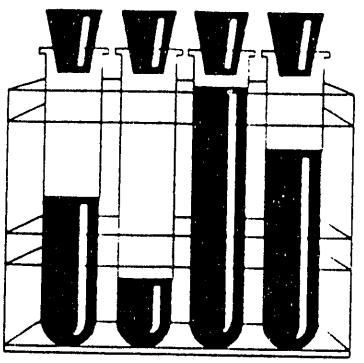
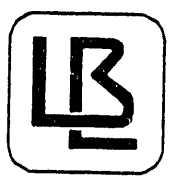
PUB-5341
August 1992

CHEMICAL HYGIENE AND SAFETY PLAN





Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720

Prepared for the U.S. Department of Energy under Contract No. DE-AC03-76SF00098

MEMORANDUM

August 28, 1992

LBL-PUB--5341

DE93 000589

TO: Distribution, PUB-3000

FROM: Klaus Berkner, Associate Laboratory Director for Operations

SUBJECT: LBL Chemical Hygiene & Safety Plan; PUB-3000 Addendum

---

The Department of Energy requires that LBL comply with all Federal OSHA regulations. For operations involving hazardous chemicals, both the OSHA Hazard Communication Standard (29 CFR 1910.1200) and the OSHA Laboratory Standard (29 CFR 1910.1450) apply. The Hazard Communication Standard applies to all non-laboratory operations; and, the Laboratory Standard (which is fairly new) applies to laboratory operations.

This Chemical Hygiene and Safety Plan (PUB-5341) incorporates the requirements of these OSHA standards and is designed to provide all LBL personnel with a comprehensive program to minimize the risks of working with chemicals. The Plan sets forth safety procedures and describes how LBL workers are informed about the potential chemical hazards in their work areas so they can avoid harmful exposures and safeguard their health. Many specific topics are addressed, such as procedures for working with toxins (e.g., cancer-causing agents, metals, reproductive toxins), training and general responsibilities for ensuring health and safety in the laboratory.

The Plan was drafted by the EH&S Industrial Hygiene Group, reviewed and edited by several EH&S professionals, and further reviewed by members of the Toxic Chemicals Subcommittee, which operates under the Safety Review Committee.

The Plan provides the framework for a comprehensive chemical hygiene program. Actual implementation of the program requires detailed training and a commitment from line management. The EH&S Industrial Hygiene and Training Groups will be working with Divisional Safety coordinators to provide division-specific workshops to help all LBL Divisions in implementing the program.

The Chemical Hygiene and Safety Plan expands upon and supersedes Chapter 5 of the LBL Health and Safety Manual (Pub-3000). Please discard chapter 5 of PUB-3000 and replace it with the attached insert page that will serve to direct readers to this new publication.

Attachments: 1

CHAPTER 5

CHEMICAL SAFETY

August 28, 1992

Replace the contents of PUB-3000, Chapter 5 with this insert page.

Chapter 5, "Chemical Safety," is superseded by a new publication issued in August, 1992: PUB-5341, "Chemical Hygiene and Safety Plan". Please refer to this publication for information on chemical safety. Other chapters in PUB-3000 dealing with specific topics related to chemical safety are still in effect.

[redacted]

Matt Kotowski, Head
Safety Department
Environment, Health & Safety Division

PUB-5341
August 1992

CHEMICAL HYGIENE AND SAFETY PLAN

Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720

Prepared for the U.S. Department of Energy under Contract No. DE-AC03-76SF00098

Chemical Hygiene and Safety Plan

Contents

E. STANDARD HYGIENE AND SAFETY PRACTICES, Continued

Chemical Hygiene and Safety Plan

Appendices

A. INTRODUCTION

1. Objective

The objective of this Chemical Hygiene and Safety Plan (CHSP) is to provide specific guidance to all LBL employees and contractors who use hazardous chemicals. This Plan, when implemented, fulfills the requirements of both the Federal OSHA Laboratory Standard (29 CFR 1910.1450) for laboratory workers, and the Federal OSHA Hazard Communication Standard (29 CFR 1910.1200) for non-laboratory operations (e.g., shops). It sets forth safety procedures and describes how LBL employees are informed about the potential chemical hazards in their work areas so they can avoid harmful exposures and safeguard their health. Generally, communication of this Plan will occur through training and the Plan will serve as a the framework and reference guide for that training.

Health and safety hazards at Lawrence Berkeley Laboratory are as varied as the operations and procedures performed at LBL. They range from common industrial hazards presented by shop machinery and motor vehicles to the special hazards associated with research, including those presented by toxic chemicals, chemical carcinogens, heavy metals, and flammable liquids. Physical hazards range from high voltage electricity and pressure vessels to ionizing radiation.

This Plan focuses on *chemical hazards*. Chemical hazards are present when materials are reactive, explosive, corrosive, flammable, or toxic, and more than one hazardous property may be presented by a single material. Many chemicals are relatively nonhazardous by themselves but become dangerous when they interact with other substances, either in planned experiments or by accidental contact.

2. Policy

It is LBL's policy to provide a safe and healthful working environment for its employees. It is also LBL's policy to protect property from damage or loss caused by an accident and to prevent any harm to the general public or the environment as a result of activities at LBL. Every supervisor is responsible for managing the safety of the people he or she supervises. It is a requirement of employment and a

precondition for using Laboratory facilities that every employee, guest, visiting scientist, or contractor working on or off site, must be familiar with and implement LBL safety standards. Individual Divisions and facilities may have additional rules and procedures that must also be followed.

This Chemical Hygiene and Safety Plan is intended to ensure that all LBL workers are minimally exposed to hazardous chemicals to the extent reasonably possible. Exposures to airborne chemicals are to be kept below the Permissible Exposure Levels set forth in the Code of Federal Regulations (29 CFR 1910.1000) and the Threshold Limit Values set forth by the American Conference of Governmental Industrial Hygienists. This is accomplished with the proper combination of engineering, administrative, and personal protective controls.

3. Background

The Occupational Safety and Health Administration (OSHA) first promulgated the Toxic and Hazardous Substances Hazard Communication Standard (29 CFR 1910.1200) in 1983 for manufacturing industries. The standard was developed to inform workers who worked with hazardous chemicals of the risks associated with those chemicals. Hazard information was to be transmitted by material safety data sheets (MSDSs) and container labels. In 1987, the Hazard Communication Standard (included as Appendix 1) was expanded to cover non-manufacturing as well as manufacturing industries. The Hazard Communication Standard also applied to laboratories, but with less requirements, because a separate Laboratory Standard was to specifically address laboratories.

The "Laboratory Standard," published as "Occupational Exposures to Hazardous Materials in Laboratories" (included as Appendix 2), was promulgated in 1990. OSHA promulgated the Laboratory Standard on the basis that (1) laboratories typically differ from industrial operations in their use and handling of hazardous chemicals, and (2) a different approach than that found in OSHA's substance-specific health standards is warranted to protect laboratory workers.

"Laboratory use" is defined as "work with substances in which all of the following conditions are met":

- Chemical manipulations are carried out on a laboratory scale. That is, the work with chemicals is in containers of a size that could be easily and safely manipulated by one person.

- Multiple chemical procedures are used.

- Protective laboratory practices and equipment are available and commonly used.

- The procedures involved are not part of a production process whose function is to produce commercial quantities of materials, nor do the procedures in any way simulate a production process.

A glossary of terms common to both Standards, which includes the above definition, is included as Appendix 3.

The Laboratory Standard was written to supersede the Hazard Communication Standard and substance-specific OSHA health standards for *laboratory operations.* The Laboratory Standard differs from many OSHA health standards in that it does not establish new exposure limits, but requires additional performance provisions designed to protect laboratory workers from potential hazards in their work environments. The manner in which this is achieved is left to the discretion of each laboratory, but must involve the formulation and implementation of a Chemical Hygiene Plan.

The Department of Energy has mandated that LBL comply with Federal OSHA regulations. Consequently, both the Hazard Communication Standard and the Laboratory Standard apply, depending on the nature of the operation (i.e., laboratory operations vs. non-laboratory operations). The following section explains the scope of this Chemical Hygiene and Safety Plan.

4. Scope and Implementation

This Chemical Hygiene and Safety Plan (CHSP) is designed to provide *all* LBL personnel with a program to minimize the risks of working with chemicals; therefore, *it applies to all operations where hazardous chemicals are used.* LBL operations that include the use of hazardous chemicals are both laboratory and non-laboratory operations. Generally, the non-laboratory operations are shops (e.g., light assembly, etc.); however, some office-type operations might include the infrequent use of chemicals.

The advantage of having one broad plan for laboratory and non-laboratory operations is that it sets forth a standardized framework for chemical hygiene practices, information dissemination, and training at LBL. And, uniformity and simplicity help promote and ensure regulatory compliance.

The CHSP expands upon and supersedes Chapter 5 of the *LBL Health and Safety Manual* (Pub-3000). However, other chapters of the *LBL Health and Safety Manual* also contain pertinent chemical hygiene information, and these chapters are referenced as appropriate.

Note that while this CHSP provides the framework for chemical hygiene procedures, *the Laboratory Standard is not fully implemented until facility-specific chemical hygiene information is provided.* Facility-specific hazard information and written safety procedures are to be provided by each LBL facility within a notebook, the "Facility Notebook." The overall purpose of the Facility Notebook is to provide an organized body of facility-specific information and documentation to support compliance with DOE Order 5480.19, "Conduct of Operations," and to provide facility-specific health and safety information required by the Laboratory Standard and other OSHA standards.

The Facility Notebook serves to provide the following site-specific information *required* by the Laboratory Standard:

- Facility description and chemical hazard identification;
- Operator responsibilities;

- Lab/Shop-Specific Safety Procedures (SSPs) for routine operations using hazardous chemicals;
- Operational Safety Procedures (OSPs) for all extremely hazardous operations (those utilizing toxic gases, high radiation, etc.);
- Chemical hazard information;
- Recordkeeping; and
- Emergency protocols.

B. ROLES AND RESPONSIBILITIES

Every employee, visiting scientist, student, or other person performing work at the LBL or at one of the LBL's off-site locations is responsible for understanding the properties of the chemicals with which they will work, following all applicable safety standards and for taking the initiative in consulting with resource groups (e.g., individual EH&S Departments) when safety-related assistance or advice is needed. When faced with an unexpected threat of malfunction, injury, or damage, employees are expected to choose a course of action that provides the most protection to themselves and to others in the area. Every employee is expected to report to the supervisor any unsafe condition or practice seen in the area that would not permit him/her to work safely.

The following sections further define the roles and responsibilities of various parties.

1. Employees

Employees at LBL must:

- Work safely by observing safety standards, guidelines, and procedures, and by using good judgement based on training and expertise.
- Report unsafe conditions or injuries to the Principal Investigator or Supervisor immediately.
- Stop work under unsafe conditions.
- Be familiar with and follow emergency procedures.
- Attend safety training meetings.
- When ordering materials, identify hazardous chemicals in the hazard review section of the LBL purchase requisition form.

LBL employees have the right to:

- Be notified of measured or suspected exposures to harmful substances above legal occupational exposure limits.
- Be given an opportunity to observe monitoring for hazardous substances.
- Request a medical consultation.
- Access their workplace medical and exposure records.
- Refuse to work in unsafe conditions or to perform work that could create a hazard to them or other workers.
- File confidential health and safety complaints with the local Department of Energy (DOE) office. Employees may write a letter, submit Form 5480.4 (available from EH&S), or phone in a complaint to the Environmental Safety & Support Department, DOE-SAN, 1333 Broadway, Suite 650, Oakland, CA 94612; (510) 273-7963. Complaints will be investigated promptly, and all information is strictly confidential.

2. Principal Investigators and Supervisors

The Principal Investigator or Laboratory/Shop Supervisor:

- Has responsibility for day-to-day laboratory or shop personnel and operations.
- Enforces LBL safety rules and establishes specific safety procedures (SSPs) for all pertinent laboratory/shop operations and procedures (see Appendix 4).
- Ensures that employees, students, visiting scientists, and participating guests are trained in safety procedures, are familiar with the specific hazards in their work area(s), and have knowledge of the specific warning signs and symptoms of being exposed to the chemicals with which they work.

- Corrects improper work practices, identifies deficient conditions that could result in personal injury, and develops a positive attitude among employees toward hazard and accident prevention.

- Investigates and reports to Environment, Health & Safety and to their Department Head or Director every accident (requiring more than first aid) and significant "near miss" accidents that might have resulted in serious injury. [Note: Some accidents are reportable to DOE as an Unusual Occurrence Report (UOR). Contact the EH&S UOR Coordinator at Ext. 7612.]

- Ensures that a corrective action identified from an accident investigation or laboratory/shop inspection is implemented.

- Ensures hazards are properly labeled and controlled.

- Obtains and maintains copies of Material Safety Data Sheets (MSDSs), as required for each hazardous material used in the work area and ensures that they are readily accessible to all employees.

- Ensures that the CHSP, Pub-3000, and the Facility Notebook (with specific safety procedures) are readily available to all employees.

- Identifies hazardous materials on the LBL Purchase Requisition Form when ordering.

- Conducts periodic inspections or self-assessments to audit compliance with health and safety procedures.

- Conducts a review of laboratory/shop hazards, controls, procedures at least annually and when any new or altered procedure is introduced.

- Conducts an inventory of their hazardous materials at least annually, and more often if substantial changes occur in the quantities and/or types of materials.

3. Division Directors and Managers

Division Directors and Managers must:

- Ensure that environmental, health, and safety concerns reported by their employees are addressed.
- Provide the Supervisors and Principal Investigators with the resources needed to safely manage their staff and operations.
- Ensure that life-safety hazards are properly controlled in the facilities and operations for which they have responsibility.
- Ensure that a mechanism is in place to review and evaluate new research projects or operations and other unique activities for their potential hazards and for adequacy of the planned safety controls.
- Determine whether a proposed research project or shop operation requires an Operational Safety Procedure (OSP) during the project proposal phase.
- Ensure that accidents are thoroughly investigated and corrective action is taken to prevent a reoccurrence.
- Ensure documentation of key safety and health decisions in the minutes of the Division Safety committee.
- Ensure that all violations of codes and safety standards identified by reviews or inspections are corrected in a timely manner.

4. Chemical Hygiene Officer

The LBL "Chemical Hygiene Officer" is the EH&S Industrial Hygiene Group. The staff industrial hygienists and Group Leader all serve as Chemical Hygiene Officers. Additionally, an LBL Division Director may assign a safety coordinator to act as a chemical hygiene officer for the whole division or select departments within the division. The Industrial Hygiene Group will support the efforts of all division

hygiene officers. The Group provides the following industrial hygiene expertise and services:

- Consults with the Toxic Chemicals Subcommittee on the development and implementation of chemical hygiene and safety policies and practices.

- Assists Principal Investigators and laboratory/shop supervisors in developing safe laboratory or shop operations and procedures prior to start-up.

- Keeps current concerning the occupational and environmental legal requirements respecting hazardous substances in the laboratory and shop environments and informs management.

- Reviews the procurement and use of high hazard chemicals in the laboratories and shops, and on a case-by-case basis, determines the adequacy of safety procedures and the apparent levels of training/knowledge of the persons conducting those procedures.

- Reviews the CHSP at least annually and revises it as necessary.

- Arranges site inspections to review Specific Safety Procedures (SSPs), audits compliance, and provides chemical hygiene support services, which includes exposure monitoring and medical referrals.

5. Environment, Health & Safety Division

The Environment, Health & Safety (EH&S) Division assists supervisors and employees in working safely by providing information on the hazardous properties of materials, recommending (and at times, requiring) methods for controlling the hazards of specific operations, and by monitoring the work environment. The Industrial Hygiene Group in particular has a strong role in chemical hygiene and safety, serving as a team of Chemical Hygiene Officers. With regard to hazard communication requirements, the EH&S Division:

- Assists the Toxic Chemicals Subcommittee by providing them with technical and regulatory health and safety information.

- Maintains a central file of Material Safety Data Sheets (MSDSs).

- Provides generic training programs.

- Assists supervisors in developing hazard-specific training programs.

The Fire Department, a department within the EH&S Division, is responsible for protecting people and property from fires, explosions and other hazards through prevention and expeditious control of such events. The Fire Department provides first-response resource and transportation services in medical emergencies. In addition, the Department reviews and audits fire safety concerns related to flammable gases and liquids.

For further review of these responsibilities, refer to the LBL Health and Safety Manual (Pub-3000), Chapter 12. Specific responsibilities for the EH&S Division are provided in Chapter 2 of Pub-3000.

6. Safety Review Committee

The Safety Review Committee (SRC):

- Reports to and is advisory to the Associate Laboratory Director of Operations on matters of health and safety.

- Acts as a resource to the Division Director of EH&S for reviewing and recommending methods and/or policies for addressing special safety problems.

- Directs several subcommittees that address special safety issues of the Laboratory's programs, such as the Toxic Chemicals Subcommittee. The Toxic Chemicals Subcommittee helps in reviewing the Chemical Hygiene and Safety Plan on an annual basis. The Subcommittee meets at least quarterly and publishes meeting minutes.

7. Purchasing

The Purchasing Department:

- Ensures that chemical purchases have been approved by the Principal Investigator.
- Coordinates specialized distribution procedures for high hazard materials.
- Assists Principal Investigators and Supervisors in the procuring Material Safety Data Sheets (MSDS).
- Submits copies of all requests for hazardous materials to the Industrial Hygiene Group.
- Identifies controlled items (e.g., toxic gases) that need special hazard review.

8. Plant Engineering and Construction & Maintenance Departments

The Plant Engineering Department together with the Construction & Maintenance Department:

- Work with EH&S to ensure that existing and new laboratories/shops comply with applicable Life Safety and related building codes.
- Assist the Principal Investigator or Laboratory/Shop Supervisor in the installation of effective engineering controls.
- Maintain a proactive Preventative Maintenance Program to ensure that laboratory controls and emergency equipment are in proper operating condition.
- Alert on-site construction/equipment contractors to hazardous materials in their immediate work areas.

- Alerts on-site construction/equipment contractors that they must provide to their employees information on hazardous materials that they bring to the worksite.

- Requests MSDSs from contractors for materials that they bring on site.

9. Materiel Management and Transportation Department

The Materiel Management and Transportation Department:

- Ensures the proper storage and handling of chemicals once delivered to LBL, prior to their disbursement.

- Transports chemicals safely.

- Notifies EH&S when items needing special hazard review are received.

C. HAZARD ANALYSIS AND SAFETY PROCEDURES

Every operation or procedure that involves the use of hazardous materials must have written health and safety guidelines or procedures that analyze the hazards and provide the following information:

(1) Responsible parties

(2) A description of the operation or procedure (e.g., protein extraction, painting, electroplating)

(3) Identification of the hazardous materials utilized in the operation/procedure

(4) A hazard analysis describing all *potential* hazards inherent in the use, storage, and manipulation of these substances

(5) The intended control measures (engineering, administrative, and personal protective equipment)

(6) Provisions for waste handling, spill clean-up, decontamination, etc.

(7) Reference to pertinent medical surveillance protocols

For most operations and procedures, a simple two-page form (see Appendix 4) will suffice to generate a "Lab/Shop Specific Safety Procedure" (SSP). For very hazardous operations and procedures, a more detailed Operational Safety Procedure (OSP) is necessary. Both procedures are to be kept with or in the Facility Notebook. The two basic types of written safety procedures are described in greater detail below (Sections C.2 and C.3) following discussions that define hazardous chemicals and hazard assessment (Sections C.1 and C.2).

1. Hazardous Chemicals Defined

The term "hazardous chemical" is defined below for the purpose of demonstrating when the Chemical Hygiene and Safety Plan (CHSP) is to implemented. Thus, if

any chemical meeting the definition of "hazardous chemical" as it relates to health hazards is used by a laboratory or shop, the CHSP is to be implemented for that laboratory or shop.

A hazardous chemical is a chemical that can potentially pose a health hazard and/or a physical hazard. The term "health hazard" includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, liver toxins, kidney toxins, nerve toxins, agents that act on the hematopoietic (blood-forming) system, and agents that damage the lungs, skin, eyes, or mucus membranes. For the sake of consistency, "hazardous chemical" is defined the same way for both standards. Appendices A and B of the Hazard Communication Standard (included in this CHSP as Appendix 1) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous. A list of definitions explaining basic hazardous chemical terms is provided in Appendix 3 of this CHSP.

Both the Laboratory Standard and the Hazard Communication Standard dictate that the physical hazards (e.g., flammability) presented by chemicals be addressed in the training programs. This CHSP addresses both the health and physical hazards attributed to certain chemical groups. However, more information on physical hazards is available in Pub-3000 [Chapter 7 (Cryogenic Safety), Chapter 12 (Fire Safety), Chapter 13 (Gases),and Chapter 20 (Seismic Safety)].

One class of hazardous chemicals is carcinogens. The term "select carcinogen" was introduced in the Laboratory Standard to refer to a subgroup of carcinogens for which special considerations are given in terms of controls, use, and pre-approval. Select carcinogens are discussed further in Section G.2.

2. Hazard Assessment

Hazard assessment is an evaluation made of chemicals present in the workplace to determine if they are hazardous. Note that the hazard determination must be made regardless of the potential for exposure. If there is potential for exposure, other than in minute, trace, or exempt cases (e.g., use of commercially prepared kits within which all the reagents are self-contained), then a hazard determination must be

made. The hazard determination may declare that the potential for exposure is low and therefore the risk is low, and that additional control measures are not needed, but the exercise is still conducted and written down in the SSP.

Hazard assessment requires the evaluator to use the definitions provided in Appendix 3 of this CHSP, to refer to published lists of hazardous chemicals, and to utilize professional judgement in assessing the potential for workplace hazards.

Generally, any chemical known to be toxic, carcinogenic, or an irritant will be listed in 29 CFR 1910, Subpart Z (Federal OSHA Permissible Exposure Limits), or in California's list of OSHA-regulated chemicals and the American Conference of Governmental Industrial Hygienists' "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment." Any remaining potential carcinogens are included in lists referenced by the Laboratory Standard identifying select carcinogens. Note that chemicals presenting only physical hazards (e.g., liquid nitrogen) often require greater scrutiny because they may not be included on any of the aforementioned lists.

Many products used in the work place are actually mixtures of different chemicals. Generally, a mixture is assumed to present the same health hazards as each of its components that comprise 1% or more of the mixture (in accordance with Hazard Communications Standard, as referenced in the Laboratory Standard). A mixture must be assumed to be carcinogenic if it contains a carcinogenic component in a concentration of 0.1% or more. The physical hazard potential of a chemical mixture must be evaluated on a case-by-case basis.

The Hazard Communication Standard does not require that a hazard determination be made for hazardous waste (e.g. soil and water samples), or for consumer products that contain hazardous substances if it can be demonstrated that the products are used in the same manner in the workplace as they are in normal consumer use (such that no greater exposure results). However, employees are reminded to use good judgement when using all chemicals, even common household bleach.

3. Operational Safety Procedures

Certain laboratory or shop operations require the development of detailed Operational Safety Procedures (OSPs). An OSP is required for any operation in which a malfunction has the potential to cause serious injuries or fatalities, environmental impact, significant property damage, or major interruption of Laboratory operations. *The key elements that trigger the requirement for an OSP* (rather than a SSP) are *the gravity of the potential damage and the short time order in which that damage can occur.* Examples of operations (chemical and non-chemical) requiring OSPs include:

- Class 3 and Class 4 laser systems and other high hazard non-ionizing radiation equipment
- Systems using ionizing radiation equipment or substances (e.g., X-ray machines, irrradiators, accelerators, and experiments using kilocurie amounts of radioactive substances)
- Systems using high voltage equipment
- Systems using toxic and/or pyrophoric gases (See list in Section D.3 or G.4)
- Use of extremely reactive and/or explosive substances (e.g., perchloric acid); [Note: See Section D.3 and G.6 for listings of reactive chemicals, and consult the Industrial Hygiene Group for applicability.]
- Operations requiring the use of glove boxes for safety reasons
- Procedures recommended as Biosafety Level 3 and 4

The OSP must be reviewed by multiple parties, assigned by their areas of expertise and responsibility. Generally the Toxic Substances Safety Subcommittee, Industrial Hygiene, and other mechanical, electrical, and/or fire prevention experts are involved in the review process. For information on the requirements for the preparation of a OSP, see the LBL Health and Safety Manual (Pub-3000).

4. Specific Safety Procedures

Most laboratory and shop operations that utilize hazardous materials do not require OSPs. However, pursuant to the requirements of the Laboratory Standard, written safety procedures must indicate *specific measures* that will ensure worker safety. The Principal Investigator or Lab/Shop Supervisor has the responsibility of preparing Specific Safety Procedures (SSPs) that describe (1) the specific hazards associated with a procedure/operation, and (2) the methods (i.e., safety procedures) for controlling those hazards.

Information and guidelines for writing SSPs are included in Appendix 4. A simple, fill-in-the-blank, two-page form serves as the SSP template. *Note that the process of writing SSPs need not be unduly burdensome. Many laboratory operations can be lumped together such that only a few SSPs are required.* The Industrial Hygiene Group is available to assist supervisors in drafting their SSPs. Also, standardized SSPs for common laboratory operations/procedures may be shared among supervisors.

Examples of operations and procedures requiring SSPs include:

- Any hazardous chemical operation not requiring an OSP
- Processes that utilize hazardous chemicals at certain phases of the operation (e.g., some steps in tissue culturing and protein extractions, and the use of high pressure liquid chromatography)
- Use of Class 2 laser systems
- Use of sealed radioactive sources and radionuclides

Whereas an OSP must be submitted to, reviewed by, and approved by the applicable Safety Review Subcommittee and the Division Director an SSP is intended as an internal document. It is to be reviewed by the Principal Investigator/Supervisor at least annually and followed by all personnel performing the specific tasks/operations for which it was written.

5. Variances from Safety Guidelines

A variance from LBL safety guidelines may be requested in writing from the EH&S Division. The experimenter must first seek the concurrence of his/her division director. Variances from DOE-prescribed orders and standards require DOE approval, and must be requested through the Associate Laboratory Director for Operations.

Requests for variances must include the following elements:

- An enumeration of the specific criteria, rules, or procedures with respect to which the variance is requested;
- An explanation of the need to perform the experiment in the proposed manner;
- A description of the experimental apparatus;
- A description of the measures to be taken to ensure that the variance will not compromise safety; and
- A statement of the period during which the variance is to be in effect.

The EH&S Division Director may ask that the request for a variance be studied by the Safety Review Committee and its appropriate subcommittees. Approval or denial of a variance is given in writing by the Division Director of EH&S after a thorough evaluation of the issues. Denial of a variance may be appealed to the Associate Laboratory Director of Operations.

If a variance is granted, EH&S shall closely monitor the experimental operation for the duration of the variance to ensure that the conditions of the variance are met and that safety is not compromised.

D. CHEMICAL PROCUREMENT

1. Overview

Laboratory and shop personnel responsible for ordering chemicals must be cognizant of the following requirements:

- *Ordering of chemicals, including blanket order transactions, must be approved by the Principal Investigator, Shop Manager, or designated alternate using the University of California Purchase Requisition (Appendix 5).* After a blanket order is established, purchase requisitions are still required for each release against that order (i.e., for each subsequent chemical purchase). The purchase requisition is marked "Blanket Order" and must be sent to the Industrial Hygiene Group (Mailstop 26/109) to keep them informed of the types and amounts of chemicals being ordered. It is not necessary to send a copy of the blanket order requisition to the Purchasing Department.

- *The individual ordering chemicals is responsible for declaring the hazardous properties of those chemicals on the hazard review section of the Purchase Requisition.* The Purchasing Department will provide EH&S with copies of all orders of potentially hazardous materials.

- MSDSs must be acquired for the work area in which the chemical will be used unless the MSDSs are already on file.

- Containers must not be accepted without an adequate identifying label (e.g., chemical identity, hazard warnings, manufacturer's name and address).

- Chemical purchases must be kept to the minimum volume required to sustain laboratory/shop operations without incurring significant operational interruption so as to avoid high waste disposal costs at a later date.

