. One m^3 is about 35.3 cubic feet or 1.3 cubic yards.
Mechanical exhaust - A powered device, e.g., a motor-driven fan, that removes contaminants from a work area or enclosure.
mg/kg - Milligrams per kilogram. A term used in experimental testing to indicate the dose of a test substance, in milligrams, that was given for each kilogram of body weight of the test animal.
mg/m^3 - Milligrams per cubic meter. A way of expressing the concentration of dusts, gases, aerosols, or mists in the air.
Mist - A suspension in air of finely divided particles of liquid.
Mucous membranes - A protective lining of cells found, for example, in the mouth, throat, nose, and other parts of the respiratory system.
Mutagen - A substance capable of causing damage to genes and chromosomes, particularly those of sperm or egg cells, resulting in mutations.
Mutation - A genetic alteration that can be inherited, thus affecting future generations.

- N -

Narcosis - A state of deep unconsciousness caused by the influence of a drug or other chemical.
Nephrotoxin - A chemical that causes kidney damage (e.g., uranium).
Neurotoxin - A chemical whose primary toxic effect is on the nervous system (e.g., carbon disulfide).
NFPA - National Fire Protection Association. This organization provides information on fire protection and prevention. The NFPA 704 "Standard for the Identification of the Fire Hazards of Materials" describes a hazard-warning placarding and labeling system.
NIOSH - National Institute for Occupational Safety and Health. This agency of the Public Health Service, U. S. Department of Health and Human Services (DHHS), tests and certifies respiratory devices, recommends occupational exposure limits, and assists OSHA by conducting research and investigations.
NTP - National Toxicology Program. Publishes "Annual Report on Carcinogens," listing substances either known or anticipated to be carcinogens.

- O -

Odor threshold - The lowest concentration of a substance's vapor, in air, that a person can detect by smell. Odor thresholds are highly variable, depending on the individual and the nature of the substance.
Olfactory - Term used to refer to the sense of smell.
Oral - Term used to refer to the mouth.

Organic peroxide - A type of oxidizer that is very useful because of its reactive properties, considered by law (OSHA) to be a physical hazard.
OSHA - Occupational Safety and Health Administration. This government agency develops and enforces occupational safety and health standards for most industry and business in the U. S.
Oxidation - A reaction in which a substance combines with oxygen to cause chemical change (e.g., fire). In a broader sense, oxidation is a reaction in which electrons are lost and is accompanied by reduction—a reaction in which electrons are gained.
Oxidizer - A material that causes the ignition of combustible materials without an external source of ignition. When mixed with combustible materials, an oxidizer increases the rate of burning of these materials when the mixtures are ignited. Oxidizers usually contain their own oxygen, can, therefore, burn in an oxygen-free atmosphere, are usually very unstable or reactive, and pose a serious fire hazard.

- P -

PEL - Permissible Exposure Limit. The legal maximum amount of a substance allowed by OSHA in workplace air. This limit must not be exceeded.
pH - A measure of how acidic or basic (caustic) a substance is on a scale of 1 (very acidic) to 14 (very basic); pH 7 indicates that the substance is neutral.
Physical hazard - A substance that is a combustible liquid, a compressed gas, an organic peroxide, or an oxidizer and is explosive, flammable, pyrophoric, unstable (reactive), or water-reactive.
Polymerization - A chemical reaction in which individual molecules combine to form a single large molecule (a polymer). Hazardous polymerization is an uncontrolled reaction releasing large amounts of energy (heat).
ppb - Parts per billion. A term used to express very small concentrations of a given substance present in a mixture. Often used as a unit to measure the parts (by volume) of a gas or vapor in a billion parts of air.
ppm - Parts per million. A term used to express small concentrations of a given substance present in a mixture. Often used as a unit to measure the parts (by volume) of a gas or vapor in a million parts of air.
Pulmonary - Term used to refer to the lungs.
Pyrophoric - A chemical that can catch on fire spontaneously in air at or below 130°F.

- R -

Reactivity - A term used to describe the ease with which a chemical can undergo change, usually by reacting with another substance or by breaking down. Highly reactive substances may explode.
Respiratory protective equipment - Air cleaning or air supplying respirators that protect against toxic materials in the air.
Route of entry - The way a toxic substance enters the body. For example, absorption through the skin, inhalation, ingestion. May also be called mode of entry.

- S -

Sensitizer - A substance that can cause an allergic reaction, which usually appears after repeated exposure.
Solubility in water - A term used to indicate the amount, in %, of a substance that will dissolve in water. Solubility information is important for determining spill-cleanup and firefighting procedures.
Solvent - A liquid that dissolves other substances. Some common solvents are water, alcohol, and mineral spirits.
STEL - Short Term Exposure Limit is the maximum concentration allowed in a continuous, 15-minute exposure. There may be no more than four such exposures each day with at least one hour between exposures. The daily TWA cannot be exceeded, however.
Suspect carcinogen - A substance that might cause cancer in humans but has not yet been proven to do so.
Synonym - Another name by which a chemical is known. For example, synonyms for methyl alcohol are methanol and wood alcohol.
Systemic poison - A substance that has a toxic effect upon several organ systems of the body.

- T -

Target organ effects - Effects on specific organs of the body caused by exposure to a hazardous chemical.
TLV - Threshold Limit Value. The airborne concentration of a substance below which no adverse health effects should occur. TLV's, established by the American Conference of Governmental Industrial Hygienists (ACGIH), are voluntary limits expressed in three ways (STEL, TLV-C, TWA).
TLV-C - Threshold Limit Value-Ceiling is the maximum concentration of a toxic substance for which exposure is allowed. This limit is not to be exceeded, even momentarily. The TWA must still be observed.
TWA - Time Weighted Average is the exposure limit averaged over a normal 8-hour workday or 40-hour workweek.
Toxic substance - A substance that causes harmful biological effects after either short-term or long-term exposure.
Toxicity - All of the adverse biological effects resulting from exposure to a harmful substance.

- U -

UEL - Upper Explosive Limit.
UFL - Upper Flammable Limit.
Unstable - A chemical is unstable if it tends to decompose or undergo other undesirable chemical changes during normal handling or storage.

-V-

Vapor - The gas given off by a liquid or solid at room temperature.
Ventilation - Term used to describe the method by which inside air is circulated.
Vertigo - Term meaning to be dizzy.
Viscosity - A term used to describe the rate at which a liquid flows or pours. A very viscous liquid, like molasses, flows slowly.
Volatile - A term used for liquids that evaporate at room temperature. Very volatile liquids, such as gasoline, form vapors (evaporate) quickly and are a breathing hazard.

- W -

Water-reactive - A chemical that reacts with water to release a flammable or toxic gas.

LAWRENCE BERKELEY LABORATORY
TECHNICAL INFORMATION DEPARTMENT
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720