- Certain chemicals are controlled at the purchasing phase of procurement and may be subject to special hazard review by EH&S (see Section D.2).

2. Purchase-Controlled Substances

Some substances at LBL are controlled at the purchasing phase of procurement. These substances are controlled either prior to (1) actual placement of the order (e.g., for drug precursors), or (2) delivery of the substance to the individual who ordered it (e.g., radioactive substances). Purchase-controlled substances include radioactive substances, toxic gases, reactive (unstable) chemicals, and drug precursors.

Various departments in the EH&S Division are responsible for reviewing and/or pre-approving specific substances prior to their delivery to the user. The chemicals that the Industrial Hygiene Group is involved in *reviewing* are reactive chemicals, toxic gases, carcinogens, and any other extremely hazardous chemicals.

3. Industrial Hygiene Pre-Approval/Review

The Industrial Hygiene Group receives copies of all purchase requisitions and reviews the chemicals ordered to identify those parties who are ordering extremely hazardous materials. The Group periodically audits operations to ensure that provisions are in place to mitigate the hazards. In some cases an Operational Safety Procedure (OSP) is required (e.g., for toxic and pyrophoric gases); usually a Specific Safety Procedure (SSP) is sufficient (e.g., for carcinogens and reproductive toxins).

Reactive Chemicals

Examples of reactive chemicals of greatest concern to the Industrial Hygiene Group is given below:

benzoyl peroxide
copper azide
diethyl ether
dimethyl ether
isopropyl ether
lead azide
lithium aluminum hydride
perchloric acid
phosphorus (white)
picric acid
potassium
sodium
sodium azide
triethyl aluminum
trimethyl aluminum

Toxic and Pyrophoric Gases

The use of hazardous gases at LBL is strictly controlled. Hazardous gases include corrosive, flammable, pyrophoric, and/or toxic gases. The use of *any* hazardous gas must be strictly reviewed to ensure that appropriate and adequate safety systems are in place. It is the responsibility of Division Directors to ensure that this review has been carried out before any new equipment is used or new procedure is adopted.

Special additional policies are in force for hazardous gases designated as highly toxic or pyrophoric (spontaneously combustible) by the Uniform Fire Code. These gases are controlled items, and their purchase requires the signature of an authorized person (typically a Principal Investigator or senior Laboratory official) and the Industrial Hygiene Group.

An approved Operational Safety Procedure (OSP), which includes a hazard analysis, is required before any highly toxic or pyrophoric gas my be procured and delivered for use. (See the LBL Health and Safety Manual, Pub-3000, for instructions on the preparation of an OSP.) Under prescribed conditions, when very small amount of hazardous gases are used, the Industrial Hygiene Group may waive the requirement for an OSP.

Necessary safety equipment such as fume hoods or gas cabinets, safety showers, eyewash, and fire extinguishers must be present. In addition, the experimental apparatus must be properly installed and equipped with proper tubing, valves, ventilation for pumps, and other safety equipment as needed to handle the gas safely. Contact the Industrial Hygiene Group (Bldg. 26, Ext. 5829) for assistance.

Training in accordance with the OSP must be given to all persons operating the experiment apparatus. In general, it will be the responsibility of the Principal Investigator to provide this training. In addition, all persons subject to potential hazards from normal operation or perceivable accidents (e.g., fire fighters and other emergency crew personnel) must likewise be appropriately trained. Personnel in adjacent work areas who do not operate hazardous gas equipment must be trained in appropriate actions to take in the event of an alarm or emergency.

Examples of highly toxic and/or pyrophoric gases.

1,3 butadiene	germane	phosgene
arsenic pentafluoride	hydrogen cyanide	phosphine
arsine	hydrogen fluoride	phosphorus pentafluoride
boron trifluoride	hydrogen selenide	phosphorus trichloride
bromine pentafluoride	hydrogen sulfide	phosphorus trifluoride
bromine trifluoride	iodine pentafluoride	selenium hexafluoride
carbonyl fluoride	methyl bromide	silane
chlorine	methyl chloride	silicon tetrafluoride
chlorine trifluoride	methyl silane	stibine
cyanogen	nickel carbonyl	sulfur tetrafluoride
cyanogen chloride	nitric oxide	sulfuryl fluoride
diborane	nitrogen dioxide	tellurium hexafluoride
dichlorosilane	nitrosyl chloride	tungsten hexafluoride
fluorine	oxygen difluoride	vinyl chloride

Note: Because codes and regulations frequently change, this list in not intended to be complete. The Industrial Hygiene Group should be consulted if information is needed on the classification of a specific gas not listed above.

E. STANDARD HYGIENE AND SAFETY PRACTICES

1. General Principles

The number of hazardous chemicals and the number of reactions among them is so large that previous knowledge of all potential hazards cannot be assumed. Therefore, when the chemical properties of a material are not fully known, it should be assumed hazardous and used in as small quantities as possible to minimize exposure and thus reduce the magnitude of unexpected events.

The following general safety principles should be observed when working with chemicals:

- Substitute less toxic materials whenever possible.
- Minimize all chemical exposures through the use of engineering (e.g., lab hoods), administrative (e.g., access controls) and personal protective controls (e.g., gloves).
- Obtain and read the Material Safety Data Sheet and other hazard information on all chemicals (i.e., solids, liquids, and gases) used to support the laboratory operations.
- Confine long hair and loose clothing when working in the laboratory/shop.
- Be knowledgeable in the use of emergency equipment such as eye washes, showers and fire extinguishers and know how to obtain additional help in an emergency.
- Carefully label or cross-reference every secondary container with the identity of its contents. Appropriate hazard warnings will be required if more than one person will be using the secondary container or if the container's contents are not fully used in the same workday.
- Utilize equipment only for its designed purpose.

- Keep the work area clean and orderly.

- Observe the administrative controls set forth that restrict and control specific areas (e.g., radiation "control" areas, carcinogen "designated" areas, or "regulated" areas, etc).

- Determine the compatibility of chemicals and store incompatibles separately (refer to Section E.9).

- Provide a means of containing the material if equipment or containers should break or spill their contents (i.e., secondary containment).

- Limit the volume of volatile or flammable material to the minimum needed for short operation periods. Refer to Section G.7 for a specific discussion on flammable and combustible liquids.

- Position and clamp reaction apparatus in order to permit manipulation without the need to move the apparatus until the entire reaction is completed. Combine reagents in appropriate order, and avoid adding solids to hot liquids.

- Ensure that all chemical storage cabinets and racks, and all laboratory equipment using hazardous materials, are seismically braced in accordance with the best structural engineering practices.

- When mixing acid and water, ALWAYS ADD the ACID to the WATER so as to avoid reactions and splattering.

- Follow the requirements in the LBL Health and Safety Manual (Pub-3000), Chapter 20, Pressure Safety, if systems that can generate pressure or are operated under pressure are involved.

2. Basic Hygiene

- Use respiratory protective equipment in accordance with the established respiratory protection program. See LBL Health and Safety Manual (Pub-3000),

Chapter 19. Note: Respiratory protection is not the first line of defense; the need to use such protection is reviewed by the Industrial Hygiene Group.

- NEVER use mouth suction to pipet chemicals or to start a siphon; use a pipette bulb or an aspirator to provide vacuum.

- Wash hands with soap before leaving the laboratory/shop area. Never wash with solvent materials.

- Store, handle, and consume food in areas free of hazardous substances and hazardous equipment to prevent contamination.

- Do not store food or drink in the same refrigerator, ice chest, cold room, etc., as used to store chemicals, reagents, biologics, or animal products. Dedicate separate equipment for food and drink storage and prominently label the equipment declaring the intended use.

- Do not smoke, chew gum, or apply cosmetics in areas having chemical or biological hazardous agents present.

- Do not use glassware or utensils that have been used for laboratory/shop chemical use to prepare or consume food or beverages.

- Keep laboratory bench tops clean, and clean up the area at the end of an analysis or procedure.

- Clean the surfaces of containers of drips and wipe bottle rings off the bench top.

- Remove jewelry from wrists and hands to prevent (1) chemicals from collecting on the jewelry, (2) contact with electrical sources, (3) catching on laboratory or shop equipment, and (4) damage to the jewelry itself.

3. Personal Protective Equipment

The use of personal protective equipment is needed to complement the variety of engineering and administrative controls present in the laboratory and shop environment. See LBL Health and Safety Manual (Pub-3000), Chapter 19 for more information on personal protective equipment The following is a listing of minimum guidelines for laboratory and shop personnel:

Body and Footware

- Wear appropriate clothing, including a protective apron or laboratory coat to protect against chemical splashes or spills, and temperature extremes. Use protective apparel, including face shields, gloves, and other special clothing or footwear as needed.

- If apparel becomes contaminated, remove and place inside sealed bags. Do not launder at home if the coats/aprons become contaminated with hazardous chemicals, human blood products, or infectious agents.

- Confine loose apparel.

- Remove laboratory or shop coats/aprons prior to leaving the work area. Do not wear them into lounge areas, cafeteria, etc. The goal is to confine contaminants to the specific areas in which their presence is anticipated.

- Do not wear open-toed shoes or sandals in the laboratory/or shop. Note: Some shop areas require wearing steel-toed (safety) shoes.

Gloves

- Gloves should be worn whenever working with hazardous chemicals, rough or sharp-edged objects, or very hot or very cold materials.

- *Select gloves based on the material(s) being handled, the particular hazard(s) involved, and their suitability for the procedures being conducted.* In order to select the appropriate glove, refer to the glove selection charts in Appendix 6.

- Inspect gloves prior to use and change them often based on the frequency of use and the permeability to the chemical(s) handled.

- *All gloves are eventually permeated by chemicals.* Inspect gloves before each use for discoloration, punctures, and tears.

Eye Protection

- Safety glasses are required in all areas where chemicals are in use. The safety glasses should be impact resistant eye glasses with side shields.

- Wear goggles and/or face shields when there is danger of splashed chemicals or flying particles. (e.g., when pouring or mixing chemicals).

- Contact lenses alone (i.e., without safety glasses) are prohibited when handling corrosive chemicals.

Respirators

Respirators should not be needed in a normal laboratory or shop setting. However, if engineering and administrative controls cannot assure that concentrations of airborne hazardous chemicals are maintained below Action Levels (ALs), Permissible Exposure Levels (PELs), and Threshold Limit Values (TLVs), or when atmospheric conditions are unknown, respiratory protection is required. The Industrial Hygiene Group will determine the need for respiratory protection.

The LBL Respiratory Protection Program is established to insure a healthful working environment for LBL employees through the proper medical screening, fit testing, and training in the use of respiratory protective equipment. All use of respirators at the LBL comes under the requirements of the LBL Respiratory Protection Program, including routine and non-routine operations, emergency responses, and work in confined spaces. Respirators must be approved and obtained through the Industrial Hygiene Group.

4. Unattended Operations and Working Alone

In general, it is prudent to avoid working in hazardous operations alone. Arrangements should be made between individuals working in separate hazardous areas off-shift to cross-check each other's safety periodically. *Experiments known to be hazardous shall not be undertaken by a worker who is alone in a laboratory. At least two persons must be present.*

Precautions should be taken for laboratory or shop operations that are carried out continuously or overnight. Operations should be designed to be safe, and plans should be made to avoid hazards in case of failure. If possible, make arrangements for routine inspections of an on-going operation, leave the lights on, and leave an appropriate sign on the door.

Operations requiring cooling water shall employ monitoring devices that will shut the operation down in the event of water supply failure.

5. Housekeeping

There is a definite relationship between safety performance and orderliness in the laboratory or shop. Work areas should be kept clean and free from obstructions. Cleanup should follow the completion of any operation or at the end of each day.

Hazardous chemical wastes shall be appropriately disposed of according to established guidelines discussed in LBL publications ["Guidelines for Generators of Hazardous Chemical Waste at LBL and Guidelines for Generators of Radioactive and Mixed Waste at LBL" (Pub-3092) and "Medical and Biohazardous Waste Generator's Guide" (Pub-3095)]. Old containers and chemical wastes should be disposed of promptly and not be allowed to accumulate in the laboratory or shop.

Spilled chemicals shall be cleaned up immediately and disposed of properly. Spills of large quantities of chemicals where there is the potential for personal injury, environmental impact and property damage shall be reported to the Fire Department for response. Dial Ext. 7911 to report such incidents.

In addition, adhere to the following general housekeeping rules:

- Do not use stairways and hallways as storage areas.
- Clean up nonhazardous spills immediately.
- Maintain access to exits, emergency equipment, and other control equipment.
- Store equipment and chemicals properly and avoid clutter.

6. Use of Glassware

- Use careful handling and storage procedures to avoid damaging glassware.
- Use adequate hand protection (e.g., leather gloves) when inserting glass tubing into rubber stoppers or corks or when placing rubber tubing on glass hose connections. Tubing should be fire polished or rounded and lubricated, and hands should be held close together to limit movement of glass should fracture occur. The use of plastic or metal connectors should be considered.
- Do not attempt glass-blowing operations unless proper annealing facilities are available.
- Handle vacuum-jacketed glass apparatus with extreme care to prevent implosions. Equipment such as dewar flasks should be taped or shielded. Only glassware designed for vacuum work should be used for that purpose.
- Use hand protection (i.e., tear-resistant gloves) when picking up broken glass.
- Provide a separate marked trash receptacle or sharps container for broken glass. Glass must not be deposited in containers of wastepaper, rags, and other discarded materials.
- Provide proper instruction on the use of glass equipment designed for specialized tasks that can represent unusual risks for an inexperienced user.

(For example, separatory funnels containing volatile solvents can develop considerable pressure during use.)

7. Transport of Hazardous Materials

It is against federal regulations to transport hazardous material off-site (UC campus areas are considered off-site) without (1) an appropriate manifest of the contents of the container, and (2) proper packaging for the hazardous material as required by its nature.

Synthesized materials that need to be transported from LBL to an off-site location will require the same manifesting and packaging requirements as do stock chemicals. *A summary of hazard information is required to accompany the material prior to packaging and transport. This information should include: the chemical and physical hazards, reactivity warnings, and spill response guidelines.*

Transportation of hazardous materials by private vehicle, the LBL bus, or nondesignated LBL vehicles is not permitted because of the possibility of spillage or breakage of the container and resulting risk of injury to personnel and damage to property.

LBL personnel on campus should order stock hazardous materials from the LBL Building 7 storeroom for delivery on campus. Or, with proper authorization, they may order hazardous materials from the chemical storeroom in Latimer Hall at UC Berkeley.

8. Labeling

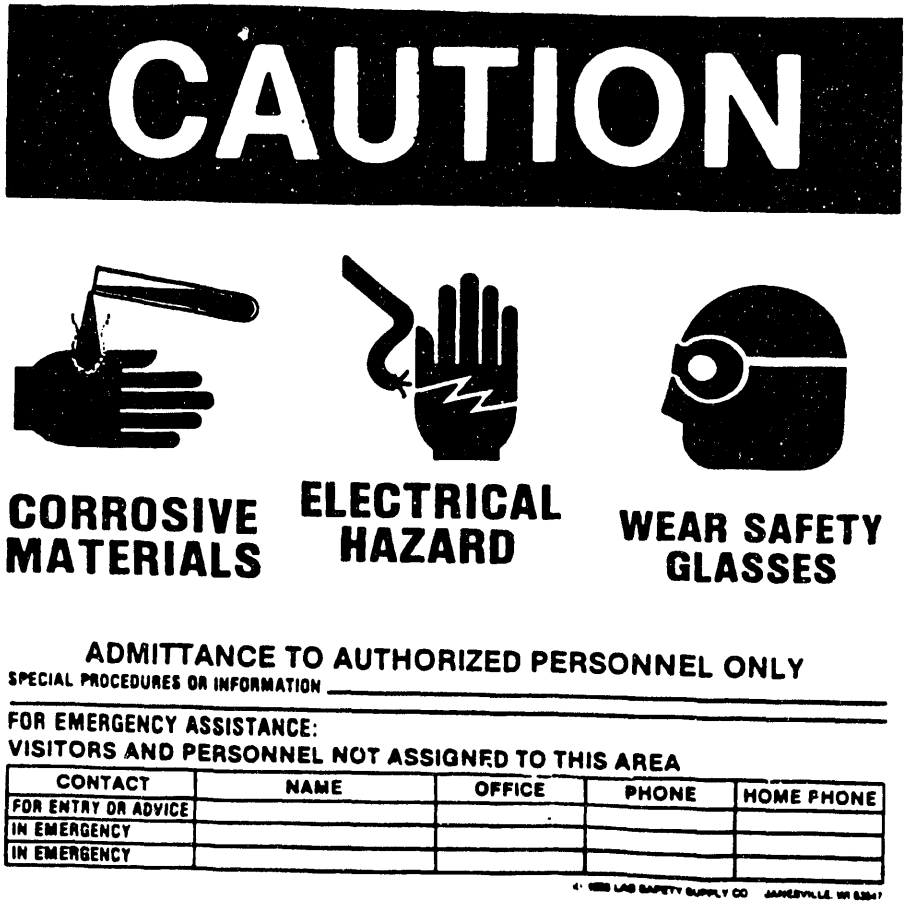
Area Entrances

Entrances to a laboratory or shop using hazardous materials or having hazardous operations must be labeled with the following information:

- "Caution"/"Danger"
- Key Hazard Pictograms
- Special Procedure Information

- Emergency Contact Information

For information on available Pictogram Hazard Keys, Refer to Appendix 7. Additional signs may be required for certain operations such as lasers, microwave sources, radioactive materials, etc.



Container Labeling

As part of the Hazard Communication Standard, hazard warning labels or tags are required on the original shipping containers and any container subsequently used for storage. The label must:

- show the name of the material;
- provide hazard warning information appropriate for employee protection; and
- be legible and prominently displayed.

Labels on shipping containers must also include the name and address of the chemical manufacturer, importer, or other responsible party. Labels on shipping containers provided by the manufacturer are required to provide all the appropriate information and must not be removed.

All containers (including lab glassware, safety cans, plastic squeeze bottles) must have labels that identify their chemical contents. Labels must also contain information on the hazards associated with the use of the chemical. Exceptions to this requirement are secondary containers used by one person within his/her workshift. Labels on containers that an employee fills for his/her personal use during a single workday are not required to show hazard warnings, but the identity of the material must be shown.

Precautionary labels are available from LBL stock (LBL Stock Catalog Section 4280) for many of the common chemicals. Refer to Appendix 7.

9. Storage of Chemicals

The separation of chemicals (both solids and liquids) during storage is necessary to reduce the potential for unwanted reactions by accidental mixing. Additional specific information on chemical storage is provided in Appendix 8. Use either distance or barriers (e.g., trays) to isolate chemicals into the following minimum classifications:

- *Solvents,* which include flammable liquids and halogenated hydrocarbons (e.g., acetone, benzene, ethers, alcohols)

- *Inorganic acids* (e.g., nitric, sulfuric, hydrochloric, and perchloric). Note: Treat acetic acid as a flammable liquid

- *Bases* (e.g., sodium hydroxide, ammonium hydroxide)

- *Oxidizers*

- *Poisons*

- *Explosives or unstable reactives,* such as picric acid. Store separately outdoors in flammable storage cabinets

The following storage rules apply to all LBL facilities:

- Store all hazardous liquid chemicals in secondary containers that are chemically resistant and unbreakable.

- Examine stored chemicals that form peroxides every few months for deterioration, integrity and expiration date (see Appendix 8).

- Limit the amount of chemicals permitted for storage to amounts that are as small as practical.

- Avoid exposure of chemicals to heat or direct sunlight.

- Do not use fume hoods as storage areas for chemicals. Chemicals temporarily housed in fume hoods should be kept to a minimum and should not block vents or alter airflow.

- Install lips, strips, or bars across the width of reagent shelves to restrain the chemicals in case of earthquake.

- Do not store chemicals in a refrigerator used for food storage. Refrigerators used for storing chemicals must be appropriately identified by placing the following label on the door (labels may be obtained from EH&S or from the Building 7 Storeroom).

CAUTION

FOOD SHALL NOT BE STORED IN THIS UNIT

10. Spill Response

The following actions should be taken when responding to chemical spills that have the potential of personal injury, environmental impact, and property damage:

- Evacuate people from the area.
- Isolate the area.
- If the material is flammable, turn off ignition and heat sources.
- Call the Fire Department, Ext. 7911, for assistance and notify the area supervisor.
- Wear appropriate personal protective equipment during cleanup.
- Pour Sorb-all or an appropriate neutralizing agent on the spill.
- Clean up and place waste in plastic bags for disposal.
- Decontaminate the area after gross spill cleanup if required.
- Follow waste labeling requirements outlined in in Pub-3092, Pub-3093, and Pub-3095 (Refer to "References," Section L).

The following tables provide phone numbers for emergencies (including spills) and spill clean-up materials that are available from Stores (Building 7).

Emergency Numbers

Location	All Emergencies	Radioactive or Other Hazardous Spills or Leaks
LBL On-Site Bldgs. incl. Campus Bldgs. Donner & Calvin Labs	7911	7911
All other LBL Off-Site Bldgs. (Bldgs. 901, 934, 935, & 936)	0-911	7911
All non-LBL Campus Bldgs.	9-911	9-911

Chemical Spill Clean-up Materials From Stores

Description	Catalog No.
Flammable Solvent Spill Kit	4240-67879
Flammable Solvent Absorbant	4240-67880
Acid Spill Kit	4240-67881
Acid spill absorbant	4240-67882
Caustic (base) Absorbant	4240-67884
Safety Equipment Kit (contains scoops, sponge, safety glasses, disposal bags, etc.)	4240-67885
Cabinet spill kits	4240-67886

11. Disposal of Chemicals

All LBL employees, participating guests, and contractors using hazardous chemicals are responsible for disposing of these chemicals safely. Federal and state regulations mandate strict disposal procedures for chemicals. In order to comply with these regulations all persons using LBL facilities must observe these procedures. And, all persons directly involved in the disposal of hazardous waste must be trained in LBL's procedures (EH&S Course #343).

Routine Disposal of Chemicals

Disposal of toxic and/or hazardous chemicals down sinks or sanitary-sewer drains is prohibited. However, in some buildings disposal of certain acids and bases is allowable because the building is equipped with a pH adjustment tank. *Disposal of any other chemicals down sinks is done only under carefully controlled conditions after consulting the Environmental Protection Group.*

Wastes shall not be accumulated for more than 90 days at "satellite accumulation areas," 60 days at "waste accumulation areas," or 7 days if it is medical/biohazardous waste or *full* sharps containers (30 days if the medical/biohazardous waste is *frozen*). See Section L for LBL publications that provide specifics on waste handling (Pub-3092, Pub-3093, and Pub-3095) and/or contact the Environmental Protection Group (Ext. 5251) for advice and guidance.

In using chemical waste storage containers, certain procedures must be observed, "as conditions for waste pickup and disposal." The procedures and/or policies are listed below:

- Establish prior to disposal what type of waste it is: hazardous, radioactive, "mixed," medical/biohazardous, or merely "trash."

- Incompatible chemicals must not be mixed in the same container (i.e., acids should not be mixed with bases, organic liquids should not be mixed with strong oxidizing agents, and flammable liquid wastes must be separated from chlorinated wastes). This is referred to as "segregation."

- Chemical containers must be "separated" in compatible groups. Containers of flammable liquids, chlorinated hydrocarbons, acids, bases, oxidizing agents, other liquids, solids, and explosive materials must be separated such that containers of incompatables are not stored together.

- Waste oils must be collected in drums. Disposal will be arranged by the Transportation of Materials Group. Ext. 5404.

- Flammable liquid wastes should be stored in approved 5-gallon containers (LBL catalog No. 7960303444). All other liquid wastes should be stored in any appropriate, properly labeled, leakproof containers.

- Leaking containers of any sort will not be accepted.

- Dry materials (gloves, wipes, pipettes, etc.,) must be securely contained in plastic bags and overpacked in a cardboard box. Packages that are wet or have sharp protruding objects will not be accepted for pick up.

- Unknown chemicals require special handling. The responsible department must make every effort to identify the material that is to be disposed of.

- Each breakable container must be properly boxed. Plastic bag all bottles, then place in a sturdy container and use an absorbent cushioning material that is compatible with the chemicals.

- Each primary container must be labeled with contents, amount, physical state, and the percentage breakdown when dealing with a mixture.

- Each box must have a complete list of contents or a description written on an official EH&S hazardous materials packing list. Blank packing lists are available from the EH&S office. Call Ext. 5251 to place an order.

- For safety purposes, boxes must be of a reasonable size and weight so the one person is able to handle them. Boxes that exceed 45 pounds or 18 inches on a side cannot be safely handled by one person and will not be acceptable for pick up.

- Check with EH&S on feasible and allowable methods to reduce or alter the hazardous properties of anticipated wastes. For example, acids and bases may be neutralized and certain toxins can be oxidized or adsorbed.

- Place contaminated sharps (e.g., blades, Pasteur pipettes, syringes) into "sharps containers."

General Housekeeping Rules

- Ensure that storage areas, or equipment containing large quantities of chemicals, are secure from accidental spills.

- Recycle unused laboratory chemicals as much as possible.

- Do not place hazardous chemicals or contaminated labware (e.g., glassware, gloves, etc.) in salvage or garbage receptacles.

- Do not pour chemicals onto the ground.

- Do not dispose of chemicals through the storm-drain system or sewer drain.

F. HAZARD CONTROL MEASURES

This section describes how to determine when controls are needed, the general types of controls that can be used to reduce employee exposures to hazardous chemicals, back-up controls such as safety and emergency equipment, and equipment maintenance protocols.

Employee exposures to potential hazards can be controlled through the following basic approaches:

- Engineering controls
- Administrative controls
- Personal protective equipment

All three of these approaches may be used for a single procedure depending upon the circumstances.

1. Criteria for Control Measures

Exposures by inhalation of airborne contaminants (gases, vapors, fumes, dusts, and mists) must not exceed (1) the levels listed in the latest edition of Threshold Limit Values (TLVs) of Airborne Contaminants published by the American Conference of Governmental Industrial Hygienists, (2) OSHA Permissible Exposure Limits (PELs), which are comparable to the TLVs, and (3) the ACGIH and/or OSHA Short Term Exposure Limits (STELs). These occupational exposure limits are normally published on the manufacturer's Material Safety Data Sheets or available through the Industrial Hygiene Group.

The TLV and PEL levels refer to airborne *8-hour, average concentrations* of substances and represent conditions under which it is believed that workers may be repeatedly exposed without adverse effect. The STELs represent 15-minute average concentrations that represent the maximum *peak concentrations* to which workers can be exposed. Not all chemicals have PELs or TLVs; and, not all chemicals that have 8-hour TLVs and PELs, also have STELS. STELs are particularly important in protecting workers from toxins that can quickly cause damage, i.e., acute toxins. The Industrial Hygiene Group conducts exposure

monitoring and evaluates exposures based the occupational exposure limits (See Section I).

In all cases of potentially harmful exposure, feasible engineering or administrative controls must first be established. In cases where respiratory protective equipment, alone or with other control measures, is required to protect the employee, the protective equipment must be approved by the Industrial Hygiene Group for each specific use.

The need for controls to reduce employee exposures during a specific operation is usually based upon a determination of the potential for exposure during the operation. This determination may be made by several different parties: The Industrial Hygiene Group and/or another health and safety professional specifically assigned to make this determination, the operator or scientist, or supervisor. In general, this determination involves evaluating the operation in terms of the following criteria to determine how serious the potential for exposure is and whether controls are needed. The criteria considered include:

- Length of employee exposures (full shift vs. short-term)
- Types of substances being handled or used including the hazardous properties and physical and chemical properties
- The nature of the operation or procedure (i.e., how easily are aerosols or vapors generated).
- Presence of existing controls to reduce exposures
- Number of employees involved
- Quantities of chemical being handled
- Routes of exposure (i.e., how the chemical enters the body)
- Occupational exposure limits

"Rules of Thumb"

The following rules of thumb are helpful. GENERALLY,

- When diluting concentrated acids and bases, use a hood.
- When using volatile toxic substances use a hood.
- When using select carcinogens, reproductive toxins, or highly toxic compounds, use a hood.
- When conducting procedures that generate particulates (e.g., dust) or liquid aerosols (e.g., when vortexing) of even moderately toxic chemicals, use a hood.
- When synthesizing or reacting chemicals, use a hood.
- When using odiferous compounds (even if they are relatively safe), use a hood.
- When using both infectious agents and hazardous chemicals together, use a properly equipped biological safety cabinet.

Situations with the potential for significant exposures should be redesigned or controlled by installing lab hoods, other exhaust ventilation, or other controls. This approach is intended to maintain exposures at low levels once the operation has been installed in the laboratory. If exposures are still significant after the operation has been implemented in the laboratory, changes in the work practices or personal protective equipment are used to provide additional protection for employees.

In general, five criteria determine if additional controls are needed:

- Employees have concerns and/or symptoms
- Changes in operation or the facility alter the needs

- Employee exposure monitoring results indicate potential or actual exposure problems

- Problem areas prone to spills and/or accidents are identified

- An industrial hygienist determines it is prudent and justifiable based on the hazard potential and/or applicable codes/standards

See also Sections G and I for more information on assessing hazards to determine which controls are best.

2. Engineering Controls

The use of engineering controls (e.g., lab hoods) often involves permanent changes to the facility that reduce or remove the hazard from the area, such that the hazardous substances cannot diffuse into the surrounding areas.
No laboratory or shop area can rely on one particular type of control technology to ensure that exposures to hazardous chemical agents are as low as reasonably achievable. However, the primary and most effective approach is through the use of engineering controls. Complementing the engineering controls are the correct combination of administrative procedures and use of personal protective equipment.

General Ventilation

The general ventilation system, referred to as the heating, ventilation and air conditioning (HVAC) system, should not be used alone to control employee exposures. The HVAC system is not a type of local exhaust ventilation. However, certain allowances for how the HVAC system operates are critical to worker safety.

Recirculation of contaminated exhaust air in laboratories or shop areas using toxic, corrosive, flammable or other hazardous agents is prohibited.

Laboratories are to be designed such that air passes through once only.
Occasionally it may be necessary to provide additional temperature control for a

single laboratory room by recirculation of the air in the room. This is permissible as long as the air does not recirculate to other rooms.

Laboratories facilities using highly volatile carcinogens and acute toxins must be designed so that a negative pressure differential exists between the laboratory and the exit corridor(s) servicing the laboratory, thus containing accidental releases to the room in which they were generated.

Local Exhaust Ventilation (e.g., hoods)

Lab hoods are the most common type of local exhaust ventilation. Generally, hoods should be considered as backup devices that can contain and exhaust toxic, offensive, or flammable materials when the design of an experiment fails and vapors or dust escape from the apparatus being used.

Self-contained (ductless) re-circulation hoods are not allowed at LBL if their use is intended to control hazardous chemicals; they may be permitted for non-toxic, odiferous work such as for some clinical laboratory tests. Consult the the Industrial Hygiene Group for more information.

Hoods are not regarded as a means for disposing of chemicals, and they are not intended for storage of chemicals. Materials used in hoods should be kept to a minimum and should not block vents or alter airflow patterns.

Hoods should be evaluated by operators prior to and during each use by means of simple visual indicators (such as mylar strips or flow monitors) for adequate air flow. User-controlled performance of a hood depends upon such factors as the placement of equipment in the hood, room drafts from open doors or windows, turbulence caused by persons walking by, and the presence of the user in front of the hood. Keep apparatus back from the front edge of the hood to reduce the potential for contaminant release.

During operations, minimize the face opening of the hood to improve the performance of the hood. Reducing the opening in the laboratory hood may also provide some protection from explosives due to chemical reactions, over-pressurization, etc. Except when adjustments of apparatus within the hood are

being made, the hood sash should be kept at or below the marked "safe sash height. " If the hood does not have a bypass grill then the sash should be left open at least six inches to avoid the flow from being choked off. Sliding sashes should not be removed from horizontal sliding-sash hoods.

Mechanical ventilation must remain in operation at all times when hoods are in use and for a sufficient time thereafter to clear hoods of airborne hazardous substances. When mechanical ventilation is not in operation, hazardous substances in the hood must be covered or capped off. Laboratory workers should be prepared for the event of ventilation failure or other unexpected occurrence such as fire or explosion in the hood.

Hoods must be inspected frequently and cleaned as necessary to ensure adequate air flow and the prevention of residue buildup. The Industrial Hygiene Group conducts an annual ventilation survey and posts flow rates and the date of test.

The end user is not solely responsible for the correct design and performance of laboratory hoods. Usually, Plant Engineering plays a role in the design of hoods, and Construction & Maintenance installs the hoods. The Industrial Hygiene Group checks the performance of the hoods at least annually and whenever asked to check for possible hood performance problems. Nonetheless, all parties should be aware of the following rules and specifications that apply to lab hoods:

- Provisions must be made for adequate make up air for all hoods that are used in a laboratory.

- General room air flow near the hood should not be turbulent and should be relatively uniform throughout the laboratory/shop.

- Laboratory-type hood face velocities must be sufficient to maintain an inward flow of air at all openings into the hood under operating conditions. *Air flow into hoods depends upon configuration but must be at a minimum average of at least 100 linear feet per minute (lfpm) face velocity with a minimum of 70 lfpm at any point, except where more stringent special requirements are identified.*

- *Generally, the face velocity must be obtainable with the movable sashes opened at least 24 inches.* Where the required velocity can be obtained by partly closing the sash, the sash and/or jamb must be marked to show the maximum opening at which the hood face velocity meets the requirements. Any hood failing to meet the requirements must be considered deficient in airflow and must be posted with placards, plainly visible, which prohibit use of hazardous substances within the hood.

- When sufficient quantities of flammable gases or liquids are used, or when combustible liquids are heated above their flash points, hoods that are not bypassed must have permanent stops installed that restrict closure of the sash so that sufficient airflow is maintained to prevent explosions. Concentrations in the duct must not exceed 20% of the lower explosive/flammable limit. (The Uniform Fire Code, Part VII sets forth requirements for the use of cryogenic fluids, and flammable and combustible liquids.)

- For new laboratory hood installations, a fire sprinkler head must be mounted on the inside of the hood. Newly purchased laboratory hoods and installed exhaust ducting for solvent operations shall be constructed of noncombustible materials to reduce the potential of damage should a fire occur within the workstation. Similarly, newly purchased laboratory hoods and exhaust ducting for corrosive applications shall be constructed from or coated with materials that are resistant to corrosive compounds.

- A minimum of 2.5 linear feet of hood space per person working at the hood is recommended.

- Laboratory hoods must be seismically braced to prevent toppling or sliding during an earthquake.

- Perchloric acid must be used in a closed system or within a specially designated acid fume hood with wash down systems to prevent the accumulation of explosive perchlorates in the fume hood. (Consult the Industrial Hygiene Group for perchloric acid hood specifications.)

- Local exhaust systems that are used in the laboratory or shop environment must be designed by Plant Engineering in accordance with ACGIH, ASHRAE, NFPA, and other nationally recognized standards.

  Two important specifications:

  (1) Exhaust fan systems must be non-sparking if exhausting sufficient quantities of flammable vapors and corrosion resistant if handling corrosive vapors, and

  (2) Exhaust stacks must be located in such a manner with respect to air intakes as to preclude the recirculation of laboratory or shop hood emissions within a building.

- Do not attach other local exhaust systems to existing fume hood exhaust ducts without consulting Plant Engineering.

- Both contaminant fume hoods and glove boxes *may require an in-line high efficiency particulate air (HEPA) filter or scrubber* to remove particularly hazardous substances from the air stream before being exhausted from the building

- Glove boxes generally operate under negative pressure (e.g., Class III biosafety cabinets), though some operate under positive pressure. In the case of positive pressure boxes, leaks can cause problems. Glove boxes should be thoroughly tested before each use and there should be a method of monitoring the integrity of the system (such as a shutoff valve or a pressure gauge designed into it).

Biosafety Cabinets ("laminar flow hoods")

Biosafety cabinets protect a laboratory from biologically hazardous agents that could cause laboratory-acquired infections. They are designed to provide for the control of airborne particulates and aerosols, within a combined space, through the use of directional airflow and high efficiency particulate air (HEPA) filters.

Biosafety cabinets are divided into three classes, based upon their design and intended purpose:

Class I Cabinets: Designed to protect the operator and the environment through the use of an inward flow of unrecirculated air. They are sometime fitted with glove panels, gloves and air intake filters to increase the protection afforded the operator. *This class of cabinetry is not intended to protect against contamination of materials being handled within the cabinet.*

Class II Cabinets: Designed to protect the operator, environment and experiment from particulate contamination, including microorganisms, using an inward flow of room air through a front work opening, directional flow of HEPA-filtered air through the work area, and HEPA filtration of exhaust air. They should be used for work with infectious agents and some recombinant DNA work. Most laboratory personnel doing tissue culture work use Class II hoods.

Class III Cabinets: Totally enclosed ventilated cabinets of gas-tight construction. Work is done through attached rubber gloves. Class III cabinets are always operated under negative pressure, so that any leak, as in the case of a punctured glove, will be into the cabinet. They are designed for work with highly pathogenic organisms, but are sometimes used for work with carcinogenic chemicals. A minimum of 2 volume changes per hour and a negative pressure of 0.5 inches of water must be ensured for glove boxes.

Additional Ventilation Considerations

The following specific uses of laboratory/shop space or operations bear consideration for ventilation safety.

- Gas safety cabinets may be required for the use and storage of toxic and pyrophoric gases.

- Environmental rooms, whether refrigeration cold rooms or warm rooms for growth of organisms and cells, are usually closed air-circulation systems; therefore, evaluate the potential consequences of release of hazardous chemicals.

- Magnetic latches or breakaway handles on doors of environmental rooms should be installed to allow a trapped person to dismantle the door.

- Environmental rooms shall be provided with emergency lighting (battery- or generator-powered) so that persons are never left in these areas without light.

- Volatile flammable solvents shall not be used in cold rooms due to fire hazards from ignition sources.

- The use of volatile acids should be avoided in cold rooms because such acids can corrode the cooling coils in the refrigeration system, which can lead to the development of leaks of hazardous refrigerants.

- Laboratory apparatus that may discharge hazardous vapors (e.g., vacuum pumps and distillation columns) must be vented to a local exhaust system.

3. Administrative Controls

Correct Work Practices

Changes in employee work practices for a specific operation can be an effective means of controlling exposures, especially for those operations in which individual variations can result in large differences in exposure levels. The purpose of using correct work practices is to design and implement the procedures and techniques that result in the least amount of exposures. The Industrial Hygiene Group will audit operations, evaluate work practices, and determine the need for changes that can reduce or better control exposures. This approach requires training to inform the employees of the correct procedures to ensure that all employees comply. *Examples* of this approach include the following:

- Allowing an experiment to dissipate any residual vapors before opening it to the lab environment.

- Using good techniques to maximize the ability of a lab hood to capture emissions.

- Using the correct tools and equipment to minimize the potential for spills and releases.

- Developing procedures for the correct sequence in mixing chemicals to minimize releases of vapors, e.g., whenever possible add powders to water rather that water to powers.

- Minimizing the quantities of volatile chemicals used.

- Keeping test chambers covered or enclosed during test reactions and other uses.

- Substituting a less toxic substance for a more toxic substance (e.g., using less concentrated acid or aqueous soap instead of organic solvent).

Use of Restricted Areas

Many of the substance-specific OSHA Standards for carcinogens describe the use of "regulated areas" as a means of hazard control. The regulated area is marked off, signs are placed, and access is controlled.

In similar fashion, the Laboratory Standard refers to "designated areas," to control the hazards associated with working with certain chemicals. A "designated area" means an area that may be used to work with "select carcinogens," reproductive toxins, or substances that have a high degree of toxicity. Basically, an area is "designated" to be the location in which such work may occur. A designated area may be the entire laboratory, an area of the laboratory, or a device such as a lab hood. The management must post a notification in the "designated area" to ensure that all employees in the area are informed of the hazardous substance(s) used in the area.

The purpose of the designated area is to heighten the awareness of working with specific substances and to restrict all activities involving these substances to the

selected area. All handling and use of these substances should occur only in the designated area. The designated area may include the following controls:

- Well identified boundaries (usually a room or laboratory section).
- Signs indicating the designated area and the types of substances being handled.
- Entry restricted to authorized personnel.
- Special controls for minimizing exposures (e.g., lab hoods, enclosed systems).
- A special storage area for those substances separate from other materials being stored in the laboratory.
- The use of wet housekeeping techniques.
- Special training requirements regarding the hazards and controls.
- Special hygiene facilities (e.g., clean room/dirty room) with a walk-through shower for entering and exiting.
- Special procedures for entering and exiting.

See Section G for more discussion of the use of designated areas.

4. Personal Protective Equipment

Personal protective equipment should be considered ancillary to other control measures, and users should understand which type of equipment is best for their purposes. This type of hazards control requires that employees cooperate in using the equipment correctly whenever it is needed, and that they understand the limitations of the equipment. Protection such as goggles, face shields, gloves, aprons, and lab coats should be used, when needed, in addition to other controls such as those previously described. Respiratory protection should only be used if

other controls are not feasible or adequate to achieve acceptable exposure levels. Proper selection of the correct personal protective equipment for a particular operation is very important. See Section E.3 for more information on personal protective equipment.

5. Safety and Emergency Equipment

Equipment Guarding

All mechanical equipment shall be adequately furnished with guards that prevent access to electrical connections, pinch points or moving parts, and all guards should be inspected before using equipment.

Employees are not to turn on, use, repair, or operate any hazardous laboratory or shop equipment unless trained and authorized to do so by the responsible supervisor.

Shields

Safety shields must be used for protection against possible explosions or uncontrolled reactions. Laboratory equipment must be shielded on all sides so that there is no line-of sight exposure of personnel. The sash on a chemical fume hood is a readily available partial shield. However, a portable shield must also be used, particularly with hoods that have vertical-rising sashes rather than horizontal-sliding sashes for operations having the potential for explosion such as:

- Whenever a reaction is attempted for the first time (small quantities of reactants should be used to minimize hazards).

- Whenever a familiar reaction is carried out on a larger than usual scale.

Pressure

Guidelines for the use of pneumatic and high pressure hydraulic equipment are given in the LBL Health and Safety Manual (Pub-3000), Chapter 20; however, the following are additional requirements for laboratory operations:

- Reactions should never be carried out in, nor heat applied to, an apparatus that is a closed system unless it is designed and tested to withstand pressure.

- Pressurized apparatus shall have an appropriate relief device.

- If the reaction cannot be opened directly to the air, an inert gas purge and bubbler system should be used to avoid pressure buildup.

- All pressurized gas cylinders must follow procedures for safe equipment usage, handling, and storage discussed in Pub. 300, Chapter 13.

Eyewash and Showers

Eyewash fountains are required if a substance in use or stored presents an eye hazard (e.g., any corrosive and many irritants). The eyewash fountain must provide a soft stream or spray of aerated water.

Fully-plumbed safety showers must be provided when a rapid fire hazard exists, and in areas where one liter or more of any of the following are present: corrosives, eye irritants, and chemicals that are highly toxic via skin and/or eye contact. The shower must be capable of drenching the victim immediately in the event of an emergency. *Hand-held wash units (at a sink or elsewhere) are allowed for the above-mentioned substances if the quantities present comprise less than one liter. Eye wash squeeze bottles are not acceptable, anytime.*

Eyewash fountains and safety showers should be located close to each other so that, if necessary, the eyes can be washed while the body is showered. Access to these facilities must remain open at all times and reachable within 10 seconds or 100 linear feet, whichever is less. Showers shall not be located nearer than 25 inches from any wall and shall not be next to unprotected electrical panels or electrical equipment.

In case of accident, flush the affected part for at least 15 minutes. Report the accident to Health Services and the Laboratory/Shop Supervisor immediately.

Eyewash and showers should be flushed at least weekly for three minutes to ensure that they are operating properly and that microbial contamination does not occur. At a minimum, eyewashes and showers shall be flushed monthly. Inspection tags should be filled out to document the testing. Note: Construction and Maintenance personnel check and flush the eyewashes and showers every three months; but, more periodic flushing is required by the users.

Fire Extinguishers

Laboratories and shops using hazardous chemicals must have an ABC-rated, dry chemical, fire extinguisher within 50 ft. of any exit for use on ordinary combustibles, flammable liquids, and electrical fires. If additional extinguishers are needed for an area, contact the Fire Department for information concerning recommendations and requirements.

Flammable Liquid Storage Cabinets

Not more than 60 gallons of Class I flammable liquids or Class II combustible liquids, nor more than 120 gallons of Class III combustible liquids may be stored in a storage cabinet. Storage of flammable liquids in excess of ten gallons must be in an UL listed, Factory Mutual (FM) approved, flammable liquid storage cabinet.

Flammable liquid storage cabinets should be used for the storage of flammable and combustible liquids only. Do not store corrosives, oxidizers, or reactive chemicals with flammable or combustible liquids. Cabinets must be labeled "Flammable - Keep Fire Away."

(Note: A storage cabinet for flammable liquids is not fireproof, but only protects the contents from extreme temperatures for a limited time to allow evacuation of personnel and prompt entry of fire fighters.)

Refer to Section G.7 for more information on flammable/combustible liquids)

6. Preventive Maintenance

Because of the wide variety of laboratory hoods (chemical fume hoods, biological safety cabinets, vented enclosures) and other local exhaust ventilation (vented waste containers, refrigerators, analytical instruments), the monitoring program for each piece of equipment should reflect the specific design and recommended operating practices. For laboratory operations involving hazardous substances, where exhaust ventilation is used for primary control of personal exposures, *a regularly scheduled ventilation system monitoring and maintenance program should be implemented.* At LBL, the Industrial Hygiene Group checks every hood once per year.

Each laboratory facility should develop facility-specific safety procedures (SSPs) for the maintenance of engineering controls in their laboratories. Such procedures should include periodic inspections by EH&S, with correction and follow-up as necessary. For example, it might be written that when a worker observes reduced hood velocity readings below 100 feet per minute, that they report the finding and call the Industrial Hygiene Group.

Equipment Maintenance

Proper equipment maintenance is important for safe, efficient operation. Equipment should be inspected and maintained on a regular basis.

Hood Performance Evaluations

- All hoods are checked by the EH&S when they are first installed and annually thereafter, for adequate ventilation performance.

- Performance of a ventilation system must be checked whenever there has been a change in a system or location.

- Laboratory and shop ventilation equipment scheduled for maintenance or repair work must be cleaned and/or decontaminated. Maintenance workers have the right to refuse to do work if the area or equipment is not clear of hazards.

- All ventilation systems need routine maintenance to prevent blocked or plugged air intakes and exhaust, loose belts, bearings in need of lubrication, motors in need of attention, corroded duct work, and component failure.

- Filters should be replaced periodically in certain types of ventilation systems, such as electrostatic precipitators and cyclones for dust collection.

- Monitoring devices such as a magnehelic or flow meters should be installed in all new ventilation systems and in systems that control certain highly toxic operations such as toxic gases or potent carcinogens.

- Class II biological safety cabinets must be "certified" by an outside contractor proficient in the process. The cabinets should be tested for filter integrity, air velocity, and air flow patterns (1) upon installation, and (2) at least annually thereafter, (3) when relocated, and (4) when HEPA filters are changed.

  Note: A Class II biological safety cabinet does not require annual certification *if* it is not being utilized as a Class II cabinet, i.e., it is not being used to the level for which it was designed (when it is being used to protect the work product solely and not the worker). BUT the cabinet must be posted to alert workers. Place a caution sign on the hood with the following message:

> CAUTION
> This hood is not certified to protect workers from hazardous chemicals, biological agents, or radioactive substances.
>
> DO NOT STORE or USE hazardous agents in this hood.

Calibration of Corrosive, Pyrophoric and Toxic Gas Detection Systems

Fixed gas detection systems may be required for operations using toxic gases that demonstrate poor human physiological warning properties. The specifications of

the calibration technique for each system and the frequency of calibration must be documented. As a minimum, the specifications must be outlined in procedures associated with the operation of the apparatus (e.g., the OSP) with which the gas-detecting system is associated. It is recommended that calibrations of these systems be performed by an approved contractor or by other trained personnel. The Construction and Maintenance Department has resources available to assist in the formulation of maintenance contract.

It is the responsibility of every scientific program operating gas systems to pay the full costs for all calibration of gas-detection equipment associated with experimental apparatus or required by a particular scientific program. Costs for the calibration of equipment required to monitor building-air quality and ventilation systems or to control fire alarm transmission facilities are borne by the Construction and Maintenance Department.

7. Equipment Decommissioning

Cleanup of Vacated Space

Principal Investigators and Lab/Shop Supervisors are responsible for assuring that all laboratory and shop space occupied by their programs and/or activities is maintained free from undue hazards. This responsibility extends throughout the period of occupancy and when vacating laboratory and shop space. *When vacating an area, all hazardous materials must be attended to such that all chemicals, radioactive materials and hazardous wastes are removed, transferred to new ownership, and/or properly disposed.* Surface decontamination of floors, walls, ducts, etc. may also be necessary. The Environment, Health and Safety Division (Ext. 5251) can provide assistance in making radiological surveys and removing chemicals and waste.

If laboratory or shop premises are left in an environmentally unacceptable state, it may be necessary to obtain the services of outside contractors to identify and dispose of unidentified chemicals and waste. Should this be necessary, the costs of these services will be borne by the vacating party (individual, department, etc.).

On occupying new space, personnel are advised to assure themselves that said space is free from hazards. The Environment, Health and Safety Division (Ext. 5251) including the Industrial Hygiene Group (Ext. 5829) can offer advice and assistance.

G. USING HIGH HAZARD CHEMICALS

This section of the Chemical Hygiene and Safety Plan provides information on specific high hazard chemicals or groups of chemicals, and how to control the hazards presented by them. Discussions of the "particularly hazardous" chemicals identified by OSHA (i.e., carcinogens, reproductive toxins, and high acute toxicity substances) are included, along with discussions of other hazardous chemicals that may be pertinent to work conducted at LBL. Solvents, discussed as a group in Section G.7, can be acute toxins and/or chronic toxins. Toxic metals and polychlorinated biphenyls, discussed independently, are generally associated with chronic toxicity rather than acute toxicity. Toxic metals merit a separate discussion because they are encountered in many shop activities. Finally, some of the physical hazards that chemicals can present are addressed (Section G.9).

1. Definitions and Requirements

"Particularly Hazardous Substances"

The OSHA Laboratory Standard dictates that provisions be in place providing additional employee protection for work with "particularly hazardous substances," described as "select carcinogens, reproductive toxins, and substances with a high degree of acute toxicity." Carcinogens and reproductive toxins are discussed in Sections G.2 and G.3. High acute toxicity substances are defined by the Standard as those substances such as hydrogen cyanide, hydrogen sulfide, and nitrogen dioxide which "may be fatal or cause damage to target organs as a result of a single exposure or exposures of short duration."

High acute toxicity substances include substances that are capable of causing intense irritation that can result in pulmonary edema (fluid and swelling in the lungs), chemical asphyxia, and systemic (body-wide) poisoning. As it happens, many substances in this high acute toxicity category are toxic gases, which are discussed in Section G.4. Examples of other substances that are considered to be high acute toxicity substances include:

acrolein	(PEL = 0.1 ppm)
acrylonitrile	(PEL = 2 ppm)

2-aminopyridine	(PEL = 0.5 ppm)
dimethyl sulfate	(PEL = 0.1 ppm)
1,1-dimethylhydrazine	(PEL = 0.5 ppm)
hydrogen fluoride	(PEL = 3 ppm)

Note that chemicals known to cause high acute toxicity generally have very low occupational exposure limits (i.e., PELs less than 10 ppm).

Required Considerations

The Laboratory Standard allows flexibility in assessing the hazards presented in using particularly hazardous substances and choosing the control measures that best mitigate those hazards. The only baseline *requirement* for working with particularly hazardous substances *is that consideration be given to the following provisions* and that they be utilized when appropriate:

(1) establishment of a designated area;
(2) use of containment devices;
(3) establishment of contaminated waste removal procedures; and
(4) establishment of decontamination procedures.

Some of the OSHA substance-specific standards require the use of "regulated areas" to control access and control hazards to particularly hazardous substances. The requirements specified in the substance-specific standards are applicable to non-laboratory work such as that conducted in LBL shops. The Industrial Hygiene Group assesses the applicability of using regulated areas (and other specific procedures identified in the OSHA substance-specific standards) for LBL's shop operations.

The "designated area" cited in the Laboratory Standard (and therefore strictly applicable to all laboratory work) differs from a regulated area in that *the only duty associated with it is to post the area and assure that all employees working in the area are informed of the hazardous substances used there.* The designated area may be a room, a section of a room, or actually be a containment device such as a lab hood. The use of designated areas is also discussed in Section F.2, "Administrative Controls."

Fume hoods or equivalent containment devices are required to be considered for handling "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity. Circumstances that may *require* the use of containment devices when using particularly hazardous chemicals include procedures where (1) the chemicals are volatile, (2) aerosol generation is possible, and (3) manipulations or chemical reactions could result in uncontrolled releases. In addition, if employees experience health effects or if the results of exposure monitoring establish that significant employee exposures are possible, a containment device is required. [See "Hazard Control Measures" (Section F) for a more information on the use of hoods; see "Exposure Monitoring," (Section I) for a discussion on hazard assessment and criteria for monitoring.]

Waste handling procedures for particularly hazardous substances are almost always appropriate and should be addressed in the Specific Safety Procedure (discussed in Section C).

Specific decontamination procedures may or may not be required. Decontamination is more than spill cleanup; decontamination may be required even when no known spill or release has occurred. For example, decontamination procedures are warranted for the use of any carcinogen that could leave residual powders, dusts, or films. Decontamination may not be necessary for highly volatile substances (such as methylene chloride) when used in a hood because residual materials are unlikely.

2. Chemical Carcinogens

This section discusses carcinogens and how they are evaluated, and describes the LBL Carcinogen Program. The *Carcinogen Program* sets forth recommendations and requirements to govern the use of chemical carcinogens for the purpose of minimizing, to the extent practical, the health risks attributed to them.

All LBL personnel using chemical carcinogens are expected to be familiar with the Program guidelines and to conduct their operations accordingly. The purpose of the guidelines is to assist the Principal Investigator or Lab/Shop Supervisor in the selection and use of appropriate safeguards. These safeguards consist of proper engineering controls and safe work practices that permit the safe use of high hazard

chemicals and maintain exposures to these substances as low as reasonably achievable.

Carcinogen Classification

Carcinogens are diverse agents that are defined by their ability to cause neoplasms (tumors) in humans and/or animals. Carcinogenic agents may be organic chemicals, inorganic chemicals, hormones, or ionizing radiation. Some carcinogens react directly with a cell's genetic information (the DNA), causing changes (mutations) that are incorporated into subsequent generations of that cell. Other carcinogens do not bind with the DNA, but produce neoplasms after another carcinogen has reacted with the DNA or by some other independent mechanism. For regulatory purposes, no distinction is made for the mechanism by which a chemical is carcinogenic; the key parameter is the *strength of evidence* for carcinogenicity in humans.

Despite public perception and the apparent large number of chemicals included as known, possible, or suspect carcinogens, *not all chemicals are carcinogens.* Cancer is caused by distinct mechanisms whereby small, repeated exposures can result in cumulative effects. Consequently, cancer does not manifest itself until a certain latency period has passed, sometimes ten to twenty years after the initial exposure. For this reason it is best to minimize all exposures to carcinogens.

Four organizations /agencies that evaluate and classify carcinogens are (1) the Occupational Safety and Health Administration (OSHA), (2) the International Agency for Research on Cancer (IARC), (3) the National Toxicology Program (NTP), and (4) the American Conference of Governmental Industrial Hygienists (ACGIH).

OSHA regulates health and safety in workplaces. Permissible Exposure Limits (PELs) are established for airborne concentrations of substances to indicate the amounts of a substance to which most workers can be exposed daily for a working lifetime without experiencing adverse effects. Over 400 PELs have been established but they are not generally set to protect workers from potential carcinogenic effects. OSHA does regulate a small number of carcinogens in independent substance-specific health standards (e.g., benzene, asbestos, and vinyl chloride).

The IARC is a program designed to evaluate existing evidence on chemicals for their carcinogenic risks to humans. IARC places chemicals into four groups: **Group 1**- carcinogenic to humans; **Group 2A** - "probably carcinogenic to humans"; **Group 2B** - "possibly carcinogenic to humans"; **Group 3** - not (yet) classifiable as to carcinogenicity; **Group 4**- probably not carcinogenic.

The NTP is involved with testing and classifying chemicals. A weight-of-evidence approach is used in placing carcinogens into **Group 1** , "chemicals known to be carcinogens," or **Group 2**, "chemicals reasonably expected to be carcinogens."

The ACGIH provides guidelines for occupational exposures, called Threshold Limit Values (TLVs), which are intended to protect workers from harm. The ACGIH recommends TLVs for approximately 55 suspected human carcinogens, based on either limited epidemiological evidence or demonstration of carcinogenesis in one or more animal species by appropriate methods. ACGIH classifications include: **A1** - "confirmed human carcinogens", and **A2** - "suspected human carcinogens."

Select Carcinogens

Particularly relevant to LBL are those chemicals that the OSHA Laboratory Standard terms "select carcinogens." *A select carcinogen includes any substance that meets one of the following criteria:*

- it is regulated by OSHA as a carcinogen;
- it is listed under the category "known to be carcinogens" in the Annual Report on Carcinogens published by the NTP (latest edition); or
- it is listed in Group 1, "carcinogenic to humans," by the IARC (latest edition of monograph).

Select carcinogens are also substances listed either by NTP under the category "reasonably anticipated to be carcinogens," or listed by IARC in Group 2A or 2B if

they have been shown to cause significant tumor incidence in experimental animals in accordance with any of the following criteria:

- after inhalation exposure of 6 or 7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3;
- after repeated skin application of less than 300 mg/kg body weight per week; or
- after oral dosages of less than 50 mg/kg of body weight per day.

OSHA decided that it is more effective to allow individual laboratories to make determinations as to whether substances listed as NTP Group 2 and IARC Groups 2A and 2B meet the above criteria for moderate to high carcinogenic potency. Substances on these lists need not be treated as select carcinogens under the Laboratory Standard if data corresponding to the carcinogenic potency criteria described above do not appear in the IARC or NTP documentation or in other existing literature for these substances. However, it is the responsibility of the employer to determine whether literature exists (or does not exist). And, some NTP Group 2 chemicals are also IARC Group 1 chemicals, so the option to independently evaluate the chemical to determine if it classifies as a select carcinogen is voided.

Since it is not feasible for LBL to track and continuously evaluate all the literature on NTP and IARC Group 2 carcinogens, and especially since the only requirement for use of a select carcinogen is consideration for certain specified control measures, *LBL chooses to include all NTP and IARC Group 2 chemicals as select carcinogens.*

The select carcinogens are listed in Appendix 9. They are listed by class (i.e., OSHA; IARC Groups 1, 2A, and 2B; and NTP Groups 1 and 2). The ACGIH carcinogens are listed in Appendix 10. Then for the convenience of LBL employees, the select carcinogens are listed in one "composite working" list (the Composite Working Select Carcinogen List) in Appendix 11.

The Composite Working Select Carcinogen List does not include manufacturing processes (e.g.,steel founding) and medical treatments (e.g., cancer therapeutic regimens) included in the first formal list because they are not applicable to LBL operations and processes. In addition, the actual compounds of interest are listed for

certain group entries (e.g., "hexavalent chromium compounds") to actually identify those compounds. Finally, the working list includes three ACGIH A2 carcinogens (hexachlorobutadiene, vinyl cyclohexene dioxide, and xylidene) that are not technically select carcinogens. DOE Orders require LBL to consider ACGIH carcinogens and to follow OSHA regulations. Therefore, the working list includes ACGIH carcinogens not already included as select carcinogens.

Particularly noteworthy select carcinogens for operations and procedures conducted at LBL are chloroform, benzene, methylene chloride, acrylamide, aniline and benzidine dyes, formaldehyde, and perchloroethylene.

Program Basics

The LBL Carcinogen Program consist of ten basic elements or steps.

(1) Identification of all the locations in which select carcinogens are stored and used;

(2) Assessment of the feasibility of substituting for less hazardous substances and for reducing the amount and/or frequency of use;

(3) Completion of a Carcinogen Exposure Assessment Survey Form by lab/shop personnel for all carcinogen use/storage locations to identify carcinogen users and to assess their exposure potential;

(4) Ongoing review by the Industrial Hygiene Group of carcinogen purchases;

(5) Development of written Specific Safety Procedures for every procedure/operation using hazardous chemicals to address the hazards and the intended hazard mitigation methods;

(6) Use of labeled designated areas for carcinogen use, with required training as a prerequisite for access;

(7) Use of a containment device (e.g., hood) if appropriate;

(8) Use of established safe work practices, including decontamination procedures, if appropriate, and procedures for disposing of generated waste;

(9) Exposure monitoring and medical surveillance, as appropriate.

(10) Routine safety audits and self-assessments to identify and correct potential problems

Responsibilities

Roles and responsibilities regarding chemical hygiene and safety are discussed in Section B of this Plan, and apply to the use of all hazardous chemicals, including carcinogens. However, *the following defines responsibilities specific to the Carcinogen Program.*

The first step of the Carcinogen Program is to identify which chemicals are considered carcinogens. The Industrial Hygiene Group will assist lab/shop personnel in identifying the carcinogens in their chemical inventories. Many MSDSs and other sources of information use the terms "animal carcinogen," "experimental carcinogen," "suspect carcinogen," "mutagen," etc. Now that an "official" OSHA list is available, *i.e., the Select Carcinogen List* (Appendix 9, composited in Appendix 11), it is possible to peruse the chemical inventories of all LBL laboratories and shops, looking for specific chemicals.

The Principle Investigator or Lab/Shop Supervisor then determines if the carcinogens present in his/her areas are actually used and/or needed. [It may happen that a carcinogen identified in a location is never actually used, but only resides in the location on some forgotten shelf.]

The best way to protect the carcinogen user, others, and the environment is to keep the use of carcinogens to a minimum. If smaller amounts are routinely kept and used, the risks of exposure and the likelihood of major incidents are reduced. Further, the costs of waste disposal are reduced. Principle investigators and laboratory/shop supervisors must review their procedures/operations to amounts of toxic chemicals used and the frequency of their use.

All laboratories and shops must participate in a carcinogen exposure assessment survey. A Carcinogen Exposure Assessment Survey Form (Appendix 12) is to be completed by the Principal Investigator or Laboratory/Shop Supervisor to aid the Industrial Hygiene Group in assessing the potential for on-going and projected exposures to carcinogens. Principle investigators and Lab/Shop Supervisors are to track and submit the names of all personnel using carcinogens.

The Industrial Hygiene Group prioritizes inspections based on exposure survey results. Industrial hygienists evaluate the adequacy of control measures, conduct air monitoring as appropriate, and refer to Health Services the names of all personnel identified as potential candidates for medical surveillance. [Unfortunately, established exposure monitoring protocols and/or specific medical surveillance tests are not available for many of the carcinogens (See Sections I and J).]

In addition, the Industrial Hygiene Group reviews chemical purchase requisitions to identify new carcinogen users whose operations/procedures have not been audited for that purpose. The Group reviews Specific Safety Procedures (Section C) written by for each procedure/operation using hazardous chemicals and determines if the intended control measures are adequate for the particular operation/procedure.

Prior to working with carcinogens, all personnel are required to receive training to learn about the health and safety hazards and to understand the specific handling and emergency procedures pertinent to their lab/shop operations and procedures, all stipulated in the Specific Safety Procedures (SSPs). The written SSPs, which include hazard analyses and specific control measures for using the carcinogens, must be filed with the Facility Notebook (See Appendix 4). All SSPs must be updated regularly to reflect current operations, and must be reviewed no less than annually.

EH&S inspections and Division self-assessments help ensure that laboratory/shop practices, engineering controls, and personal protective equipment are utilized most effectively to reduce the potential for exposure to that level which is as low as reasonably achievable.

The Industrial Hygiene Group provides technical guidance to personnel regarding the selection of appropriate laboratory practices and engineering controls. The Group also investigates all reported incidents that result in exposure of personnel or the environment to chemical carcinogens and will recommend corrective actions that reduce the potential for recurrence.

Control Measures

OSHA considers carcinogens in the context of laboratory work as only a subset of other particularly hazardous substances. And, OSHA only focuses on those carcinogens for which there is strong evidence indicating human carcinogenicity, (i.e., "select carcinogens"). Laboratories are allowed flexibility in assessing the need for protective measures and in determining the appropriate precautions needed to effectively control exposures to all particularly hazardous substances, including carcinogens. The only "requirements" in terms of control measures are those already outlined in Section G.1 as "required considerations" when using particularly hazardous substances.

In selecting appropriate safeguards, specific attention must be given to:

- The quantity of the carcinogen used;
- The physical and chemical properties;
- The carcinogenic potency;
- The type of experimental procedures involved;
- The frequency of use;
- The engineering controls available in the work area; and
- The applicable health and safety standards.

Adhere to the following rules and guidelines for controlling carcinogen exposures.

- Maintain an inventory of all carcinogens including the quantities acquired, dates of acquisition, disposition, and the personnel potentially exposed.

- Keep working quantities of carcinogens to a minimum; do not exceed the amounts required for use in one week. This does not include amounts stored in a designated area or a cabinet that is located within the laboratory.

- *Use disposable lab coats when working with large quantities of carcinogens and/or with concentrations in excess of 0.1%.* [LBL Storeroom, catalog numbers 8405-63672 (large size) and 8405-63673 (extra large size).]

- Wear safety glasses with shields when handling of transferring carcinogens.

- Adhere to all the standard chemical hygiene practices pertinent for using any hazardous chemical (See Section E).

- *Know which carcinogens being used are absorbed through the skin and wear gloves appropriate to the task.* Discard used gloves after each use and immediately after any obvious contact with a carcinogen.

- *Label all primary and secondary containers* and place hazard identification signs on entrances to work or storage areas. To obtain appropriate labels and signs, call the Industrial Hygiene Group, Ext. 5829. (Reference labeling requirements discussed in Section E.9 of this Plan).

- *Establish designated areas to restrict carcinogen use storage/areas to authorized personnel. Post the areas.* Remember that maintenance and emergency personnel must be advised of the potential problems and hazards before entering these work or storage areas.

- *To facilitate decontamination, cover work surfaces with stainless steel or plastic trays, absorbant paper with a moisture-proof lining, or other impervious material.* Decontaminate or discard the protective covering materials after the procedure has been completed as a hazardous waste.

- *Conduct aerosol-generating procedures or procedures involving volatile carcinogens in a chemical fume hood, a glove box, or other suitable containment equipment.* Examples of aerosol-producing operations are the opening of closed vessels; transfer operations; preparation of mixtures; blending; sonification; open vessel centrifugation; and the application, injection, or inoculation of a carcinogen into experimental animals.

- *Capture vapors or aerosols produced by analytical instruments with local exhaust ventilation or ventilation into a chemical fume hood.*

- Provide a mechanical exhaust ventilation system that controls the air movement from areas of lower contamination potential to areas of higher contamination potential (e.g., from entry corridors into the laboratory).

- *Decontaminate obviously contaminated equipment.* This is especially applicable to dusts and powders.

- *Transfer carcinogens in tightly closed containers* placed within a durable outer container.

- Dissolve finely divided powdered carcinogens, if possible, into a liquid. This reduces the possibility of generating an aerosol.

- Use mixtures that are as dilute as possible.

- Place contaminated materials in a closed, plastic bag within a sealed, primary container. Place the primary container in a durable box before transporting.

- Inactivate carcinogens, if possible, before disposal. However, first consult with EH&S to determine the technical and legal feasibility of the process.

- *When cleaning carcinogens that are dusts, use a wet mop or vacuum cleaner equipped with a high efficiency particulate air (HEPA) filter.* Do not dry sweep or dry mop.

- *Protect vacuum lines, pumps, and equipment* with an absorbent liquid trap and a HEPA filter to prevent entry of chemical carcinogens into the system. When working with volatile carcinogens, use a separate vacuum pump placed within or vented to a chemical fume hood. This pump should be labeled for use with carcinogens and the oil discharged as carcinogenic waste when it is changed.

- Determine through the EH&S Division, in consultation with the area supervisor, if exhaust air from open-faced laboratory-type hoods should be cleaned prior to its release to the environment. Treat exhaust air from glove boxes by filtration and/or adsorption, whichever is appropriate.

- Design and operate exhaust air treatment systems, such as filters or absorbers, in a manner that allows maintenance to be performed and avoids direct contact with the collection medium.

- Design exhaust air discharge to minimize the possible reentry of exhaust contaminants into the supply air intake of any building.

Exposure Monitoring and Medical Services

Employee exposure monitoring (i.e., air sampling) is required by OSHA for a limited number of carcinogens (See Section I.3). For other carcinogens, the Industrial Hygiene Group will assess the need for employee exposure monitoring. Employees must notify the Industrial Hygiene Group of any suspected exposures, of symptoms potentially affiliated with chemical exposures, and of concerns regarding the adequacy of existing control measures. An industrial hygienist will assess the operation or procedure, conduct air sampling as appropriate (and technically feasible), and refer affected employees to Health Services.

Employees may also report known or suspected exposures directly to Health Services, and Health Services will then alert the Industrial Hygiene Group that an investigation is warranted. Both groups must interact because each can supply information necessary to the other. The Industrial Hygiene Group assesses the exposure levels and Health Services (1) assesses the plausibility of the symptoms being associated with the particular agent(s), and (2) decides on the best medical

surveillance protocols for the particular exposure. Medical consultations and surveillance, including the requirements for specific carcinogens, are discussed in Section J.

Employees must understand their requirement to report all exposures, suspected symptoms, and incidents to their supervisors, who in turn must report them to the Health Services and the Industrial Hygiene Group.

Employees are encouraged to participate in recommended medical surveillance programs to identify changes in their health status. Women who are pregnant must consult with Health Services before the start of any laboratory or shop activity involving hazardous chemicals, including carcinogens.

3. Reproductive Toxins

Reproductive toxins are defined in the Laboratory Standard as they are in the Hazard Communication Standard, as "chemicals that affect reproductive capabilities including chromosomal damage (mutations) and produce effects on fetuses (teratogenesis)." Examples of adverse reproductive health effects include birth defects, spontaneous abortion, fetal developmental damage, and infertility.

Toxic chemicals are only one type of agent known to cause reproductive damage. Fatigue, illness, stress, some medications, alcohol, tobacco, ionizing radiation, viruses, and other agents are all known to cause reproductive damage. It is estimated that about 15% to 30% of all pregnancies end in spontaneous abortion and the causes of these spontaneous abortions are largely unknown. Also, the background rate for serious birth defects for all newborns is approximately 2% to 3%. The actual cause of most birth defects is unknown.

Most industrial chemicals have not been adequately tested for their ability to effect reproduction. No agencies comparable to the NTP or the IARC routinely evaluate and classify reproductive toxins. Unfortunately, the lack of rigorous testing and evaluation has resulted in a void of hazard warning information regarding potential adverse reproductive health effects. Most of the information available on human reproductive toxins comes from testing laboratory animals, but most known human reproductive toxins have exhibited similar effects in animals. Therefore, if

there are any significant data on a chemical that suggests it may cause human reproductive damage, it is prudent to assume it is a reproductive toxin.

The first trimester is the period of most concern to the developing fetus because this is when the organs and the limbs are being formed. During this period many women are not yet aware that they are pregnant. Control measures must already be in place to protect the woman and her fetus from toxic exposure levels. See Section J.7 for further discussion on LBL's policy respecting fetal protection, medical consultations, etc.

It is important to recognize that women, fetuses, and men are all subject to reproductive toxicity. Examples of agents causing birth defects are glycol ethers, lead, ionizing radiation, and certain drugs. Examples of female reproductive toxins are lead and ionizing radiation, which may cause infertility or alter the normal reproductive cycle. Examples of male reproductive toxins that affect fertility are 2-methoxyethanol (an organic solvent) and dibromocloropropane (a banned pesticide).

A list of reproductive toxins, extracted from the State of California Safe Drinking Water and Toxic Enforcement Act (Proposition 65) list of chemical known to cause reproductive toxicity is provided in Appendix 13. Note, however, that many of the listed chemicals are medicines and other chemotherapeutic agents that cause adverse reproductive effects when consumed orally or when injected into the body. The potential for reproductive toxicity resulting from other routes of exposure common to the laboratory use of chemicals (i.e., inhalation and skin absorption) may be negligible. Laboratories and shops should consider, at a minimum, the following chemicals known to cause reproductive effects when inhaled:

carbon disulfide	ethylene oxide
dinitrobenzene	lead and lead compounds
ethylene glycol monoethyl ether	mercury and mercury compounds
ethylene glycol monomethyl ether	toluene

The control measures appropriate for the particular operation or procedure being conducted depend on a number of factors, including the volatility of the substance, if the substance can be absorbed through the skin (e.g., glycol ethers), and how much of the substance is being used over a time period. Refer to Section G.1 for required

control considerations and consult with the Industrial Hygiene Group to choose the appropriate control measures.

4. Toxic and Pyrophoric Gases

The use of any hazardous gas must be carefully reviewed by the Principal Investigator in cooperation with the Industrial Hygiene Group (for toxic gases) or the LBL Fire Department (for pyrophoric and flammable gases) to ensure that appropriate and adequate safety systems are in place. The concentration of the toxic or pyrophoric gas is considered in the hazard evaluation. It is the responsibility of Division Directors to ensure that this review has been carried out before any new equipment is used or any new procedure adopted

Scope

Examples of highly toxic and/or pyrophoric gases are:

1,3-butadiene	germane	phosgene
arsenic pentafluoride	hydrogen cyanide	phosphine
arsine	hydrogen fluoride	phosphorus pentafluoride
boron trifluoride	hydrogen selenide	phosphorus trichloride
bromine pentafluoride	hydrogen sulfide	phosphorus trifluoride
bromine trifluoride	iodine pentafluoride	selenium hexafluoride
carbonyl fluoride	methyl bromide	silane
chlorine	methyl chloride	silicon tetrafluoride
chlorine trifluoride	methyl silane	stibine
cyanogen	nickel carbonyl	sulfur tetrafluoride
cyanogen chloride	nitric oxide	sulfuryl fluoride
diborane	nitrogen dioxide	tellurium hexafluoride
dichlorosilane	nitrosyl chloride	tungsten hexafluoride
fluorine	oxygen difluoride	vinyl chloride

Note: Because Codes and Regulations frequently change, the above list is not intended to be complete. The Industrial Hygiene Office (Ext. 5829) should be consulted if information is needed on the classification of a specific gas not listed above.

Preparation

An approved Operational Safety Procedure (OSP), which includes a safety analysis and describes hazard mitigation methods, is required before any highly toxic or pyrophoric gas may be procured and delivered for use. See Section C. Under prescribed conditions, when very small amounts of hazardous gases are used, the Industrial Hygiene Group may waive the need for the OSP (refer to Section C for more details).

The facility in which the highly toxic or pyrophoric gas will be used must be constructed and operated in such a way as to meet the applicable requirements of the Uniform Building Code (UBC) and the Uniform Fire Code (UFC). Division Directors are responsible for ensuring that the total quantity of gases contained in their building comply with the UBC and UFC. In buildings where there are programs operated by several program divisions, it will be necessary for the responsible Division Director to clearly define these responsibilities and to delegate them with sufficient authority to ensure that Laboratory policy will be implemented.

Necessary safety equipment such as fume hoods or gas cabinets, safety showers, eyewash, and fire extinguishers must be present. In addition, the experiment apparatus must be designed and installed with the proper safety controls. Contact the Industrial Hygiene Group and/or the Fire Department for assistance.

The research process tool or apparatus must meet all appropriate requirements of the UBC, UFC, NPFA, Life Safety Code, and the LBL Health & Safety Manual (PUB-3000).

Training in accordance with the OSP must be given to all persons operating the process tool or experimental apparatus. In general, it will be the responsibility of the Area Supervisor or Principal Investigator to provide and document this training. In addition, all persons subject to potential hazard from emergency events (e.g., fire fighters and other emergency crew personnel) must have hazardous materials response training. Personnel in adjacent work areas who do not operate hazardous gas equipment will be trained in appropriate actions to take in the event of an alarm or emergency.

Purchase and Delivery

Highly toxic and pyrophoric gases will normally be obtained by purchase requisition, form RL-2350 (Appendix 5). The requester must complete the Hazard Review Box on the form. The completed requisition form is to be sent to the Industrial Hygiene Group for approval and forwarding to the Purchasing Department.

It is important that gas cylinders be returned promptly when they are empty or no longer needed by the user. For certain reactive gases, it is very important to comply with the return date and the special instructions placed upon the cylinder. The user of the highly toxic or pyrophoric gas is responsible for removing the cylinder from the equipment to which it is attached, and for scheduling the return of the empty cylinder.

Key Contacts

Persons planning to order highly toxic or pyrophoric gases should contact the following for information:

- Industrial Hygiene Group, Building 26, Room 30, Ext. 5829, to obtain detailed information on Operational Safety Procedures, safety data sheets on gases, and general information on where to obtain assistance.

- Purchasing Department, Building 69, Ext. 4556, or Industrial Gases Group, Building 69, Ext. 6220, for availability or product information.

- Plant Engineering Department, Building B90K, Ext. 4171, to obtain information on the Uniform Building Code.

- Fire Department, Building 48, Ext. 6015, to obtain information on the Uniform Fire Code.

- UCB Campus Office of Environment, Health and Safety (642-3078) for complete UCB health and safety regulations on all campus buildings other

than the Calvin and Donner Laboratories (which are within the jurisdiction of LBL).

- The Toxic Substances Safety Subcommittee of the LBL Safety Review Committee, for information on the installation and operation of research apparatus using hazardous gases.

5. Toxic Metals

Beryllium

Beryllium is used predominantly in three forms: beryllium metal, beryllium oxide, and beryllium-copper alloys. Beryllium-copper alloys may consist of 0.5 to 4% beryllium, although the most common alloy has about 2% beryllium. Beryllium may also be alloyed with other metals, such as nickel and cobalt, or be found as a salt, e.g., beryllium fluoride, chloride, nitrate, or sulfate, and as beryllium hydroxide.

Exposure to beryllium and its compounds can damage the skin, eyes, and respiratory system. The soluble beryllium salts, especially the fluoride and sulfate, are skin sensitizers and in high concentrations are also primary skin irritants. If beryllium gets into broken skin, the cut may abscess and not heal properly until the substance is removed. Eye irritations are also common, and splash-burns can cause damage to the cornea. Breathing dust and fumes, however, is the most common cause of beryllium poisoning. The effects of inhaling high levels of beryllium can range form mild inflammation of the nose and throat, a condition that resembles a cold, to a severe pneumonia-like reaction characterized by coughing, difficulty in breathing, pain and tightness in the chest, loss of appetite, and general fatigue. The effects of inhaling low levels of beryllium over an extended period of time may be delayed from a few months to years after the last exposure. Chronic beryllium poisoning in most cases affects the respiratory tract. The onset may be manifested by weakness, loss of weight, shortness of breath, and coughing.

Beryllium dusts or powders constitute a moderate fire hazard. However, any fire involving beryllium is a serious threat to the health of nearby personnel.

Specific work practices and precautions are required for personnel when working with beryllium compounds.

- *Avoid skin contact with beryllium salts or salt solutions, and do not allow metallic beryllium to come in contact with open wounds or abrasions.* Wear gloves when handling beryllium or beryllium compounds when loose contamination (dust or chips) is present. There is no danger in ordinary skin contact with beryllium metals, alloys, or fused-ceramic material.

- *Conduct all operations involving the generation of airborne beryllium under controlled conditions, and obtain approval of these operations from the Industrial Hygiene Group, Ext. 5829.* Operations such as machining, grinding, welding, cutting, drilling, sawing, and milling must be enclosed and the exhaust ventilated through high-efficiency filters. A hazardous concentration of beryllium fumes may be generated when the metal is heated above 650°C (1200°F), or when the oxide is heated above 1540°C (2800°F). [The following work on beryllium-copper alloys may be performed without special controls: lathe cutting using a coolant, shearing, forming, hand sawing, hand filing, hand sanding, and soft soldering in a hood.]

- Scrupulously adhere to good housekeeping practices and personal cleanliness.

- Store and transport all beryllium parts in labeled containers.

- Ensure that all beryllium and beryllium-contaminated waste is placed in properly marked containers and picked up by the Waste Management Group, Ext. 5251.

Cadmium

The greatest exposure potential is probably from welding or burning cadmium-plated parts and brazing or silver soldering with cadmium-containing rods and wires. The brazing alloys contain 15 to 19% cadmium. Table G.5-1 indicates the important properties of all the silver solders stocked at LBL.

Table G.5-1. Properties of Silver Solders

Trade Name				Melt Pt.		Flow Pt.		
Englehard Ind	Handy&Hardman	LBL Cat. #	%Cd	°F	°C	°F	°C	Description
Silvaloy #50	Easy-Flo	3439-28753	18	1160	625	1175	635	Strip, 50% Ag
Silvaloy #50	Easy-Flo	3439-28756	18	1160	625	1175	635	Wire, 50% Ag
Silvaloy 503	Easy-Flo #3	3439-41772	16	1170	630	1270	690	Wire, 50%Ag
Silvaloy #15	Sil-Fos	3439-28747	—	1185	640	1300	705	Strip, 15% Ag
Silvaloy #60	Braze 603	3439-28572	—	1115	600	1325	720	Wire, 60% Ag
Silvaloy Easy	Braze Easy	3439-28751	—	1240	670	1325	720	Wire, 65% Ag

Finely divided cadmium metal and cadmium oxide fumes are highly toxic and must not be inhaled or ingested. A single exposure to high levels of cadmium in air can cause severe lung irritation, which may be fatal. Symptoms usually appear 4 to 10 hours after exposure when cough, labored breathing, and commonly a feeling of constriction or a burning sensation in the chest develop. Generalized flu-like symptoms characterized by shaky chills, sweating, aching in the extremities and back, headache, and dizziness may also develop. Continued exposure to low levels of cadmium in air can result in chronic poisoning characterized by irreversible lung injury and kidney damage. Cadmium is suspected of causing cancer in humans. Symptoms of the cumulative effects of cadmium may appear after exposure has terminated.

Cadmium metal dust will burn with evolution of a very hazardous brownish-yellow fume.

The following work practices and precautions are applicable to specific operations involving cadmium compounds:

- Remove all cadmium from plated parts before welding or burning.
- Substitute cadmium-free silver solder whenever possible.
- When cadmium is melted, temperatures should be kept as low as possible, consistent with the requirement of the operation, to prevent excessive fume generation.
- When indoor work or continuous outdoor work involves the generation of airborne cadmium, enclose the process to the maximum extent practical and provide a good exhaust system that collects and removes the fumes as they are formed. If the work is outdoors and intermittent, a properly fitted fume respirator must be used.
- Separate cadmium-containing and cadmium-plated parts from parts not containing cadmium and mark them appropriately so that accidental exposures resulting from cutting and welding do not occur.
- Use a vacuum pickup or wet mopping to clean up cadmium dust. Do not dry-sweep or blow.

Mercury

The most widely used form of mercury at LBL is elemental mercury. Mercury also exists as a salt and as an organic compound. From the standpoint of risk to human health, the most important forms of mercury are elemental mercury vapor and short-chain organo-alkylmercurials such as methylmercury and ethylmercury.

Mercury can enter the body through the lungs, the skin, and the digestive system. Because mercury vaporizes at room temperature, inhalation of its vapors is the most likely route of entry. Short exposures to high levels of mercury vapor can cause acute poisoning-characterized by tightness and pain in the chest, difficulty in breathing, inflammation of the mouth and gums, fever, and headaches. Acute poisoning, however, is rare. Much more common among workers is chronic poisoning caused by long term exposure to lower levels of mercury. Steady exposure can cause a slow build-up of mercury in the body that can result in illness, personality changes, and eventual disability. Symptoms of chronic poisoning include inflammation of the mouth and gums, weakness, loss of appetite and weight, shaking (particularly in the hands), and irritability.

Adhere to the following work practices when working with mercury:

- Avoid skin contact.
- Keep mercury containers closed when not in use.
- Use plastic or metal catch cans under all mercury apparatus that is likely to break or spill; and make transfers over a catch pan.
- Provide adequate ventilation, especially if mercury is heated above room temperature.
- Use a label on all equipment and vessels containing mercury.
- Store in a protected area in closed, labeled containers, preferably plastic. If a glass bottle is used, place it in a secondary container.
- Clean up mercury spills within a work area immediately because mercury vaporizes slowly at room temperature. If mercury is spilled at room temperature, notify the Hazardous Waste Management Group as soon as possible to obtain clean-up equipment and a mercury vapor survey. If mercury is released at elevated temperatures, evacuate the area immediately and notify the emergency dispatcher at the Fire Department, Ext. 7911.

- Dispose of mercury by placing in sealed, labeled containers. Send unused mercury to Salvage. If the mercury is being disposed of as waste, call the Waste Management Group at Ext. 5251, for pickup. Do not pour mercury down laboratory drains.

- Drain equipment of mercury prior to sending it to the warehouse for storage. Be sure that the equipment is properly secured and tagged with a mercury label.

6. Reactive Chemicals

Unstable (reactive) compounds are solids and liquids that in pure state, or as commercially produced or transported, will vigorously polymerize, decompose, combine, or become self-reactive under conditions of shock, pressure, or temperature. Use of such materials must have prior approval from the Industrial Hygiene Group on a case-by-case basis.

Peroxidizable Compounds

Isopropyl ether, ethyl ether, dioxane, tetrahydrofuran, and other alkyl ethers form peroxides on exposure to air and light. Because these chemicals are packaged in an air atmosphere, peroxides can form even though the containers have not been opened. The longer the storage period of these chemicals, the greater the amount of dangerous peroxides that may form. Experience has shown that isopropyl ether is by far the worst offender.

These peroxides are highly unstable, explosive chemicals that may detonate if subjected to high temperature, shock, or friction. Concentration by evaporation or distillation of an ether with formed peroxides increases the risk of detonation.

Adhere to the following work practices and precautions when working with peroxidizable compounds:

- Purchase ethers containing an inhibitor when possible.

- Store ethers in cans rather than glass bottles.

- Store ethers in as cool a location as feasible (but not in refrigerators unless flammable proof).

- Test ethers for peroxide content before any distillation procedure and, call EH&S if peroxides are detected.

- Place safety shields in front of reaction vessels or distillation apparatus in hoods when using ethers.

- Leave at least 10% "bottoms" when distilling.

- Do not open any container of uncertain age or condition, particularly when the cap or stopper is tightly stuck.

- *Dispose of ether containers one year after purchase, or three months after opening*. Do not attempt to physically remove or dispose of containers; let EH&S personnel handle the containers (Hazardous Waste Management Group, Ext. 5251).

- Label containers of ether with a red colored label and indicate the date of purchase. These labels should be applied by storeroom personnel. The container shall be labeled when received and when it is opened by the Area Supervisor or Principal Investigator.

Other Reactive Compounds

Other reactive chemicals include combustible liquids or solids (e.g., perchloric acid, certain metals such as potassium and phosphorus), pressure-sensitive chemicals (e.g., picric acid), and unstable compounds (e.g., sodium azide). The following are all considered reactive chemicals that may require special control measures and pre-authorization for use, depending on the quantities, concentrations, and intended use.

copper azide	phosphorus (white)
lead azide	picric acid
lithium	potassium
aluminum hydride	sodium
perchloric acid	sodium azide
trimethyl aluminum	triethyl aluminum

See also Section C on written safety procedure requirements and Section D.3 on the chemical procurement review process. Combustible liquids are also discussed in the next section on solvents.

7. Solvents

This section includes discussions on three types of solvents: (1) flammable and combustible liquids, (2) chlorinated hydrocarbons, and (3) fluorocarbon solvents. However, a solvent may fall into more than one class (e.g., a chlorinated hydrocarbon that is flammable).

Flammable and Combustible Liquids

Technically, flammable and combustible liquids do not burn. However, under appropriate conditions, they generate sufficient quantities of vapors to form ignitable vapor-air mixtures. As a general rule, the lower the flash point of a liquid, the greater the fire and explosion hazard. (The flash point of a liquid is the minimum temperature at which it gives off sufficient vapor to form an ignitable mixture with the air near its surface or within its containment vessel.)

Flammable and combustible chemicals include liquids (e.g., oils, greases, tars, oil base paints, and lacquers) and flammable gases. Flammable aerosols (e.g., spray cans) are also discussed. (Cryogenic and pressurized flammable gases are discussed in the LBL Health and Safety Manual (Pub. 3000), Chapters 7 and 13, respectively.)

Flammable and combustible liquids are defined and divided into classes by the National Fire Protection Association. The classes are described below.

• **Flammable Liquids (Class I).** Liquids having flash points below 100°F (37.8°C) and having vapor pressures not exceeding 40 pounds per square inch (absolute) at 100°F (37.8°C). Flammable Class I liquids are subdivided as follows:

Class IA. Liquids having flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C). Flammable aerosols (spray cans) are included in Class IA.

Class IB. Liquids having flash points below 73°F (22.8°C) and having boiling points at or above 100°F (37.8°C).

Class IC. Liquids having flash points at or above 73°F (37.8°C) and below 100°F (37.8°C). The boiling point is not considered.

• **Combustible Liquids (Classes II and III).** Liquids having flash points at or above 100°F (37.8°C). Combustible liquids in Classes II and III are subdivided as follows:

Class II. Liquids having flash points at or above 100°F (37.8°C) and below 140°F (60.0°C).

Class IIIA: Liquids having flash points at or above 140°F (60.0°C) and below 200°F (93.4°C).

Class IIIB: Liquids having flash points at or above 200°F (93.4°C).

Fires involving combustibles and flammables are especially dangerous because they release heat quickly, causing the fire to spread rapidly. The handling and use of these combustibles presents the most significant single source of fire hazard at LBL. Misuse or improper storage threatens not only the researcher and the experiment, but the laboratory unit and the entire building.

Liquids with flash points below room temperature (Class IA and IB liquids) continually emit sufficient quantities of vapors to be ignitable, except when chilled to temperatures below their flash points. Even when chilled, if spilled on a floor or work surface, they will heat rapidly and pose severe fire and explosion hazards. Liquids with flash points above room temperature (Class IC, II, IIIA, and IIIB liquids)

can easily be heated to the point at which they will create flammable vapor-air mixtures.

Flammable liquid vapors are heavier than air. They can travel for appreciable distances and accumulate in low places. Since it is the vapor of flammable liquids that burns, the fire hazard may not be confined to the immediate vicinity of actual use. Vapors can be ignited several hundred feet from the point of vapor generation. Flammable liquid vapors generally have low ignition-energy requirements and can often be ignited by small sparks from electrical motors, switches, relay contacts, etc.

Recommended precautions are based on the properties of the liquid to be used and the intended application. The user cannot make a correct decision on necessary precaution unless the properties of the liquid are known and the intended use is reviewed from a safety standpoint.

There must be sufficient ventilation to preclude the accumulation of flammable vapors. Flammable liquids should be used in a fume hood or with local exhaust ventilation. Normal room ventilation may be sufficient to permit small-scale use of flammable liquids (milliliter quantities). However, if larger quantities of liquid must be used in such facilities, it will be necessary to provide additional ventilation by opening doors and windows or providing some form of temporary exhaust ventilation.

Extreme care must be exercised when using flammable liquids in closed ("confined") spaces with minimal ventilation (such as glove boxes and tanks). Even milliliter quantities of flammable liquids can cause the build-up of explosive mixtures in the confined space.

Water should not be applied to fires involving flammables or combustibles. The use of water may float burning liquids, causing the fire to spread more rapidly. The fires are usually extinguished by excluding the air around the burning liquid. This is accomplished by one of several approved types of fire extinguishing agents, e.g., carbon dioxide, ABC multipurpose dry chemical, and Halon 1301 (a vaporizing liquid that breaks the flame front).

Many flammable and combustible liquids also pose health hazards.

It is the responsibility of the user to ensure that all flammables and combustibles are properly identified, labeled, handled, and stored. If assistance is required, contact the Fire Department.

The maximum allowable sizes of containers and portable tanks are provided below.

Table G.7-1. Containers for Combustible & Flammable Fluids

	Flammable liquids			Combustible liquids	
Class	**1A**	**1B**	**1C**	**II**	**III**
Glass or approved plastic	1pt[a]	1qt[a]	1gal	1gal	1gal
Metal (other than Department of Transportation (DOT) drums)	1gal	5gal	5gal	5gal	5gal
Safety cans[b]	2gal	5gal	5gal	5gal	5gal
Metal drums (DOT specifications)	60gal	60gal	60gal	60gal	60gal
Approved portable tanks	660gal	660gal	660gal	660gal	660gal

[a] Glass or approved plastic containers or no more than 1 gallon capacity may be used for Class IA or IB flammable liquids if (1) such liquid either would be rendered unfit for its intended use by contact with metal or would excessively corrode a metal container so as to create a leakage hazards or (2) the user's process either would require more than 1 pint of a Class IA liquid or more than 1 quart of a Class IB liquid, of a single assay lot, to be used at one time.

[b] Approved safety cans of various materials and capabilities are available through the Central Storeroom (LBL stock, Section 7960).

The following rules and precautions apply to the use and/or storage of flammable/combustible liquids:

- Storage cabinets must be designed and approved for the anticipated usage. Approved metal storage cabinets are available in various sizes from stores (LBL stock, Section 7195).

- Not more than 120 gallons of Class I, Class II, and Class IIIA liquids, combined, may be stored in a storage cabinet. Of this total, not more than 60 gallons may be of Class I and Class II liquids, combined, and not more than three such cabinets may be located in a single fire-separation area.

- Ordinary domestic refrigerators must not be used for the storage of flammable liquids because they contain certain built-in ignition sources (such as electrical contacts). These sources of ignition may initiate a fire or an explosion if flammable vapors are present. In special cases, ordinary refrigerators have been modified by the Electricians' Shop to specifications approved for storage of flammable liquids. Refrigerators are now available commercially that are specifically designed and approved for storage of flammable materials.

- To adequately manage the exposure hazards in each building or fire-separation area in each building, it is necessary to consider the needs of all users, and/or of user groups in aggregate, for each building or fire-separation area.

Quantity restrictions are usually intended to provide guidance for lower usage levels. In general, quantities in excess of three-months usage should not be stored. If the need for larger quantities is anticipated, contact the Fire Department for assistance. *The maximum allowable quantities for flammables and combustibles outside designated and approved storage rooms or facilities are listed below:*

- One gallon size is the maximum allowable container size for for general dispensing of Class I and Class II liquids unless in approved safety cans.

- The maximum allowable safety container size for Class I-A flammable liquids is 2 gallons.

- The maximum allowable safety container size for Class I-B, Class I-C, Class II, and Class III-A liquids is 5 gallons.

- Where more than one laboratory unit or shop is located in a single fire-separation area, all Class I and Class II liquids must be stored in approved storage cabinets or approved safety cans.

- For single fire-separation areas, 10 gallons of flammable and combustible liquids, combined, is the maximum quantity allowable *outside* of approved storage cabinets or approved safety cans.

Chlorinated Hydrocarbons

The chlorinated hydrocarbons as a whole have many industrial as well as laboratory uses. At LBL they are commonly used as cleaners, degreasers, paint removers, solvents, and extractants.

Most of these compounds have an anesthetic (narcotic) effect, causing workers to feel "drunk," become unconscious, or even die if the amount of inhaled vapor is excessive. Individuals working around moving machinery can be subject to accidents when their judgment and coordination are impaired by the anesthetic effects of inhaled solvents. Usually it is the anesthetic effect that is responsible for sudden unconsciousness of persons exposed to solvents in tanks, pits, and other confined spaces. Trichloroethylene, ethylene dichloride, and chloroform are examples of compounds that are powerful anesthetics.

Some, but not all, of the chlorinated hydrocarbons are strong poisons that damage the liver, kidneys, nervous system, and/or other parts of the body. This damage may be permanent or even cause death, although recovery from lesser exposures does occur. Single exposures to higher concentrations of vapors, as well as repeated exposure to small concentrations can produce symptoms of poisoning. These symptoms most often come on gradually, with nausea, loss of appetite, vomiting, headaches, weakness, and mental confusion most often noted. Carbon tetrachloride, tetrachloroethane, and 1,1,2- trichloroethane are examples of compounds that are strong poisons.

All chlorinated hydrocarbons on repeated contact with the skin can cause rashes (dermatitis) because of their ability to remove the protective fats and oils from the skin. A few of these solvents are known to be capable of entering the body through contact with the skin. In addition, many of these compounds are highly irritating to the membranes around the eyes and in the nose, throat, and lungs. Examples of chlorinated hydrocarbons that have irritant properties are ethylene dichloride and chloroform.

Many of these compounds are on the Select Carcinogen List, e.g.,carbon tetrachloride, methylene chloride, chloroform, perchloroethylene, trichloroethylene, and ethylene dichloride. See Section G.2 for further discussion on carcinogens and Appendix 10 for lists of select carcinogens.

When heated, these compounds can decompose, forming highly toxic fumes of phosgene, hydrochloric acid, and chlorine. Most of the chlorinated hydrocarbons are nonflammable; however, there are exceptions. Table G.7-2 lists important characteristics of some of the common chlorinated hydrocarbon solvents. For questions concerning the hazards of a specific compound, contact the Industrial Hygiene Group, Ext. 5829.

Table G.7-2. Chlorinated Hydrocarbon Data

Common Name	Chemical Name	PEL[a] (ppm)	Volatility[b] (mm Hg)	Flammability
Acetylene dichloride	1,2-Dichloroethylene	200	200	Moderate
Carbon tetrachloride[c]	Tetrachloromethane	2	115	Nonflammable
Chloroform[c]	Trichloromethane	2	200	Nonflammable
Ethylene dichloride[c]	1,2-Dichloroethane	1	80	Moderate
Methyl chloroform	1,1,1-trichloroethane	350	132	Nonflammable
Methylene chloride[c]	Dichloromethane	25*	435	Nonflammable
Perchloroethylene[c]	Tetrachloroethylene	25	18	Nonflammable
Tetrachloroethane	1,1,2,1-tetrachloroethane	1	8	Nonflammable
Trichloroethane	1,1,2-trichloroethane	10	25	Nonflammable
Trichloroethylene	Trichloroethylene	50	76	Nonflammable

[a] The Permissible Exposure Limit (PEL) is expressed as parts of pure solvent vapors per million parts of air (ppm). The asterisk (*) by the methylene chloride PEL signifies that this is the value in the new proposed rule (Nov., 1991).

[b] The vapor pressure at 77°F (25°C).

[c] Designated as an OSHA Select Carcinogen.

Adhere to the following rules and precautions when using chlorinated hydrocarbons.

- Consider information on the occupational exposure limits (i.e., the OSHA PEL and the ACGIH TLV), the volatility, and the flammability of a compound. These three characteristics always must be taken into careful consideration in selecting a compound in order to minimize the health hazards connected with its use.

- If there is a possibility of skin or eye contact, wear the appropriate protective equipment. Gloves made of impervious material should be worn for hand protection. Reference Appendix 6 or call the Industrial Hygiene Group (Ext. 5829) for recommendations on the types of materials that are acceptable.

- For high vapor concentrations (and especially if the solvent is on the Select Carcinogen List), control exposures by using local exhaust ventilation. If the solvent is on the select carcinogen list, consider the need for local exhaust ventilation even for moderate and low vapor concentrations. Contact the Industrial Hygiene Group, Ext. 5829, for an assessment of the airborne concentration.

- Store chlorinated hydrocarbons in cool, dry, and well-ventilated areas. Containers should be checked for leaks because metal corrosion can occur from hydrochloric acid produced by the decomposition of the solvent. Decomposition may occur under conditions of high temperature, exposure to moisture, and exposure to ultraviolet light.

- Label compounds, both in the original containers and in secondary containers used by employees, so that the potentially injurious substances are plainly identified. Labels for perchloroethylene, trichloroethylene, and carbon tetrachloride can be obtained at the LBL Central Storeroom, Bldg. 7.

- Place waste chlorinated hydrocarbons in an organic liquid waste can for disposal. When the waste can is full, contact the Waste Management Group.

Fluorocarbon Solvents

Fluorocarbon solvents are organic compounds containing fluorine. Many also contain chlorine and are technically "chlorofluorocarbons." Common names for some members of this family are Freon-TF, Freon-TMC, and Freon-11.

The vapors are four to five times heavier than air and tend to accumulate in tanks, pits, and low places. This displaces the oxygen, which can cause suffocation, or the vapors themselves may be toxic in high concentrations.

Fluorocarbon solvent will dissolve and extract the natural oils present in the skin. If contact is prolonged, the skin may become dry and perhaps cracked. The vapors have little or no effect on the eyes. If the liquid is splashed in the eyes, temporary redness may be produced.

Lower boiling liquids may cause freezing if splashed on the skin or in the eyes.

Fluorocarbon vapors decompose when exposed to high temperatures, ultraviolet and radiofrequency radiation. Toxic fumes such as hydrofluoric acid, hydrochloric acid, and phosgene may be formed. Fluorocarbon solvents are nonflammable.

Adhere to the following rules for work with fluorocarbons:

- Contact the Industrial Hygiene Group, Ext. 5829, if fluorocarbon solvents are used in enclosed areas such as tanks and pits. A confined space entry permit is required, and forced-air ventilation and air-supplied respirators may be required.

- Avoid contact with hot surfaces, electric heating elements, or open flames. If toxic fumes are formed, good ventilation will be required.

- Wear gloves made of neoprene or equivalent when there is the possibility of prolonged or repeated skin contact with the liquid. Wear protective clothing and eye goggles if the liquid may be splashed.

- Control environmental releases pursuant to air quality regulations (to protect the earth's ozone layer).

8. Polychlorinated Biphenyls (PCBs)

PCBs are a broad class of nonflammable, synthetic, chlorinated hydrocarbon insulating fluids previously used in capacitors and transformers. Synonyms include askarel, aroclor, inerteen, pyranol, therminol, and many others.

Prolonged skin contact with PCB oils can cause skin irritation and occasionally the formation of acne-like cysts. Eye contact can cause severe irritation and inflammation. Breathing the vapor or mist from heated oil can cause respiratory irritation. PCBs are listed as suspect carcinogens and can cause liver damage.

PCBs may produce toxic and carcinogenic dioxin compounds when heated, as in a fire. But generally, PCBs do not break down in the environment, due to their inert character and stability under extreme physical stresses. PCBs are widely dispersed in the environment and can accumulate in foods found in the human diet.

The following precautions apply when working with PCBs:

- Wear the appropriate protective equipment including viton gloves, coveralls, and splash goggles when working with PCB-contaminated equipment or on PCB spills.

- Clean up small PCB spills with vermiculite or Sorb-all. Place waste material in plastic bags and call the Waste Management Group, Ext. 5251. All equipment containing PCBs must be disposed of through the EH&S Waste Management Group.

- In case of large PCB spills or explosions of PCB-containing equipment, evacuate all personnel from the area. Call the Fire Department, Ext. 7911, for assistance. Provide or maintain ventilation in the affected area, if possible. If entry to the area is necessary, a self-contained breathing apparatus must be worn.

- If PCB splashes on an employee, remove any contaminated clothing promptly and wash the skin with soap and water. If the eyes are affected, flush immediately for about 15 minutes. Report to Health Services.

- Place equipment containing PCBs in a manner to ensure minimum contamination to the environment. Equipment must be stored and transported in a manner that eliminates any leaks to the environment.

- Label all equipment containing PCBs. Note: PCBs have been phased out of all the large utility transformers at LBL.

9. Physical Hazards

Compressed Gases

The general precautions for compressed gas cylinders must be followed. [See the LBL Health and Safety Manual (Pub-3000), Chapter 13]. The basic rules are summarized below:

- Do not purchase large cylinders of hazardous gases if it is possible to use small cylinders.

- Do not use cylinder color coding to identify cylinder contents. These colors have not been standardized by the suppliers. Rely on the label placed on the cylinder.

- Return empty cylinders to the vendor as soon as possible after use. It is not uncommon for gas cylinders to develop leaks during storage. Arrangements for pickup of used cylinders are made by contacting LBL Transportation. Before pickup, the cylinder valve must be closed, the regulator or needle valve must be removed, the dust cap replaced, and the valve cover put back on the cylinder.

- If a cylinder is leaking, contact the Industrial Hygiene Group or the Fire Department.

Oxygen-Pumping in Vacuum Systems

Oxygen in concentrations 25% by volume should not be introduced into a mechanical vacuum pump charged with hydrocarbon oil, which is a combustible fluid. During compression in the pump, the pressure of the oxygen may reach as high as 2-3 atmospheres, and at this pressure it may cause an explosion if combined with a hydrocarbon oil.

Various fluids are available, such as Fomblin or Halo Vac (Sargent-Welch Scientific Company). Modification of the pump may be required because these fluids have high molecular weights and high specific gravities and may be incompatible with seals. An inquiry to the pump manufacturer is recommended.

Pumps modified for oxygen service shall be permanently identified and used only with the specified fluid.

Cryogenic Hazards

The primary hazard of cryogenic materials is extreme coldness. They, and surfaces they cool, can cause severe burns if allowed to contact the skin. Division guidelines and standards for the safe storage and handling of cryogenic materials are given in the LBL Health and Safety Manual (Pub-3000), Chapter 7, however, the following are some general rules for laboratory operations:

- Use gloves and a face shield when preparing or using cold baths.

- Do not use liquid nitrogen or liquid air to cool a flammable mixture in the presence of air because oxygen can condense from the air, and can lead to an explosion.

- Use appropriate dry gloves and face shields when handling dry ice, and add the ice slowly to the liquid portion of the cooling bath to avoid foaming. Workers should avoid lowering their heads into a dry ice chest to prevent suffocation.

- Transport materials packed in dry ice in such a manner as to prevent the accumulation of carbon dioxide gas.

H. TRAINING AND EMPLOYEE INFORMATION

1. Requirements

Employees must be provided training on the hazards to which they may be exposed and the means to avoid these hazards. Training must be updated when a new hazard is introduced into the workplace.

Safety training is the responsibility of the employee's division or department. New Employee Safety Orientation is required for all new employees and participating guests within the first month of work. To assist the departments, other safety training is conducted by EH&S (See Section H.3). However, *the division or department is responsible for providing specific job safety orientation, hazard communication, chemical hygiene and safety, and skills training.* Supervisors must instruct their personnel about the potential hazards involved in their work, the proper safety precautions to follow, the warning signs of possible exposures to chemicals in their operations (e.g., odors, irritation, etc.), and the emergency procedures to use if an accident should occur.

Complete training for those working with hazardous chemicals involves three levels of training:

(1) The LBL New Employee Safety Orientation (Course EHS-10), which provides general hazard communication training,

*(2) CHSP Training (Course EHS-348), a course geared toward the elements of this Plan, and

(3) Operation/procedure-specific training provided individually or in small groups by the Principal Investigator or Laboratory/Shop Supervisor.

* *The Chemical Hygiene and Safety Plan training provided by EH&S ("CHSP Training") consists of two different formats: one geared towards laboratory operations, and one geared towards shop operations.*

Collectively, the training must minimally include discussion of the following topics:

- The requirements of the Hazard Communication and Laboratory Standards, whichever applies
- Potential chemical, physical, and biological hazards
- Which operations involve hazardous materials
- Applicable health standards (e.g., OSHA PELs and ACGIH TLVs)
- Use and location of Material Safety Data Sheets
- Labeling requirements
- General safe working practices
- Purpose and use of control measures
- The use of administrative controls (e.g., controlled areas, designated/regulated areas, etc).
- Personal protection measures
- The warning properties of chemical releases (e.g., odors, eye irritation, etc.)
- The signs and symptoms of chemical overexposure
- Purpose and results of exposure monitoring
- Purpose and requirements of medical surveillance
- Spill response and emergency protocols
- Possible non-routine tasks

- Hazards of unlabeled pipes, wastes, etc.

A Safety Training Check List, attached as Appendix 14, lists specific training topics.

2. Hazard Communication Resources

Information on hazardous properties of a chemical substance can be accessed through the following resources:

Material Safety Data Sheets (MSDSs)

Manufacturers and distributors are required to develop a material safety data sheet (MSDS) for each hazardous material they produce or import. All MSDSs provide information regarding the specific chemical identity of the material(s) involved and their 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. Refer to Appendix 15 for details on "Using the Material Safety Data 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. The Principal Investigators and Lab/Shop Supervisors are responsible for securing MSDSs and making sure that they are available (See Section B.2). 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 (Ext. 5829). If the MSDS is not on file, the Industrial Hygiene Group will contact the manufacturer and obtain one.

Individual laboratories and shop areas must maintain those MSDSs that are received with their shipments. In some cases an MSDS is not needed for all chemical products. For example, when a laboratory or shop purchases a household consumer product that contains a hazardous substance (e.g., Formula 409 all-purpose cleaner), and the product is used in a household application similar to that intended by the manufacturer, a MSDS is not required.

Computer MSDSs

Two additional resources are available to LBL laboratory personnel as "on-line" MSDS Systems: Canadian MSDSs, and some manufacturer-specific MSDSs available from the UC Office of the President. Both are accessed via LBL Ethernet. Refer to Appendix 15 for an example of a Chemical Infogram (MSDS) that can be accessed through the Ethernet System.

TOMES

The Micromedex TOMES (Toxicology, Occupational Medicine, and Environmental Series) System is a combination of a number of excellent databases on chemical hazard information. Included on one compact disk, and updated every 90 days, the information (685 megabytes, equivalent to a stack of references 50 feet high) includes toxicity data, hazardous reactions, emergency response guidance, environmental regulations, fire safety, etc.

EMS

The Environmental Management System (EMS) is the database that holds LBL's Chemical Inventory files. The locations of every chemical, site-wide, can be determined as well as the room-by-room inventory listings.

Books

Refer to Section L for a list of recommended references and information resources.

3. Training Resources

A listing of EH&S courses is published in the quarterly Health and Safety Course announcement. Supervisors or others planning safety meetings or training may obtain educational materials, audiovisual aids, and advice from EH&S.

One course specifically designed for laboratory and shop supervisors is *strongly recommended and may be required.* The course presents an overview of EH&S requirements/responsibilities:

- EH&S Training for Supervisors

Other courses that *may be required or recommended* are dependent on the operations, chemical agents and/or physical hazards:

- Chemical Safety for Semiconductor Operations
- Radiation Safety Orientation
- Radiation Protection - Radionuclides
- Respirator Use
- Laser Safety
- Forklift Safety
- Incidental Crane Operator Safety
- Hearing Conservation
- Confined Space Entry
- CPR
- First Aid
- Fire Extinguisher Use
- Waste Generator's Training
- Pressure Safety/Compressed Gases

I. EXPOSURE MONITORING

1. Purpose

Exposure monitoring refers to testing the air for the presence of specific chemicals or types of chemicals. Measurements are of two types, direct and time-integrated. Direct measurements provide information on the air concentration of a chemical at one moment in time and are useful for screening purposes. Time-integrated sampling allows the industrial hygienist to establish the average air concentration of the chemical over a specific period of exposure. Results of time-integrated exposure monitoring can be compared to legal exposure limits (i.e., PELs).

The purpose of exposure monitoring is to:

(1) Identify laboratory or shop operations/procedures requiring improved controls;

(2) Establish the effectiveness of existing controls for new or altered operations/procedures;

(3) Identify the personnel potentially or actually exposed to hazardous chemicals at unsafe levels, including those personnel who report symptoms consistent with exposure; and

(4) Establish safe air concentrations following cleanup of chemical spills/releases.

The Industrial Hygiene Group must measure an employee's exposure to any substance regulated by an OSHA standard (which includes any chemical with an OSHA PEL) *if there is reason to believe that exposure levels for that substance exceed the action level (or in the absence of an action level, the PEL).* The initial monitoring must be followed by periodic monitoring if the results of the initial monitoring indicate exposures at or above the action level or PEL. (See Section I.4 or Appendix 3 definitions on PELs, action levels, etc.)

Employee exposure monitoring is sometimes used during an initial evaluation of an operation to determine if controls are needed. This is performed on a test basis during the initial phase of an operation. Exposure monitoring may also be performed, if needed, after the operation has been implemented to verify that exposure levels are safe. Results from the employee exposure monitoring are used to determine whether any additional controls are needed.

2. Hazard Assessment and Criteria for Monitoring

Generally, exposure monitoring is just one part of the hazard assessment process, and it is frequently not warranted. The first steps in a hazard assessment of any laboratory or shop operation/procedure include an evaluation of the following factors:

- The physical and chemical properties of the chemical (e.g., volatility, reactivity);
- The toxicity of the chemical, i.e., the acute and chronic health effects attributed to specific exposure levels, including low, long-term, and brief high exposure levels; and
- The "routes of exposure" or ways that the chemical can enter the body, such as via inhalation and/or skin absorption.

A hazard assessment is conducted for each laboratory or shop procedure as part of the Laboratory/Shop Specific Safety Procedure (SSP). See Section C and Appendix 4.

The decision to conduct exposure monitoring of an operation or procedure is based upon consideration of the potential amount of exposure. Factors to consider in assessing the need or benefit of exposure monitoring include:

- *How long the operation/procedure lasts.* Monitoring is usually not needed if the exposure lasts fewer than 10 minutes and involves materials of low toxicity/hazard.

- *The presence of other controls* (e.g., if the operation/procedure is performed in a lab hood and the hood is functioning properly, monitoring is usually not needed).

- *The number of employees involved.* Monitoring has greater priority if many employees are being exposed.

- *The physical form of the substance.* Airborne emissions are unlikely from solid metal bars but possible with metal powders.

- *The amount of substance being used or released.* If only small quantities (e.g., 10 milliliters or 1 gram, or low concentrations) of the material are being used, and/or if materials are in closed containers, monitoring may not be needed. However, if visible emissions are present (e.g., visible dust, fumes) or if vapors are released over a significant time period (e.g., 30 minutes or more), monitoring may be needed.

- *Availability of established monitoring methods.* Sampling and analytic methods are not available for all chemicals.

3. Substances that Require Monitoring

Employee exposure monitoring is *not required for laboratories* unless there is reason to suspect exposures are at or above (1) the OSHA Action Level (which for chemicals that have them, is usually one-half of the PEL value), or (2) the OSHA PEL, for chemicals that do not have Action Levels. However, *certain substance-specific OSHA standards (e.g., the lead standard) do require monitoring* to establish exposure levels, and specify monitoring protocols. LBL shops are subject to the monitoring requirements of these substance-specific standards. The Industrial Hygiene Group determines the appropriate exposure monitoring needs for the shops and laboratories.

The list of substances with specific monitoring requirements is given below:

acrylonitrile
asbestos

benzene
dibromochloropropane
ethylene dibromide (California OSHA only)
ethylene oxide
formaldehyde
inorganic arsenic
inorganic lead
vinyl chloride

4. Interpretation of Results

Monitoring is performed under the direction and management of an industrial hygienist and the monitoring results are compared with accepted criteria:

- The OSHA Permissible Exposure Limit (PEL) for a substance. The PEL is a *legal limit* that must be met for any operation, laboratories included. The PEL represents an 8-hour, time-weighted *average* concentration.

- The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV). A TLV is a recommended limit that should be used as a *guideline*. The TLV is also an 8-hour, time-weighted average concentration.

- The OSHA Action Level (AL) for the substance, if one exists. An action level, usually one-half the PEL, triggers additional monitoring and/or medical surveillance requirements. The AL is measured for a workday i.e., an 8-hour time-weighted average concentration.

- The OSHA and ACGIH Short-Term Exposure Limit (STEL) is the average concentration to which workers can be exposed for a short period of time (15 minutes). The STEL supplements the 8-hour PEL/TLV and is intended to protect workers from acute toxic effects.

Many substances have both a PEL and a TLV. In some cases, the values of these two limits are different for the same substance. In these cases it is LBL's policy, pursuant to DOE orders, to use the lower of the two limits to evaluate the exposure results.

LBL's Industrial Hygiene Group shall within 15 working days after the receipt of any monitoring results, notify the employee's supervisor. The supervisor will in turn (and within the same 15-day period) notify the affected employee(s) of the results. The notification must be in writing and either presented individually or by posting the results in an appropriate location that is accessible to the employee(s). Consideration is given to an employee's desire for confidentiality.

The Industrial Hygiene Group shall notify Health Services of potential exposure problems by providing them (1) a copy of the completed Hazard Evaluation Form, which is routinely used by the Group (See Appendix 12), and (2) a copy of the memo relaying exposure monitoring results to the employee and his/her supervisor. The Hazard Evaluation Form is also used to document follow-up evaluations that occur after Health Services refers potential exposure problems to the Industrial Hygiene Group (See Section Section J.5).

J. MEDICAL CONSULTATIONS AND SURVEILLANCE

1. Overview of Medical Services

Medical consultation and examinations are provided under the direction of Health Services, a group within the EH&S Health Department. The mission of Health Services is to provide a comprehensive occupational health program. The primary objectives of the program are to:

- Ensure that employees are assigned duties they are physically able to perform;
- Provide medical care and rehabilitation of the occupationally ill and injured;
- Provide emergency treatment for illnesses and injuries;
- Encourage employees to maintain their physical and mental health;
- Assist in maintaining a healthful and safe work environment; and
- Monitor for signs and symptoms of possible exposure or overexposure to hazardous chemicals, infectious agents, noise, and radiation.

Health Services provides emergency medical services, medical consultations, and medical examinations. A medical consultation is a consultation that takes place with a health care provider for the purpose of determining whether a medical examination and/or medical procedures are appropriate. A medical examination is a physical examination by a licensed physician for the purpose of assessing health status. Medical examinations are one of three types: pre-placement, periodic (e.g., for medical surveillance), and employment termination.

A medical examination usually consists of an occupational and medical history and tests to identify health problems. Special attention is given to potential health effects that are associated as health hazards specific to hazardous agents that an employee may be exposed to in the work area. Potential occupational exposures to hazardous situations or agents are investigated on a continuing basis in

cooperation with Industrial Hygiene, Occupational Safety, and other groups in the Environment, Health & Safety (EH&S) Division.

Medical surveillance is the application of clinical procedures ("medical screening") to select personnel who are identified as being at risk for exposure to hazardous agents at occupationaliy significant levels. Clinical procedures may be utilized to detect evidence of the agent itself (e.g., lead in the blood), or clinical manifestations resulting from the agent (e.g., changes in liver function). Medical surveillance and other periodic preventative physical examinations are provided on a scheduled basis. Specific examination protocols as set forth by the National Institute for Occupational Safety and Health (NIOSH) may be implemented based on the individual's age, laboratory or shop processes and chemicals used, and prior medical history. Specialized examinations are provided for:

- Individuals returning to work following non-occupational illness or injury;
- Individuals returning to work following occupational illness or injury;
- Laser users;
- Individuals with significant potential for internal exposure to radioisotopes;
- Individuals using an OSHA-regulated compound that are exposed to air concentrations of that compound at or above the compound's action level (or in the absence of an action level, the PEL);
- Individuals identified as at-risk for exposure to carcinogens; and
- Individuals reporting an exposure to hazardous agents or complaining of symptoms potentially attributed to exposure of such agents.

2. Medical Surveillance for Exposure to Hazardous Chemicals

A medical surveillance program (medical surveillance) may include any combination of medical consultations, examinations,and clinical testing. In deciding the type of medical program, if any, that is appropriate for laboratory

workers, it is important to keep in mind the nature of exposure conditions in a typical laboratory. Typically, chemicals used and procedures performed vary substantially between laboratories and, sometimes, within a single laboratory. Moreover, operations and chemicals may change over time. This section describes the general medical surveillance requirements under the OSHA Laboratory Standard, and LBL's policy for its laboratory and shop workers.

Consistent with DOE and UC policies, all LBL permanent personnel receive base line, pre-placement medical examinations and are strongly encouraged to participate in periodic medical examinations. However, OSHA does not *require* baseline medical examinations as a general policy for all laboratory personnel. Given the unpredictable array of chemicals in laboratories, general baseline examinations may not provide meaningful correlation to future adverse exposures. On the other hand, OSHA does not suggest that medical provisions are not needed under any circumstance. Clearly, an employee should receive appropriate medical attention if he/she exhibits signs of symptoms possibly related to exposure to a hazardous chemical or if he/she is subjected to events such as spills, leaks, explosions or other unexpected occurrences where there is a likelihood of exposure to hazardous chemicals.

The OSHA Laboratory Standard provides for *medical examinations* in the case of symptoms and *medical consultations* for events (i.e., spills, leaks, fugitive emissions) or occurrences resulting in the likelihood of a significant exposure to a hazardous chemical. The medical consultation is provided for the purpose of determining the need for a medical examination.

An employee shall be afforded an opportunity to receive any examinations recommended by the physician. Medical examinations and consultations are (1) performed by or under the direct supervision of a licensed physician, (2) provided at a reasonable time and place, and (3) provided without cost to the employee.

3. Identifying the Need for Medical Surveillance

Generally the purpose of a Medical Surveillance Program is to watch for early health effects that may be related to an exposure and serve as an early warning of

more serious health effects that could ensue. Occasionally, medical surveillance is utilized to help establish the dose of a chemical that the body has received.

Medical surveillance may be useful in: (1) assessing the effects of exposure to hazardous chemicals; and, (2) ruling out bodily damage/injury. Unfortunately, medial examinations are not always useful in measuring the actual dose of a hazardous chemical that the body receives. Most medical tests are not specific for the chemical exposure and tests used actually measure damage, or the early signs of disease (e.g., liver enzymes). Medical surveillance is more useful when performed in conjunction with exposure monitoring because the potential dose is easier to assess and correlate with any clinical findings that may be present.

Medical surveillance may be useful in a number of different operations and should be considered on a case-by-case basis. *However, there are four occasions in which employees must be provided the opportunity to receive medical surveillance to address the potential for adverse health effects associated with exposures:*

- When employees develop symptoms that appear to be associated with exposures to hazardous chemicals;.

- When employees are involved in responding to a spill, leak, explosion or other release that results in exposures to hazardous chemicals;

- When air monitoring has demonstrated exposures at or above occupational exposure limits; and

- When required by substance-specific OSHA regulations.

4. When OSHA Regulations Require Medical Surveillance

The OSHA Laboratory Standard, which applies to all laboratory workers (and not strictly to shop workers) supersedes the requirements specified in substance-specific standards (e.g., for asbestos, benzene, etc.). The only requirement for laboratory personnel is to maintain exposures below occupational exposure levels. If there is reason to suspect that exposures exceed those limits, a medical consultation is provided.

For non-laboratory operations (i.e., shop operations), OSHA regulations *require* that a medical surveillance program be implemented for two different groups of substances: regulated carcinogens and those substances that specify a surveillance program in a substance-specific OSHA standard.

Because LBL chooses to provide equal protection for all its employees all existing OSHA medical surveillance protocols will be considered, regardless of whether personnel work in laboratories or in shops. However, the likelihood of significant exposures in a laboratory setting is small.

OSHA Regulated Carcinogens:

Employees involved in handling, working with, or using any of the substances listed below in concentrations at or above the percentage amount shown must be included in a medical surveillance program. There are only two exceptions from the medical surveillance requirement:

- Operations that only handle the carcinogens in closed, sealed containers that are not opened at any point during the operations, i.e., there is no potential exposure, and

- Operations that only handle the carcinogen in concentrations below those listed below.

OSHA Regulated Carcinogens

Name	*Percent concentration*
2-acetylaminofluorene	1.0
4-aminodiphenyl	0.1
benzidine and its salts	0.1
3,3'-dichlorobenzidine and it salts	1.0
4-dimethylaminoazobenzene	1.0
alpha-naphthylamine	1.0
beta-naphthylamine	0.1
4-nitrobiphenyl	0.1
N-nitrosodimethylamine	1.0
beta-propiolactone	1.0
bis-chloromethyl ether	0.1
methyl chloromethyl ether	0.1
ethyleneimine	1.0

Substance-Specific OSHA Health Regulations:

The second group of substances that require medical surveillance programs are those with complete, substance-specific OSHA health regulations. Laboratories or shops that handle, work with, or use these substances in a manner which could potentially result in employee exposures at or above the action level for the substance must implement a medical surveillance program as described in the specific regulation. The action level is a trigger level which is different for each substance. Normally, employee exposure monitoring is required to measure the employees' exposure levels and to determine whether these levels exceed the action level and medical surveillance is required. The chemicals having substance-specific regulations include:

acrylonitrile
asbestos
benzene
coke oven emissions

dibromochloropropane (DBCP)
ethylene dibromide (California OSHA only)
ethylene oxide
formaldehyde
inorganic arsenic
inorganic lead
4,4'-methylene bis(2-chloroaniline) ["MBOCA"]
vinyl chloride (monomer)

5. Medical Consultations in Response to Symptoms and/or Chemical Releases

Employees who develop symptoms that appear to be related to exposures associated with their jobs shall be provided the opportunity to receive medical surveillance. The content of the medical surveillance will vary depending on the nature of the exposure, the substances involved and the operation. Because of the wide diversity in types of exposures, potential adverse health effects and complicating factors, it is not possible to provide a set of simple, clear cut guidelines on when medical surveillance is needed. Each potential situation needs to be addressed on a case-by-case basis, working with LBL's Industrial Hygiene Group and Health Services.

Employees who are exposed to chemicals as a result of spills, explosions, or other releases need to be considered for medical consultation. The decision to proceed depends on a number of factors and will be decided on a case-by-case basis. For example, if a spill occurs and the proper personal protective equipment is not worn in the clean-up (contrary to the rules of this CHSP), medical consultation is warranted. *Medical surveillance is normally not needed under the following circumstances:*

- The release involved substances of low hazard;
- The release only caused a few seconds of exposure before the employee vacated the area;

- Employees responding to the release used the correct personal protective equipment, were trained in the correct procedures for responding to the release, and did not experience any symptoms or adverse health effects following the response; or

- The release involved small quantities of materials which were isolated from the main work area of the laboratory or shop and only the employees with proper equipment and training were involved in responding to the incident.

Employees must inform their supervisor of adverse health effects and spills so that this information can be used, along with information on the substances being used and the operation itself, to decide if a medical surveillance is needed. Health Services notifies the Industrial Hygiene Group of potentially unsafe work conditions by sending them a copy of the Supervisor's Accident Analysis Report, which indicates their assessment that Industrial Hygiene needs to know of the accident/injury and probably needs to evaluate the work site.

6. Exposures to Carcinogens

The most prudent practice is to minimize *all* exposures to carcinogens. Although some carcinogens have established occupational exposure limits (i.e., PELs), the criteria utilized in establishing those limits may not have included carcinogen effects. And the decision to establish a new lower PEL following the discovery of carcinogenic effects is not based only on risk assessment results, but on technical feasibility to reduce exposures, cost data, etc. It takes years to change a chemical's PEL. Recent changes were made for benzene, ethylene oxide, and formaldehyde, but these are the exception.

The key to minimizing exposures to carcinogens is controlling the potential for exposures. The Carcinogen Program (Section G.2) outlines procedures to control exposures. The Industrial Hygiene Group will assess the adequacy of the control measures that each laboratory or shop utilizes by (1) conducting site inspections to observe operating procedures, and (2) reviewing written Specific Safety Procedures contained in the Facility Notebooks.

In addition, laboratories and shops are to participate in a carcinogen exposure assessment survey. A Carcinogen Exposure Assessment Survey form (Appendix 12) is to be completed by the Principal Investigator or Laboratory/Shop Supervisor to aid the Industrial Hygiene Group in assessing the potential for on-going and projected exposures to carcinogens. The Industrial Hygiene Group will prioritize inspections based on the survey results.

The Industrial Hygiene Group will evaluate the adequacy of control measures, and conduct air monitoring as appropriate, and refer to Health Services the names of all personnel identified as potential candidates for medical surveillance. Unfortunately, established exposure monitoring protocols and/or specific medical surveillance tests are not available for many of the carcinogens. However, employees are encouraged to participate in recommended medical surveillance programs to establish that their health status has not been affected negatively.

7. Exposures to Reproductive Toxins

Both men and women may be exposed to hazardous agents that pose a reproductive hazard such as infertility, hormonal changes, birth defects and genetic damage. These agents include ionizing radiation, alcohol, cigarette smoke, pharmaceuticals, and some of the thousands of different chemicals that are used in the home or workplace. Although many of these have been tested to determine whether they cause acute (immediate) effects on the body, few have been studied to see if they cause, birth defects (teratogens) or genetic defects (mutagens). Even fewer have been studied to see if they can cause infertility, reduced sperm count, menstrual disorders, or other disorders relating to reproduction.

The primary path for hazardous substances to reach an unborn child is through the placenta. Many chemicals and drugs that enter a pregnant woman's body (through breathing, swallowing, absorption through the skin, etc.) will eventually enter the mother's blood circulation, cross the placenta and thus affect the developing fetus.

In general, the important questions of exactly how much of the toxic substance that enters the mother's body will reach the fetus, or what concentration the fetus can tolerate without harmful effects are not yet answered.

The fetus is usually most vulnerable in the early weeks of pregnancy (first 13 weeks or trimester) but may be also at risk later in pregnancy. In light of the potential harm of workplace exposures to both the pregnant woman and her developing fetus, it is very important, and is required by LBL policy, for the woman to inform Health Services of her pregnancy (or plans to become pregnant) as soon as possible, so that any necessary steps to avoid potential exposure problems can be taken. This policy exists in no way to discriminate against women; rather, it is intended to provide the pregnant woman with information about the possible hazards and her options.

Refer to Appendix 13 for a listing of reproductive toxins.

K. RECORDKEEPING

Accurate documentation and recordkeeping of exposure monitoring, medical surveillance, and health and safety training is an important component of the LBL Chemical Hygiene and Safety Program. Further, because LBL relies on each *facility* to conduct hazard assessments of their operations/procedures, and to write Specific Safety Procedures (SSPs) as appropriate, the SSP documentation is paramount to the Program. The Facility Notebook is the recommended place to store those records required of the Principal Investigator or Laboratory/Shop Supervisor.

Specific Recordkeeping Requirements and Responsibilities:

- Current chemical inventories for each laboratory and shop area must be readily available for reference in the event of an emergency (pursuant to hazardous materials management requirements).

  Responsibility: Principal Investigator or Laboratory/Shop Supervisor

- Documentation of Laboratory/Shop Specific Safety Procedures (SSPs) must be maintained.

  Responsibility: Principal Investigator or Laboratory/Shop Supervisor

- Exposure records for hazardous chemicals and harmful physical agents (i.e., analytical reports and memos notifying employees, supervisors, and/or Health Services) will be maintained for at least 75 years (and possibly longer) in accordance with DOE orders.

  Responsibility: EH&S Industrial Hygiene Group (for all except radiation exposures)

- Names of workers working with chemicals of high acute toxicity, reproductive toxins and carcinogens must be maintained and submitted to the Industrial Hygiene Group. Records should indicate the dates the employees worked with the particularly hazardous chemicals. (Note: Do not destroy old records in the process of updating chemical use information to reflect current workers.)

Responsibility: Principal Investigator or Laboratory/Shop Supervisor and Industrial Hygiene Group

- Medical records for employees exposed to hazardous chemicals and harmful physical agents will be maintained for the duration of employment plus 75 years in accordance with DOE orders. (Note: "Exposed to" hazardous chemicals is not necessarily the same as "working with" hazardous chemicals.)

  Responsibility: Health Services

- Employee training records must be maintained and readily available. Records are to be kept for at least 75 years beyond the class or, for individuals, beyond the conclusion of their employment.

  - EH&S Sponsored Classes:

  Responsibility: EH&S Training Group

  - Individual Laboratory or Shop Sponsored Classes:

  Responsibility: Principal Investigator or Laboratory/Shop Supervisor

- Accident investigations must be written and retained in an organized manner.

  Responsibility: Principal Investigator or Laboratory/Shop Supervisor; Occupational Safety Department, if appropriate.

- Maintenance records (i.e., inspection checks, repair work, etc.)) of safety equipment and local exhaust ventilation equipment must be maintained for at least the duration of the time that the equipment is in use.

  - Eyewash and shower checks:

  Responsibility: Principal Investigator or Construction & Maintenance in conjunction with Laboratory/Shop Supervisor

- Fire extinguishers:

  Responsibility: The LBL Fire Department

- Local exhaust ventilation (e.g., lab hoods):

  Responsibility: The Industrial Hygiene Group

- Biosafety cabinets:

  Responsibility: The Principal Investigator or Laboratory/Shop Supervisor. (Note: The Industrial Hygiene Group may conduct some testing but cannot "certify" these hoods.)

L. REFERENCES AND INFORMATION RESOURCES

The following is a list of references and information resources that pertain to chemical hygiene and safety in the laboratory. These references can be ordered to supplement available information on chemical and physical hazards for laboratory employees. Known locations of these materials are provided for the convenience of individuals who need quick access to chemical hygiene information.

Reference/Resource	Location
American Conference of Governmental Industrial Hygienists, *Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes,* P.O. Box 1937, Cincinnati, OH 45201 (latest edition). • Annual pamphlet with latest occupational exposure TLVs.	Industrial Hygiene Dept., Bldg. 26
International Agency for Research on Cancer, *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man,* World Health Organization Publications Center, 49 Sheridan Ave., Albany, NY 12210 (latest editions). • Provides lists of carcinogens and criteria for their classification.	Industrial Hygiene Dept., Bldg. 26
Lawrence Berkeley Laboratory, *Health and Safety Manual,* Pub-3000. • The primary LBL health and safety manual.	Site-wide distribution
Lawrence Berkeley Laboratory, *Guidelines for Generators of Hazardous Chemical Waste and Guidelines for Generators of Radioactive and Mixed Waste at LBL,* Pub-3092. • Training course required at LBL for generators of hazardous waste. Provides guidelines and requirements for chemical and radioactive waste collection, storage, and EH&S pickup.	Site-wide distribution
Lawrence Berkeley Laboratory, *Guidelines for Waste Accumulation Areas (WAAs) at LBL,* Pub-3093.	Site-wide distribution

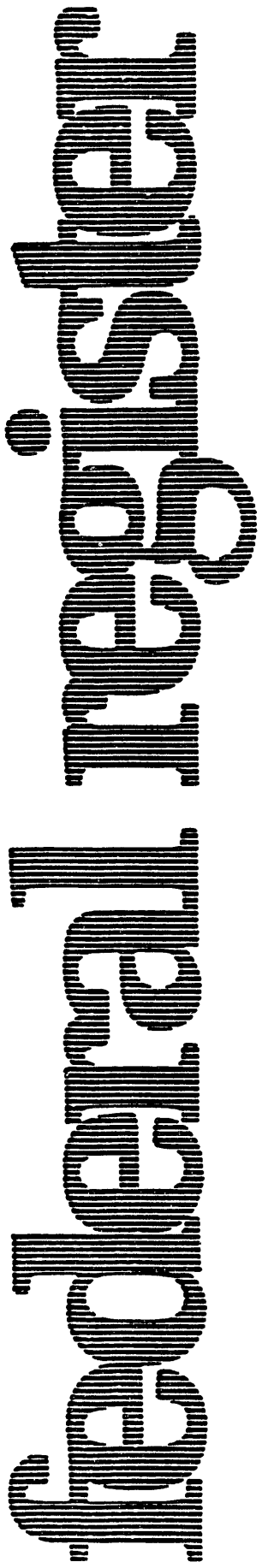
Reference/Resource	Location
• Provides guidelines and requirements for secondary waste collection areas (i.e., where waste is transfered after removal from satellite areas and prior to transfer to the Waste Handling Facility.	
Lawrence Berkeley Laboratory, *Medical and Biohazardous Waste Generator's Guide,* Pub-3095.	Site-wide distribution
• Training course required at LBL for generators of medical and biohazardous waste. Provides guidelines and requirements for collecting, packaging, and disposing of biological waste.	
29 CFR, Part 1910, Subpart Z, Government Printing Office, Washington, D.C. 20402 (latest edition).	Indusrial Hygiene Dept., Bldg. 26
• The Federal OSHA regulations.	
Mahn, W.J., *Fundamentals of Laboratory Safety, Physical Hazards in the Academic Laboratory,* Van Nostrand Reinhold, NY (1991).	Industrial Hygiene Dept., Bldg. 26
• General guide to the fundamentals of laboratory safety.	
Mahn, W.J., *Fundamentals of Laboratory Safety, Chemical Hazards Guidebook,* Van Nostrand Reinhold, NY (1991).	Indusrial Hygiene Dept., Bldg. 26
• General guide to the fundamentals of laboratory chemical safety.	
The Matheson Company, Inc. *Gas Data Book,* (latest edition).	Bldg. 26 Library; Bldg. 90
• Excellent information on the safe use and handling of compressed gases, including health effects.	
National Fire Protection Association, *Fire Protection Guide on Hazardous Materials,* (latest edition), National Fire Protection Association, Battermarch Park, Quincy, MA.	Bldg. 26 Library; Fire Dept., Bldg. 48
• Guide to proper fire prevention and decision-making in emergencies.	

Reference/Resource	Location
National Toxicology Program, *Annual Report on Carcinogens,* Public Health Service, U.S. Dept. of Health and Human Services, Government Printing Office, Washington, D.C. 20402 (latest edition). • Provides lists of carcinogens and criteria for their classification.	Industrial Hygiene Dept., Bldg. 26
National Research Council, *Prudent Practices for Handling Hazardous Chemicals in Laboratories,* National Academy Press,Washington, DC, 1983. • Recommends comprehensive procedures for the safe handling of hazardous chemicals in all types of laboratories. Addresses potential hazards from fire, explosion, and toxic substances.	Bldg. 26 Library; Donner Library; Bldg. 62 Library
NIOSH/OSHA, *Pocket Guide to Chemical Hazards,* U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No., 85-114, 1985. • Quick reference for 380 chemical hazards for which there are specific federal regulations. Contains data on exposure levels, properties, incompatibilities, personal protection, and health hazards.	Bldg. 26 Library
Ottoboni, M.A., *The Dose Makes the Poison, A Plain-Language Guide to Toxicology,* Vincente Books, Berkeley, CA (1984). • Serves as a primer on toxicology	Industrial Hygiene Dept., Bldg. 26
Public Health Service *Registry of Toxic Effects of Chemical Substances,* U.S. Dept. of Health and Human Services, Centers for Disease Control, National Institute for Occcupational Safety and Health, revised annually, for sale by Supt. of Documents, Government Printing Office, Washington, D.C. 20402. • Provides very detailed toxic effects information.	Industrial Hygiene Dept., Bldg. 26

Reference/Resource	Location
Proctor, Nick H. & James P. Hughes. *Chemical Hazards of the Workplace,* Philadelphia PA, J.B. Lippincott Co., 1978. • Excellent source of health hazard summary information.	Bldg. 26 Library; Donner
Steere, Norman V., *CRC Handbook of Laboratory Safety,* The Chemical Rubber Company, Cleveland, OH, 1971. • A reference on first aid, biohazards, chemical and radiation hazards.	Bldg. 62 Library; Bldg. 50; Bldg. 26 Library; Donner
Steere, Norman V. *Safety in the Chemical Laboratory* (Volumes 1-3) J. Chem Ed., American Chemical Society, Easlon, PA, 1981. • Provides general and detailed laboratory safety information.	Bldg. 26 Library; UCB
Young, Jay A., *Improving Safety in the Chemical Laboratory,* John Wiley & Sons, Inc., New York, 1987. • Includes information on how to recognize close calls and eliminate accidents, personal protective equipment, contingency training programs, equipment and emergency checklists, and how to make sure safety objectives are met.	Bldg. 62 Library

Appendix 1

OSHA Hazard Communication Standard
(29 CFR 1910.1200)



Monday
August 24, 1987

Part III

Department of Labor

Occupational Safety and Health Administration

29 CFR Parts 1910, 1915, 1917, 1918, 1926, and 1928

Hazard Communication; Final Rule

secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable.

Section 1918.90 also issued under 5 U.S.C. 553 and 29 CFR Part 1911.

PART 1926—SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

5. The authority citation for Subpart D of Part 1926 is revised to read as follows:

Authority: Sec. 107, Contract Work Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable.

Section 1926.59 also issued under 5 U.S.C. 553 and 29 CFR Part 1911.

PART 1928—OCCUPATIONAL SAFETY AND HEALTH STANDARDS FOR AGRICULTURE

6. The authority citation for Part 1928 is revised to read as follows:

Authority: Secs. 6 and 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 655, 657); Secretary of Labor's Orders 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable; 29 CFR Part 1911.

Section 1928.21 also issued under 5 U.S.C. 553.

PARTS 1910, 1915, 1917, 1918, 1926 and 1928—[AMENDED]

7. Parts 1910, 1915, 1917, 1918, and 1928 are amended by revising § 1910.1200 as set forth below, and by adding §§ 1915.99, 1917.28, 1918.90, and 1926.59 to contain the identical text of the revised § 1910.1200, including Apendices A, B, C, and D of 1910.1200:

§ ——— Hazard communication.

(a) *Purpose.* (1) The purpose of this section is to ensure that the hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employers and employees. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets and employee training.

(2) This occupational safety and health standard is intended to address comprehensively the issue of evaluating the potential hazards of chemicals, and communicating information concerning hazards and appropriate protective measures to employees, and to preempt any legal requirements of a state, or political subdivision of a state, pertaining to the subject. Evaluating the potential hazards of chemicals, and communicating information concerning hazards and appropriate protective measures to employees, may include, for example, but is not limited to, provisions for: developing and maintaining a written hazard communication program for the workplace, including lists of hazardous chemicals present; labeling of containers of chemicals in the workplace, as well as of containers of chemicals being shipped to other workplaces; preparation and distribution of material safety data sheets to employees and downstream employers; and development and implementation of employee training programs regarding hazards of chemicals and protective measures. Under section 18 of the Act, no state or political subdivision of a state may adopt or enforce, through any court or agency, any requirement relating to the issue addressed by this Federal standard, except pursuant to a Federally-approved state plan.

(b) *Scope and application.* (1) This section requires chemical manufacturers or importers to assess the hazards of chemicals which they produce or import, and all employers to provide information to their employees about the hazardous chemicals to which they are exposed, by means of a hazard communication program, labels and other forms of warning, material safety data sheets, and information and training. In addition, this section requires distributors to transmit the required information to employers.

(2) This section applies to any chemical which is known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency.

(3) This section applies to laboratories only as follows:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced;

(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees; and,

(iii) Employers shall ensure that laboratory employees are apprised of the hazards of the chemicals in their workplaces in accordance with paragraph (h) of this section.

(4) In work operations where employees only handle chemicals in sealed containers which are not opened under normal conditions of use (such as are found in marine cargo handling, warehousing, or retail sales), this section applies to these operations only as follows:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced;

(ii) Employers shall maintain copies of any material safety data sheets that are received with incoming shipments of the sealed containers of hazardous chemicals, shall obtain a material safety data sheet for sealed containers of hazardous chemicals received without a material safety data sheet if an employee requests the material safety data sheet, and shall ensure that the material safety data sheets are readily accessible during each work shift to employees when they are in their work area(s); and,

(iii) Employers shall ensure that employees are provided with information and training in accordance with paragraph (h) of this section (except for the location and availability of the written hazard communication program under paragraph (h)(1)(iii)), to the extent necessary to protect them in the event of a spill or leak of a hazardous chemical from a sealed container.

(5) This section does not require labeling of the following chemicals:

(i) Any pesticide as such term is defined in the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136 et seq.), when subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Environmental Protection Agency;

(ii) Any food, food additive, color additive, drug, cosmetic, or medical or veterinary device, including materials intended for use as ingredients in such products (e.g. flavors and fragrances), as such terms are defined in the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 301 *et seq.*) and regulations issued under that Act, when they are subject to the labeling requirements under that Act by the Food and Drug Administration;

(iii) Any distilled spirits (beverage alcohols), wine, or malt beverage intended for nonindustrial use, as such terms are defined in the Federal Alcohol Administration Act (27 U.S.C. 201 *et seq.*) and regulations issued under that Act, when subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Bureau of Alcohol Tobacco, and Firearms; and,

(iv) Any consumer product or hazardous substance as those terms are defined in the Consumer Product Safety Act (15 U.S.C. 2051 et seq.) and Federal Hazardous Substances Act (15 U.S.C. 1261 et seq.) respectively, when subject to a consumer product safety standard or labeling requirement of those Acts, or regulations issued under those Acts by

the Consumer Product Safety Commission.

(6) This section does not apply to:

(i) Any hazardous waste as such term is defined by the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6901 et seq.), when subject to regulations issued under that Act by the Environmental Protection Agency;

(ii) Tobacco or tobacco products;

(iii) Wood or wood products;

(iv) Articles;

(v) Food, drugs, cosmetics, or alcoholic beverages in a retail establishment which are packaged for sale to consumers;

(vi) Foods, drugs, or cosmetics intended for personal consumption by employees while in the workplace;

(vii) Any consumer product or hazardous substance, as those terms are defined in the Consumer Product Safety Act (15 U.S.C. 2051 *et seq.*) and Federal Hazardous Substances Act (15 U.S.C. 1261 *et seq.*) respectively, where the employer can demonstrate it is used in the workplace in the same manner as normal consumer use, and which use results in a duration and frequency of exposure which is not greater than exposures experienced by consumers; and,

(viii) Any drug, as that term is defined in the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 301 *et seq.*), when it is in solid, final form for direct administration to the patient (i.e. tablets or pills).

(c) *Definitions.*

"Article" means a manufactured item: (i) Which is formed to a specific shape or design during manufacture; (ii) which has end use function(s) dependent in whole or in part upon its shape or design during end use; and (iii) which does not release, or otherwise result in exposure to, a hazardous chemical, under normal conditions of use.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Chemical" means any element, chemical compound or mixture of elements and/or compounds.

"Chemical manufacturer" means an employer with a workplace where chemical(s) are produced for use or distribution.

"Chemical name" means the scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS) rules of nomenclature, or a name which will clearly identify the chemical for the purpose of conducting a hazard evaluation.

"Combustible liquid" means any liquid having a flashpoint at or above 100 °F (37.8 °C), but below 200 ° F (93.3 ° C), except any mixture having components with flashpoints of 200 °F (93.3 °C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"Common name" means any designation or identification such as code name, code number, trade name, brand name or generic name used to identify a chemical other than by its chemical name.

"Compressed gas" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 °F (21.1 °C); or

(ii) a gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 °F (54.4 °C) regardless of the pressure at 70 °F (21.1 °C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 °F (37.8 °C) as determined by ASTM D-323-72.

"Container" means any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purposes of this section, pipes or piping systems, and engines, fuel tanks, or other operating systems in a vehicle, are not considered to be containers.

"Designated representative" means any individual or organization to whom an employee gives written authorization to exercise such employee's rights under this section. A recognized or certified collective bargaining agent shall be treated automatically as a designated representative without regard to written employee authorization.

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or designee.

"Distributor" means a business, other than a chemical manufacturer or importer, which supplies hazardous chemicals to other distributors or to employers.

"Employee" means a worker who may be exposed to hazardous chemicals under normal operating conditions or in foreseeable emergencies. Workers such as office workers or bank tellers who encounter hazardous chemicals only in non-routine, isolated instances are not covered.

"Employer" means a person engaged in a business where chemicals are either used, distributed, or are produced for use or distribution, including a contractor or subcontractor.

"Explosive" means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

"Exposure" or "exposed" means that an employee is subjected to a hazardous chemical in the course of employment through any route of entry (inhalation, ingestion, skin contact or absorption, etc.), and includes potential (e.g., accidental or possible) exposure.

"Flammable" means a chemical that falls into one of the following categories:

(i) "Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) "Gas, flammable" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of thirteen (13) percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than twelve (12) percent by volume, regardless of the lower limit;

(iii) "Liquid, flammable" means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture;

(iv) "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in § 190.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

"Flashpoint" means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79)) for liquids with a viscosity of less than 45 Saybolt University Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a

tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7–1979 (ASTM D 93–79)) for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278–78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

"Foreseeable emergency" means any potential occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which could result in an uncontrolled release of a hazardous chemical into the workplace.

"Hazardous chemical" means any chemical which is a physical hazard or a health hazard.

"Hazard warning" means any words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning which convey the hazard(s) of the chemical(s) in the container(s).

"Health hazard" means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. Appendix A provides further definitions and explanations of the scope of health hazards covered by this section, and Appendix B describes the criteria to be used to determine whether or not a chemical is to be considered hazardous for purposes of this standard.

"Identity" means any chemical or common name which is indicated on the material safety data sheet (MSDS) for the chemical. The identity used shall permit cross-references to be made among the required list of hazardous chemicals, the label and the MSDS.

"Immediate use" means that the hazardous chemical will be under the control of and used only by the person who transfers it from a labeled container and only within the work shift in which it is transferred.

"Importer" means the first business with employees within the Customs Territory of the United States which receives hazardous chemicals produced in other countries for the purpose of supplying them to distributors or employers within the United States.

"Label" means any written, printed, or graphic material, displayed on or affixed to containers of hazardous chemicals.

"Material safety data sheet (MSDS)" means written or printed material concerning a hazardous chemical which is prepared in accordance with paragraph (g) of this section.

"Mixture" means any combination of two or more chemicals if the combination is not, in whole or in part, the result of a chemical reaction.

"Organic peroxide" means an organic compound that contains the bivalent -O-O-structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

"Oxidizer" means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

"Physical hazard" means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

"Produce" means to manufacture, process, formulate, or repackage.

"Pyrophoric" means a chemical that will ignite spontaneously in air at a temperature of 130 °F (54.4 °C) or below.

"Responsible party" means someone who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

"Specific chemical identity" means the chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.

"Trade secret" means any confidential formula, pattern, process, device, information or compilation of information that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it. Appendix D sets out the criteria to be used in evaluating trade secrets.

"Unstable (reactive)" means a chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

"Use" means to package, handle, react, or transfer.

"Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

"Work area" means a room or defined space in a workplace where hazardous chemicals are produced or used, and where employees are present.

"Workplace" means an establishment, job site, or project, at one geographical location containing one or more work areas.

(d) *Hazard determination.* (1) Chemical manufacturers and importers shall evaluate chemicals produced in their workplaces or imported by them to determine if they are hazardous. Employers are not required to evaluate chemicals unless they choose not to rely on the evaluation performed by the chemical manufacturer or importer for the chemical to satisfy this requirement.

(2) Chemical manufacturers, importers or employers evaluating chemicals shall identify and consider the available scientific evidence concerning such hazards. For health hazards, evidence which is statistically significant and which is based on at least one positive study conducted in accordance with established scientific principles is considered to be sufficient to establish a hazardous effect if the results of the study meet the definitions of health hazards in this section. Appendix A shall be consulted for the scope of health hazards covered, and Appendix B shall be consulted for the criteria to be followed with respect to the completeness of the evaluation, and the data to be reported.

(3) The chemical manufacturer, importer or employer evaluating chemicals shall treat the following sources as establishing that the chemicals listed in them are hazardous:

(i) 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA); or,

(ii) *Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment,* American Conference of Governmental Industrial Hygienists (ACGIH) (latest edition).

The chemical manufacturer, importer, or employer is still responsible for evaluating the hazards associated with the chemicals in these source lists in accordance with the requirements of this standard.

(4) Chemical manufacturers, importers and employers evaluating chemicals shall treat the following sources as establishing that a chemical is a carcinogen or potential carcinogen for hazard communication purposes:

(i) National Toxicology Program (NTP), *Annual Report on Carcinogens* (latest edition);

(ii) International Agency for Research on Cancer (IARC) *Monographs* (latest editions); or

(iii) 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration.

Note.—The *Registry of Toxic Effects of Chemical Substances* published by the National Institute for Occupational Safety and Health indicates whether a chemical has been found by NTP or IARC to be a potential carcinogen.

(5) The chemical manufacturer, importer or employer shall determine the hazards of mixtures of chemicals as follows:

(i) If a mixture has been tested as a whole to determine its hazards, the results of such testing shall be used to determine whether the mixture is hazardous;

(ii) If a mixture has not been tested as a whole to determine whether the mixture is a health hazard, the mixture shall be assumed to present the same health hazards as do the components which comprise one percent (by weight or volume) or greater of the mixture, except that the mixture shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of 0.1 percent or greater which is considered to be a carcinogen under paragraph (d)(4) of this section;

(iii) If a mixture has not been tested as a whole to determine whether the mixture is a physical hazard, the chemical manufacturer, importer, or employer may use whatever scientifically valid data is available to evaluate the physical hazard potential of the mixture; and,

(iv) If the chemical manufacturer, importer, or employer has evidence to indicate that a component present in the mixture in concentrations of less than one percent (or in the case of carcinogens, less than 0.1 percent) could be released in concentrations which would exceed an established OSHA permissible exposure limit or ACGIH Threshold Limit Value, or could present a health hazard to employees in those concentrations, the mixture shall be assumed to present the same hazard.

(6) Chemical manufacturers, importers, or employers evaluating chemicals shall describe in writing the procedures they use to determine the hazards of the chemical they evaluate. The written procedures are to be made available, upon request, to employees, their designated representatives, the Assistant Secretary and the Director. The written description may be incorporated into the written hazard communication program required under paragraph (e) of this section.

(e) *Written hazard communication program.* (1) Employers shall develop, implement, and maintain at the workplace, a written hazard communication program for their workplaces which at least describes how the criteria specified in paragraphs (f), (g), and (h) of this section for labels and other forms of warning, material safety data sheets, and employee information and training will be met, and which also includes the following:

(i) A list of the hazardous chemicals known to be present using an identity that is referenced on the appropriate material safety data sheet (the list may be compiled for the workplace as a whole or for individual work areas); and,

(ii) The methods the employer will use to inform employees of the hazards of non-routine tasks (for example, the cleaning of reactor vessels), and the hazards associated with chemicals contained in unlabeled pipes in their work areas.

(2) *Multi-employer workplaces.* Employers who produce, use, or store hazardous chemicals at a workplace in such a way that the employees of other employer(s) may be exposed (for example, employees of a construction contractor working on-site) shall additionally ensure that the hazard communication programs developed and implemented under this paragraph (e) include the following:

(i) The methods the employer will use to provide the other employer(s) with a copy of the material safety data sheet, or to make it available at a central location in the workplace, for each hazardous chemical the other employer(s)' employees may be exposed to while working;

(ii) The methods the employer will use to inform the other employer(s) of any precautionary measures that need to be taken to protect employees during the workplace's normal operating conditions and in foreseeable emergencies; and,

(iii) The methods the employer will use to inform the other employer(s) of the labeling system used in the workplace.

(3) The employer may rely on an existing hazard communication program to comply with these requirements, provided that it meets the criteria established in this paragraph (e).

(4) The employer shall make the written hazard communication program available, upon request, to employees, their designated representatives, the Assistant Secretary and the Director, in accordance with the requirements of 29 CFR 1910.20(e).

(f) *Labels and other forms of warning.* (1) The chemical manufacturer, importer, or distributor shall ensure that each container of hazardous chemicals leaving the workplace is labeled, tagged or marked with the following information:

(i) Identity of the hazardous chemical(s);

(ii) Appropriate hazard warnings; and

(iii) Name and address of the chemical manufacturer, importer, or other responsible party.

(2) For solid metal (such as a steel beam or a metal casting) that is not exempted as an article due to its downstream use, the required label may be transmitted to the customer at the time of the intial shipment, and need not be included with subsequent shipments to the same employer unless the information on the label changes. The label may be transmitted with the initial shipment itself, or with the material safety data sheet that is to be provided prior to or at the time of the first shipment. This exception to requiring labels on every container of hazardous chemicals is only for the solid metal itself and does not apply to hazardous chemicals used in conjunction with, or known to be present with, the metal and to which employees handling the metal may be exposed (for example, cutting fluids or lubricants).

(3) Chemical manufacturers, importers, or distributors shall ensure that each container of hazardous chemicals leaving the workplace is labeled, tagged, or marked in accordance with this section in a manner which does not conflict with the requirements of the Hazardous Materials Transportation Act (49 U.S.C. 1801 *et seq.*) and regulations issued under that Act by the Department of Transportation.

(4) If the hazardous chemical is regulated by OSHA in a substance-specific health standard, the chemical manufacturer, importer, distributor or employer shall ensure that the labels or

other forms of warning used are in accordance with the requirements of that standard.

(5) Except as provided in paragraphs (f)(6) and (f)(7) the employer shall ensure that each container of hazardous chemicals in the workplace is labeled, tagged or marked with the following information:

(i) Identity of the hazardous chemical(s) contained therein; and

(ii) Appropriate hazard warnings.

(6) The employer may use signs, placards, process sheets, batch tickets, operating procedures, or other such written materials in lieu of affixing labels to individual stationary process containers, as long as the alternative method identifies the containers to which it is applicable and conveys the information required by paragraph (f)(5) of this section to be on a label. The written materials shall be readily accessible to the employees in their work area throughout each work shift.

(7) The employer is not required to label portable containers into which hazardous chemicals are transferred from labeled containers, and which are intended only for the immediate use of the employee who performs the transfer.

(8) The employer shall not remove or deface existing labels on incoming containers of hazardous chemicals, unless the container is immediately marked with the required information.

(9) The employer shall ensure that labels or other forms of warning are legible, in English, and prominently displayed on the container, or readily available in the work area throughout each work shift. Employers having employees who speak other languages may add the information in their language to the material presented, as long as the information is presented in English as well.

(10) The chemical manufacturer, importer, distributor or employer need not affix new labels to comply with this section if existing labels already convey the required information.

(g) *Material safety data sheets.* (1) Chemical manufacturers and importers shall obtain or develop a material safety data sheet for each hazardous chemical they produce or import. Employers shall have a material safety data sheet for each hazardous chemical which they use.

(2) Each material safety data sheet shall be in English and shall contain at least the following information:

(i) The identity used on the label, and, except as provided for in paragraph (i) of this section on trade secrets:

(A) If the hazardous chemical is a single substance, its chemical and common name(s);

(B) If the hazardous chemical is a mixture which has been tested as a whole to determine its hazards, the chemical and common name(s) of the ingredients which contribute to these known hazards, and the common name(s) of the mixture itself; or,

(C) If the hazardous chemical is a mixture which has not been tested as a whole:

(*1*) The chemical and common name(s) of all ingredients which have been determined to be health hazards, and which comprise 1% or greater of the composition, except that chemicals identified as carcinogens under paragraph (d)(4) of this section shall be listed if the concentrations are 0.1% or greater; and,

(*2*) The chemical and common name(s) of all ingredients which have been determined to be health hazards, and which comprise less than 1% (0.1% for carcinogens) of the mixture, if there is evidence that the ingredient(s) could be released from the mixture in concentrations which would exceed an established OSHA permissible exposure limit or ACGIH Threshold Limit Value, or could present a health hazard to employees; and,

(*3*) The chemical and common name(s) of all ingredients which have been determined to present a physical hazard when present in the mixture;

(ii) Physical and chemical characteristics of the hazardous chemical (such as vapor pressure, flash point);

(iii) The physical hazards of the hazardous chemical, including the potential for fire, explosion, and reactivity;

(iv) The health hazards of the hazardous chemical, including signs and symptoms of exposure, and any medical conditions which are generally recognized as being aggravated by exposure to the chemical;

(v) The primary route(s) of entry;

(vi) The OSHA permissible exposure limit, ACGIH Threshold Limit Value, and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the material safety data sheet, where available;

(vii) Whether the hazardous chemical is listed in the National Toxicology Program (NTP) *Annual Report on Carcinogens* (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) *Monographs* (latest editions), or by OSHA;

(viii) Any generally applicable precautions for safe handling and use which are known to the chemical manufacturer, importer or employer preparing the material safety data sheet, including appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for clean-up of spills and leaks;

(ix) Any generally applicable control measures which are known to the chemical manufacturer, importer or employer preparing the material safety data sheet, such as appropriate engineering controls, work practices, or personal protective equipment;

(x) Emergency and first aid procedures;

(xi) The date of preparation of the material safety data sheet or the last change to it; and,

(xii) The name, address and telephone number of the chemical manufacturer, importer, employer or other responsible party preparing or distributing the material safety data sheet, who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

(3) If not relevant information is found for any given category on the material safety data sheet, the chemical manufacturer, importer or employer preparing the material safety data sheet shall mark it to indicate that no applicable information was found.

(4) Where complex mixtures have similar hazards and contents (i.e. the chemical ingredients are essentially the same, but the specific composition varies from mixture to mixture), the chemical manufacturer, importer or employer may prepare one material safety data sheet to apply to all of these similar mixtures.

(5) The chemical manufacturer, importer or employer preparing the material safety data sheet shall ensure that the information recorded accurately reflects the scientific evidence used in making the hazard determination. If the chemical manufacturer, importer or employer preparing the material safety data sheet becomes newly aware of any significant information regarding the hazards of a chemical, or ways to protect against the hazards, this new information shall be added to the material safety data sheet within three months. If the chemical is not currently being produced or imported the chemical manufacturer or importer shall add the information to the material safety data sheet before the chemical is introduced into the workplace again.

(6) Chemical manufacturers or importers shall ensure that distributors and employers are provided an appropriate material safety data sheet with their intitial shipment, and with the first shipment after a material safety

data sheet is updated. The chemical manufacturer or importer shall either provide material safety data sheets with the shipped containers or send them to the employer prior to or at the time of the shipment. If the material safety data sheet is not provided with a shipment that has been labeled as a hazardous chemical, the employer shall obtain one from the chemical manufacturer, importer, or distributor as soon as possible.

(7) Distributors shall ensure that material safety data sheets, and updated information, are provided to other distributors and employers. Retail distributors which sell hazardous chemicals to commercial customers shall provide a material safety data sheet to such employers upon request, and shall post a sign or otherwise inform them that a material safety data sheet is available. Chemical manufacturers, importers, and distributors need not provide material safety data sheets to retail distributors which have informed them that the retail distributor does not sell the product to commercial customers or open the sealed container to use it in their own workplaces.

(8) The employer shall maintain copies of the required material safety data sheets for each hazardous chemical in the workplace, and shall ensure that they are readily accessible during each work shift to employees when they are in their work area(s).

(9) Where employees must travel between workplaces during a workshift, *i.e.*, their work is carried out at more than one geographical location, the material safety data sheets may be kept at a central location at the primary workplace facility. In this situation, the employer shall ensure that employees can immediately obtain the required information in an emergency.

(10) Material safety data sheets may be kept in any form, including operating procedures, and may be designed to cover groups of hazardous chemicals in a work area where it may be more appropriate to address the hazards of a process rather than individual hazardous chemicals. However, the employer shall ensure that in all cases the required information is provided for each hazardous chemical, and is readily accessible during each work shift to employees when they are in in their work areas(s).

(11) Material safety data sheets shall also be made readily available, upon request, to designated representatives and to the Assistant Secretary, in accordance with the requirements of 29 CFR 1910.20 (e). The Director shall also be given access to material safety data sheets in the same manner.

(h) *Employee information and training.* Employers shall provide employees with information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new hazard is introduced into their work area.

(1) *Information.* Employees shall be informed of:

(i) The requirements of this section;

(ii) Any operations in their work area where hazardous chemicals are present; and,

(iii) The location and availability of the written hazard communication program, including the required list(s) of hazardous chemicals, and material safety data sheets required by this section.

(2) *Training.* Employee training shall include at least:

(i) Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

(ii) The physical and health hazards of the chemicals in the work area;

(iii) The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used; and,

(iv) The details of the hazard communication program developed by the employer, including an explanation of the labeling system and the material safety data sheet, and how employees can obtain and use the appropriate hazard information.

(i) *Trade secrets.* (1) The chemical manufacturer, importer, or employer may withhold the specific chemical identity, including the chemical name and other specific identification of a hazardous chemical, from the material safety data sheet, provided that:

(i) The claim that the information withheld is a trade secret can be supported;

(ii) Information contained in the material safety data sheet concerning the properties and effects of the hazardous chemical is disclosed;

(iii) The material safety data sheet indicates that the specific chemical identity is being withheld as a trade secret; and,

(iv) The specific chemical identity is made available to health professionals, employees, and designated representatives in accordance with the applicable provisions of this paragraph.

(2) Where a treating physician or nurse determines that a medical emergency exists and the specific chemical identity of a hazardous chemical is necessary for emergency or first-aid treatment, the chemical manufacturer, importer, or employer shall immediately disclose the specific chemical identity of a trade secret chemical to that treating physician or nurse, regardless of the existence of a written statement of need of a confidentiality agreement. The chemical manufacturer, importer, or employer may require a written statement of need and confidentiality agreement, in accordance with the provisions of paragraphs (i)(3) and (4) of this section, as soon as circumstances permit.

(3) In non-emergency situations, a chemical manufacturer, importer, or employer shall, upon request, disclose a specific chemical identity, otherwise permitted to be withheld under paragraph (i)(1) of this section, to a health professional (i.e. physician, industrial hygienist, toxicologist, epidemiologist, or occupational health nurse) providing medical or other occupational health services to exposed employee(s), and to employees or designated representatives, if:

(i) The request is in writing;

(ii) The request describes with reasonable detail one or more of the following occupational health needs for the information:

(A) To assess the hazards of the chemicals to which employees will be exposed;

(B) To conduct or assess sampling of the workplace atmosphere to determine employee exposure levels;

(C) To conduct pre-assignment or periodic medical surveillance of exposed employees;

(D) To provide medical treatment to exposed employees;

(E) To select or assess appropriate personal protective equipment for exposed employees;

(F) To design or assess engineering controls or other protective measures for exposed employees; and,

(G) To conduct studies to determine the health effects of exposure.

(iii) The request explains in detail why the disclosure of the specific chemical identity is essential and that, in lieu thereof, the disclosure of the following information to the health professional, employee, or designated representative, would not satisfy the purposes described in paragraph (i)(3)(ii) of this section:

(A) The properties and effects of the chemical;

(B) Measures for controlling workers' exposure to the chemical;

(C) Methods of monitoring and analyzing worker exposure to the chemical; and,

(D) Methods of diagnosing and treating harmful exposures to the chemical;

(iv) The request includes a description of the procedures to be used to maintain the confidentiality of the disclosed information; and,

(v) The health professional, and the employer or contractor of the services of the health professional (i.e. downstream employer, labor organization, or individual employee), employee, or designated representative, agree in a written confidentiality agreement that the health professional, employee, or designated representative, will not use the trade secret information for any purpose other than the health need(s) asserted and agree not to release the information under any circumstances other than to OSHA, as provided in paragraph (i)(6) of this section, except as authorized by the terms of the agreement or by the chemical manufacturer, importer, or employer.

(4) The confidentiality agreement authorized by paragraph (i)(3)(iv) of this section:

(i) May restrict the use of the information to the health purposes indicated in the written statement of need;

(ii) May provide for appropriate legal remedies in the event of a breach of the agreement, including stipulation of a reasonable pre-estimate of likely damages; and,

(iii) May not include requirements for the posting of a penalty bond.

(5) Nothing in this standard is meant to preclude the parties from pursuing non-contractual remedies to the extent permitted by law.

(6) If the health professional, employee, or designated representative receiving the trade secret information decides that there is a need to disclose it to OSHA, the chemical manufacturer, importer, or employer who provided the information shall be informed by the health professional, employee, or designated representative prior to, or at the same time as, such disclosure.

(7) If the chemical manufacturer, importer, or employer denies a written request for disclosure of a specific chemical identity, the denial must:

(i) Be provided to the health professional, employee, or designated representative, within thirty days of the request;

(ii) Be in writing;

(iii) Include evidence to support the claim that the specific chemical identity is a trade secret;

(iv) State the specific reasons why the request is being denied; and,

(v) Explain in detail how alternative information may satisfy the specific medical or occupational health need without revealing the specific chemical identity.

(8) The health professional, employee, or designated representative whose request for information is denied under paragraph (i)(3) of this section may refer the request and the written denial of the request to OSHA for consideration.

(9) When a health professional, employee, or designated representative refers the denial to OSHA under paragraph (i)(8) of this section, OSHA shall consider the evidence to determine if:

(i) The chemical manufacturer, importer, or employer has supported the claim that the specific chemical identity is a trade secret;

(ii) The health professional, employee, or designated representative has supported the claim that there is a medical or occupational health need for the information; and,

(iii) The health professional, employee, or designated representative has demonstrated adequate means to protect the confidentiality.

(10)(i) If OSHA determines that the specific chemical identity requested under paragraph (i)(3) of this section is not a *bona fide* trade secret, or that it is a trade secret, but the requesting health professional, employee, or designated representative has a legitimate medical or occupational health need for the information, has executed a written confidentiality agreement, and has shown adequate means to protect the confidentiality of the information, the chemical manufacturer, importer, or employer will be subject to citation by OSHA.

(ii) If a chemical manufacturer, importer, or employer demonstrates to OSHA that the execution of a confidentiality agreement would not provide sufficient protection against the potential harm from the unauthorized disclosure of a trade secret specific chemical identity, the Assistant Secretary may issue such orders or impose such additional limitations or conditions upon the disclosure of the requested chemical information as may be appropriate to assure that the occupational health services are provided without an undue risk of harm to the chemical manufacturer, importer, or employer.

(11) If a citation for a failure to release specific chemical identity information is contested by the chemical manufacturer, importer, or employer, the matter will be adjudicated before the Occupational Safety and Health Review Commission in accordance with the Act's enforcement scheme and the applicable Commission rules of procedure. In accordance with the Commission rules, when a chemical manufacturer, importer, or employer continues to withhold the information during the contest, the Administrative Law Judge may review the citation and supporting documentation *in camera* or issue appropriate orders to protect the confidentiality or such matters.

(12) Notwithstanding the existence of a trade secret claim, a chemical manufacturer, importer, or employer shall, upon request, disclose to the Assistant Secretary any information which this section requires the chemical manufacturer, importer, or employer to make available. Where there is a trade secret claim, such claim shall be made no later than at the time the information is provided to the Assistant Secretary so that suitable determinations of trade secret status can be made and the necessary protections can be implemented.

(13) Nothing in this paragraph shall be construed as requiring the disclosure under any circumstances of process or percentage of mixture information which is a trade secret.

(j) *Effective dates.* (1) Chemical manufacturers, importers, and distributors shall ensure that material safety data sheets are provided with the next shipment of hazardous chemicals to employers after September 23, 1987.

(2) Employers in the non-manufacturing sector shall be in compliance with all provisions of this section by May 23, 1988. (Note: Employers in the manufacturing sector (SIC Codes 20 through 39) are already required to be in compliance with this section.)

Appendix A to § ——— Health Hazard Definitions (*Mandatory*)

Although safety hazards related to the physical characteristics of a chemical can be objectively defined in terms of testing requirements (e.g. flammability), health hazard definitions are less precise and more subjective. Health hazards may cause measurable changes in the body—such as decreased pulmonary function. These changes are generally indicated by the occurrence of signs and symptoms in the exposed employees—such as shortness of breath, a non-measurable, subjective feeling. Employees exposed to such hazards must be apprised of both the change in body function and the signs and symptoms that may occur to signal that change.

The determination of occupational health hazards is complicated by the fact that many of the effects or signs and symptoms occur commonly in non-occupationally exposed populations, so that effects of exposure are difficult to separate from normally occurring illnesses. Occasionally, a substance causes an effect that is rarely seen in the population at large, such as angiosarcomas caused by vinyl chloride exposure, thus making it easier to ascertain that the occupational exposure was the primary causative factor. More often, however, the effects are common, such as lung cancer. The situation is further complicated by the fact that most chemicals have not been adequately tested to determine their health hazard potential, and data do not exist to substantiate these effects.

There have been many attempts to categorize effects and to define them in various ways. Generally, the terms "acute" and "chronic" are used to delineate between effects on the basis of severity or duration. "Acute" effects usually occur rapidly as a result of short-term exposures, and are of short duration. "Chronic" effects generally occur as a result of long-term exposure, and are of long duration.

The acute effects referred to most frequently are those defined by the American National Standards Institute (ANSI) standard for Precautionary Labeling of Hazardous Industrial Chemicals (Z129.1–1982)—irritation, corrosivity, sensitization and lethal dose. Although these are important health effects, they do not adequately cover the considerable range of acute effects which may occur as a result of occupational exposure, such as, for example, narcosis.

Similarly, the term chronic effect is often used to cover only carcinogenicity, teratogenicity, and mutagenicity. These effects are obviously a concern in the workplace, but again, do not adequately cover the area of chronic effects, excluding, for example, blood dyscrasias (such as anemia), chronic bronchitis and liver atrophy.

The goal of defining precisely, in measurable terms, every possible health effect that may occur in the workplace as a result of chemical exposures cannot realistically be accomplished. This does not negate the need for employees to be informed of such effects and protected from them. Appendix B, which is also mandatory, outlines the principles and procedures of hazardous assessment.

For purposes of this section, any chemicals which meet any of the following definitions, as determined by the criteria set forth in Appendix B are health hazards:

1. *Carcinogen:* A chemical is considered to be a carcinogen if:

(a) It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen; or

(b) It is listed as a carcinogen or potential carcinogen in the *Annual Report on Carcinogens* published by the National Toxicology Program (NTP) (latest edition); or,

(c) It is regulated by OSHA as a carcinogen.

2. *Corrosive:* A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. For example, a chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the U.S. Department of Transportation in Appendix A to 49 CFR Part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

3. *Highly toxic:* A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

4. *Irritant:* A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41 for four hours exposure or by other appropriate techniques, it results in an empirical score of five or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.

5. *Sensitizer:* A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

6. *Toxic.* A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

7. *Target organ effects.* The following is a target organ categorization of effects which may occur, including examples of signs and symptoms and chemicals which have been found to cause such effects. These examples are presented to illustrate the range and diversity of effects and hazards found in the workplace, and the broad scope employers must consider in this area, but are not intended to be all-inclusive.

a. Hepatotoxins: Chemicals which produce liver damage
   Signs & Symptoms: Jaundice; liver enlargement
   Chemicals: Carbon tetrachloride; nitrosamines
b. Nephrotoxins: Chemicals which produce kidney damage
   Signs & Symptoms: Edema; proteinuria
   Chemicals: Halogenated hydrocarbons; uranium
c. Neurotoxins: Chemicals which produce their primary toxic effects on the nervous system
   Signs & Symptoms: Narcosis; behavioral changes; decrease in motor functions
   Chemicals: Mercury; carbon disulfide
d. Agents which act on the blood or hematopoietic system: Decrease hemoglobin function; deprive the body tissues of oxygen
   Signs & Symptoms: Cyanosis; loss of consciousness
   Chemicals: Carbon monoxide; cyanides
e. Agents which damage the lung: Chemicals which irritate or damage the pulmonary tissue
   Signs & Symptoms: Cough; tightness in chest; shortness of breath
   Chemicals: Silica; asbestos
f. Reproductive toxins: Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis)
   Signs & Symptoms: Birth defects; sterility
   Chemicals: Lead; DBCP
g. Cutaneous hazards: Chemicals which affect the dermal layer of the body
   Signs & Symptoms: Defatting of the skin; rashes; irritation
   Chemicals: Ketones; chlorinated compounds
h. Eye hazards: Chemicals which affect the eye or visual capacity
   Signs & Symptoms: Conjunctivitis; corneal damage
   Chemicals: Organic solvents; acids

Appendix B to § ——, Hazard Determination (Mandatory)

The quality of a hazard communication program is largely dependent upon the adequacy and accuracy of the hazard determination. The hazard determination requirement of this standard is performance-oriented. Chemical manufacturers, importers, and employers evaluating chemicals are not required to follow any specific methods for

determining hazards, but they must be able to demonstrate that they have adequately ascertained the hazards of the chemicals produced or imported in accordance with the criteria set forth in this Appendix.

Hazard evaluation is a process which relies heavily on the professional judgment of the evaluator, particularly in the area of chronic hazards. The performance-orientation of the hazard determination does not diminish the duty of the chemical manufacturer, importer or employer to conduct a thorough evaluation, examining all relevant data and producing a scientifically defensible evaluation. For purposes of this standard, the following criteria shall be used in making hazard determinations that meet the requirements of this standard.

1. *Carcinogenicity*: As described in paragraph (d)(4) and Appendix A of this section, a determination by the National Toxicology Program, the International Agency for Research on Cancer, or OSHA that a chemical is a carcinogen or potential carcinogen will be considered conclusive evidence for purposes of this section.

2. *Human data*: Where available, epidemiological studies and case reports of adverse health effects shall be considered in the evaluation.

3. *Animal data*: Human evidence of health effects in exposed populations is generally not available for the majority of chemicals produced or used in the workplace. Therefore, the available results of toxicological testing in animal populations shall be used to predict the health effects that may be experienced by exposed workers. In particular, the definitions of certain acute hazards refer to specific animal testing results (see Appendix A).

4. *Adequacy and reporting of data*. The results of any studies which are designed and conducted according to established scientific principles, and which report statistically significant conclusions regarding the health effects of a chemical, shall be a sufficient basis for a hazard determination and reported on any material safety data sheet. The chemical manufacturer, importer, or employer may also report the results of other scientifically valid studies which tend to refute the findings of hazard.

Appendix C to § — Information Sources (Advisory)

The following is a list of available data sources which the chemical manufacturer, importer, distributor, or employer may wish to consult to evaluate the hazards of chemicals they produce or import:

—Any information in their own company files, such as toxicity testing results or illness experience of company employees.

—Any information obtained from the supplier of the chemical, such as material safety data sheets or product safety bulletins.

—Any pertinent information obtained from the following source list (latest editions should be used):

Condensed Chemical Dictionary
Van Nostrand Reinhold Co., 135 West 50th Street, New York, NY 10020.

The Merck Index: An Encyclopedia of Chemicals and Drugs
Merck and Company, Inc., 126 E. Lincoln Ave., Rahway, NJ 07065.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man
Geneva: World Health Organization. International Agency for Research on Cancer, 1972–Present. (Multivolume work). Summaries are available in supplement volumes. 49 Sheridan Street, Albany, NY 12210.

Industrial Hygiene and Toxicology, by F.A. Patty
John Wiley & Sons, Inc., New York, NY (Multivolume work).

Clinical Toxicology of Commercial Products
Gleason, Gosselin, and Hodge

Casarett and Doull's Toxicology: The Basic Science of Poisons
Doull, Klaassen, and Amdur, Macmillan Publishing Co., Inc., New York, NY.

Industrial Toxicology, by Alice Hamilton and Harriet L. Hardy
Publishing Sciences Group, Inc., Acton, MA.

Toxicology of the Eye, by W. Morton Grant
Charles C. Thomas, 301–327 East Lawrence Avenue, Springfield, IL.

Recognition of Health Hazards in Industry
William A. Burgess, John Wiley and Sons, 605 Third Avenue, New York, NY 10158.

Chemical Hazards of the Workplace
Nick H. Proctor and James P. Hughes, J.P. Lipincott Company, 6 Winchester Terrace, New York, NY 10022.

Handbook of Chemistry and Physics
Chemical Rubber Company, 18901 Cranwood Parkway, Cleveland, OH 44128.

Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment and Biological Exposure Indices with Intended Changes
American Conference of Governmental Industrial Hygienists (ACGIH), 6500 Glenway Avenue, Bldg. D–5, Cincinnati, OH 45211.

Information on the physical hazards of chemicals may be found in publications of the National Fire Protection Association, Boston, MA.

Note.—The following documents may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Occupational Health Guidelines
NIOSH/OSHA (NIOSH Pub. No. 81–123)

NIOSH Pocket Guide to Chemical Hazards
NIOSH Pub. No. 85–114

Registry of Toxic Effects of Chemical Substances RTECS
NIOSH Pub. No. 80–102

Miscellaneous Documents published by the National Institute for Occupational Safety and Health:
Criteria documents.
Special Hazard Reviews.
Occupational Hazard Assessments.
Current Intelligence Bulletins.

OSHA's General Industry Standards (29 CFR Part 1910)

NTP Annual Report on Carcinogens and *Summary of the Annual Report on Carcinogens*.
National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161; (703) 487–4650.

BIBLIOGRAPHIC DATA BASES

Service provider	File name
Bibliographic Retrieval Services (BRS), 1200 Route 7, Latham, NY 12110.	Biosis Previews CA Search Medlars NTIS Hazardline American Chemical Society Journal Excerpta Medica IRCS Medical Science Journal Pre-Med Intl Pharmaceutical Abstracts Paper Chem
Lockheed—DIALOG Information Service, Inc., 3460 Hillview Avenue, Palo Alto, CA 94304.	Biosis Prev. Files CA Search Files CAB Abstracts Chemical Exposure Chemname Chemsis Files Chemzero Embase Files Environmental Bibliographies Enviroline Federal Research in Progress IRL Life Science Collection NTIS Occupational Safety and Health (NIOSH) Paper Chem CAS Files Chemdex, 2, 3 NTIS
SDC—Orbit, SDC Information Service, 2500 Colorado Avenue, Santa Monica, CA 90406.	Hazardous Substances Data Bank (NSDB)
National Library of Medicine, Department of Health and Human Services, Public Health Service, National Institutes of Health, Bethesda, MD 20209.	Medline files Toxline Files Cancerlit
Pergamon International Information Corp., 1340 Old Chain Bridge Rd., McLean, VA 22101.	RTECS Chemline Laboratory Hazard Bulletin
Questel, Inc., 1625 Eye Street, NW., Suite 818, Washington, DC 20006.	CIS/ILO Cancernet
Chemical Information System ICI (CIS), Bureau of National Affairs, 1133 15th Street, NW., Suite 300, Washington, DC 20005.	Structure and Nomenclature Search System (SANSS) Acute Toxicity (RTECS) Clinical Toxicology of Commercial Products Oil and Hazardous Materials Technical Assistance Data System CCRIS CESARS MSDS
Occupational Health Services, 400 Plaza Drive, Secaucus, NJ 07094.	Hazardline

Appendix D to § — Definition of "Trade Secret" (Mandatory)

The following is a reprint of the *Restatement of Torts* section 757, comment *b* (1939):

b. Definition of trade secret. A trade secret may consist of any formula, pattern, device or compilation of information which is used in one's business, and which gives him an opportunity to obtain an advantage over competitors who do not know or use it. It may be a formula for a chemical compound, a process of manufacturing, treating or preserving materials, a pattern for a machine or other device, or a list of customers. It differs from other secret information in a business (see § 759 of the *Restatement of Torts* which is not included in this Appendix) in that it is not simply information as to single or ephemeral events in the conduct of the business, as, for example, the amount or

other terms of a secret bid for a contract or the salary of certain employees, or the security investments made or contemplated, or the date fixed for the announcement of a new policy or for bringing out a new model or the like. A trade secret is a process or device for continuous use in the operations of the business. Generally it relates to the production of goods, as, for example, a machine or formula for the production of an article. It may, however, relate to the sale of goods or to other operations in the business, such as a code for determining discounts, rebates or other concessions in a price list or catalogue, or a list of specialized customers, or a method of bookkeeping or other office management.

Secrecy. The subject matter of a trade secret must be secret. Matters of public knowledge or of general knowledge in an industry cannot be appropriated by one as his secret. Matters which are completely disclosed by the goods which one markets cannot be his secret. Substantially, a trade secret is known only in the particular business in which it is used. It is not requisite that only the proprietor of the business know it. He may, without losing his protection, communicate it to employees involved in its use. He may likewise communicate it to others pledged to secrecy. Others may also know of it independently, as, for example, when they have discovered the process or formula by independent invention and are keeping it secret. Nevertheless, a substantial element of secrecy must exist, so that, except by the use of improper means, there would be difficulty in acquiring the information. An exact definition of a trade secret is not possible. Some factors to be considered in determining whether given information is one's trade secret are: (1) The extent to which the information is known outside of his business; (2) the extent to which it is known by employees and others involved in his business; (3) the extent of measures taken by him to guard the secrecy of the information; (4) the value of the information to him and his competitors; (5) the amount of effort or money expended by him in developing the information; (6) the ease or difficulty with which the information could be properly acquired or duplicated by others.

Novelty and prior art. A trade secret may be a device or process which is patentable; but it need not be that. It may be a device or process which is clearly anticipated in the prior art or one which is merely a mechanical improvement that a good mechanic can make. Novelty and invention are not requisite for a trade secret as they are for patentability. These requirements are essential to patentability because a patent protects against unlicensed use of the patented device or process even by one who discovers it properly through independent research. The patent monopoly is a reward to the inventor. But such is not the case with a trade secret. Its protection is not based on a policy of rewarding or otherwise encouraging the development of secret processes or devices. The protection is merely against breach of faith and reprehensible means of learning another's secret. For this limited protection it is not appropriate to require also the kind of novelty and invention which is a requisite of patentability. The nature of the secret is, however, an important factor in determining the kind of relief that is appropriate against one who is subject to liability under the rule stated in this section. Thus, if the secret consists of a device or process which is a novel invention, one who acquires the secret wrongfully is ordinarily enjoined from further use of it and is required to account for the profits derived from his past use. If, on the other hand, the secret consists of mechanical improvements that a good mechanic can make without resort to the secret, the wrongdoer's liability may be limited to damages, and an injunction against future use of the improvements made with the aid of the secret may be inappropriate.

8. Section 1915.97 would be revised to read as follows:

§ 1915.97 Health and sanitation.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking, except where indicated otherwise.

(a) The employer shall provide all necessary controls, and the employees shall be protected by suitable personal protective equipment against the hazards identified under § 1915.99 of this part and those hazards for which specific precautions are required in Subparts B, C, and D of this part.

(b) The employer shall provide adequate washing facilities for employees engaged in the application of paints or coatings or in other operations where contaminants can, by ingestion or absorption, be detrimental to the health of the employees. The employer shall encourage good personal hygiene practices by informing the employees of the need for removing surface contaminants by thorough washing or hands and face prior to eating or smoking.

(c) The employer shall not permit employees to eat or smoke in areas undergoing surface preparation or preservation or where shipbreaking operations produce atmospheric contaminants.

(d) The employer shall not permit employees engaged in ship repair work on a vessel to work in the immediate vicinity of uncovered garbage and shall ensure that employees working beneath or on the outboard side of a vessel are not subject to contamination by drainage or waste from overboard discharges.

(e) No minor under 16 years of age shall be employed in shipbreaking or related employments.

9. Section 1928.21 would be amended by adding paragraph (a)(5) as follows:

§ 1928.21 Applicable standards in 29 CFR Part 1910.

(a) • • •

(5) Hazard communication—§ 1910.1200.

• • • • •

[FR Doc. 87-19137 Filed 8-19-87; 8:45 am]
BILLING CODE 4510-26-M

Appendix 2

OSHA Laboratory Standard
(29 CFR 1910.1450)

Federal Register

Wednesday
January 31, 1990

Part II

Department of Labor

Occupational Safety and Health Administration

29 CFR Part 1910

Occupational Exposures to Hazardous Chemicals in Laboratories; Final Rule

ensuring that their standards are at least as effective as the Federal standard.

The 25 States with their own OSHA-approved occupational safety and health plans must adopt a comparable standard within six months of publication of a final rule. The States are: Alaska, Arizona, California, Connecticut, Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, New York, North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Virgin Islands, Washington, Wyoming. For New York and Connecticut, plans cover only state and local government employees. Until such time as a State standard is promulgated, Federal OSHA will provide interim enforcement assistance, as appropriate, in these States.

VIII. Authority and Signature

This document was prepared under the direction of Gerard F. Scannell, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, 200 Constitution Avenue NW., Washington, DC 20210. Pursuant to sections 6(b) and 8(c) and 8(g)(2) of the Act, OSHA hereby amends 29 CFR part 1910 by adding a new § 1910.1450 as set forth below.

List of Subjects in 29 CFR Part 1910

Laboratories, Occupational safety and health.

Signed at Washington, DC, this 22nd day of January 1990.

Gerard F. Scannell,

Assistant Secretary for Occupational Safety and Health.

Part 1910 of title 29 of the Code of Federal Regulation (CFR) is hereby amended as follows:

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

1. The authority citation for part 1910, subpart Z is amended by adding the following citation at the end. (Citation which precedes asterisk indicates general rulemaking authority.)

Authority: Secs. 6 and 8, Occupational Safety and Health Act, 29 U.S.C. 655, 657; Secretary of Labor's Orders Nos. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable; and 29 CFR part 1911.

* * * Section 1910.1450 is also issued under sec. 6(b), 8(c) and 8(g)(2), Pub. L. 91–596, 84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657.

2. Section 1910.1450 is added to subpart Z, part 1910 to read as follows:

§ 191.1450 Occupational exposure to hazardous chemicals in laboratories.

(a) *Scope and application.* (1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

(2) Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

(i) For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

(ii) Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

(iii) Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements, paragraphs (d) and (g)(1)(ii) of this section shall apply.

(3) This section shall not apply to:

(i) Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

(ii) Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

(A) Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

(B) Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

(b) *Definitions*—

"*Action level*" means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

"*Assistant Secretary*" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"*Carcinogen*" (see "select carcinogen").

"*Chemical Hygiene Officer*" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated indvidual shall hold within the employer's organizational structure.

"*Chemical Hygiene Plan*" means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

"*Combustible liquid*" means any liquid having a flashpoint at or above 100 °F (37.8 °C), but below 200 °F (93.3 °C), except any mixture having components with flashpoints of 200 °F (93.3 °C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"*Compressed gas*" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 °F (21.1 °C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 °F (54.4 °C) regardless of the pressure at 70 °F (21.1 °C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 °F (37.8 °C) as determined by ASTM D–323–72.

"*Designated area*" means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

"*Emergency*" means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

"*Employee*" means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

"*Explosive*" means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

"*Flammable*" means a chemical that falls into one of the following categories:

(i) "*Aerosol, flammable*" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a

flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening:

(ii) "*Gas, flammable*" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) "*Liquid, flammable*" means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) "*Solid, flammable*" means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

"*Flashpoint*" means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24–1979 (ASTM D 56–79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7–1979 (ASTM D 93–79))-for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278–78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

"*Hazardous chemical*" means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

"*Laboratory*" means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

"*Laboratory scale*" means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

"*Laboratory-type hood*" means a device located in a laboratory, enclosure on five sides with a moveable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

"*Laboratory use of hazardous chemicals*" means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

"*Medical consultation*" means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

"*Organic peroxide*" means an organic compound that contains the bivalent —O—O— structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

"*Oxidizer*" means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

"*Physical hazard*" means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

"*Protective laboratory practices and equipment*" means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

"*Reproductive toxins*" means chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis)

"*Select carcinogen*" means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be

carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6–7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m³;

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

"Unstable (reactive)" means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

"Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

(c) *Permissible exposure limits.* For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

(d) *Employee exposure determination*—(1) *Initial monitoring.* The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

(2) *Periodic monitoring.* If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

(3) *Termination of monitoring.* Monitoring may be terminated in accordance with the relevant standard.

(4) *Employee notification of monitoring results.* The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

(e) *Chemical hygiene plan—General.* (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan.) (1) Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

(i) Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

(ii) Capable of keeping exposures below the limits specified in paragraph (c) of this section.

(2) The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

(3) The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection:

(i) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

(ii) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

(iii) A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

(iv) Provisions for employee information and training as prescribed in paragraph (f) of this section;

(v) The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

(vi) Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

(vii) Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer and, if appropriate, establishment of a Chemical Hygiene Committee; and

(viii) Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

(A) Establishment of a designated area;

(B) Use of containment devices such as fume hoods or glove boxes;

(C) Procedures for safe removal of contaminated waste; and

(D) Decontamination procedures.

(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

(f) *Employee information and training.* (1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

(2) Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

(3) *Information.* Employees shall be informed of:

(i) The contents of this standard and its appendices which shall be made available to employees;

(ii) The location and availability of the employer's Chemical Hygiene Plan;

(iii) The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

(iv) Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

(v) The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

(4) *Training.* (i) Employee training shall include:

(A) Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

(B) The physical and health hazards of chemicals in the work area; and

(C) The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(ii) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

(g) *Medical consultation and medical examinations.* (1) The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

(i) Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

(ii) Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

(iii) Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

(2) All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

(3) *Information provided to the physician.* The employer shall provide the following information to the physician:

(i) The identity of the hazardous chemical(s) to which the employee may have been exposed;

(ii) A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

(iii) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) *Physician's written opinion.* (i) For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

(A) Any recommendation for further medical follow-up;

(B) The results of the medical examination and any associated tests;

(C) Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace; and

(D) A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

(ii) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

(h) *Hazard identification.* (1) With respect to labels and material safety data sheets:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

(2) The following provisions shall apply to chemical substances developed in the laboratory:

(i) If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

(ii) If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

(iii) If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

(i) *Use of respirators.* Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

(j) *Recordkeeping.* (1) The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

(2) The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.20.

(k) *Dates*—(1) *Effective date.* This section shall become effective May 1, 1990.

(2) *Start-up dates.* (i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

(ii) Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(l) *Appendices.* The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

Appendix A to § 1910.1450—National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

Table of Contents

3. Chemicals of Moderate Chronic or High Acute Toxicity
4. Chemicals of High Chronic Toxicity
5. Animal Work with Chemicals of High Chronic Toxicity

F. Safety Recommendations

G. Material Safety Data Sheets

Foreword

As guidance for each employer's development of an appropriate laboratory Chemical Hygiene Plan, the following non-mandatory recommendations are provided. They were extracted from "Prudent Practices for Handling Hazardous Chemicals in Laboratories" (referred to below as "Prudent Practices"), which was published in 1981 by the National Research Council and is available from the National Academy Press, 2101 Constitution Ave., NW., Washington DC 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices", organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

"Prudent Practices" deals with both safety and chemical hazards while the laboratory standard is concerned primarily with chemical hazards. Therefore, only those recommendations directed primarily toward control of toxic exposures are cited in this appendix, with the term "chemical hygiene" being substituted for the word "safety". However, since conditions producing or threatening physical injury often pose toxic risks as well, page references concerning major categories of safety hazards in the laboratory are given in section F.

The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized, and headings have been added. However, their sense has not been changed.

Corresponding Sections of the Standard and this Appendix

The following table is given for the convenience of those who are developing a Chemical Hygiene Plan which will satisfy the requirements of paragraph (e) of the standard. It indicates those sections of this appendix which are most pertinent to each of the sections of paragraph (e) and related paragraphs.

Paragraph and topic in laboratory standard	Relevant appendix section
(e)(3)(i) Standard operating procedures for handling toxic chemicals.	C, D, E
(e)(3)(ii) Criteria to be used for implementation of measures to reduce exposures.	D
(e)(3)(iii) Fume hood performance	C4b
(e)(3)(iv) Employee information and training (including emergency procedures).	D10, D9
(e)(3)(v) Requirements for prior approval of laboratory activities.	E2b, E4b
(e)(3)(vi) Medical consultation and medical examinations.	D5, E4f
(e)(3)(vii) Chemical hygiene responsibilities.	B
(e)(3)(viii) Special precautions for work with particularly hazardous substances.	E2, E3, E4

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A–D. Those recommendations of primary concern to employees who are actually handling laboratory chemicals are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

In addition to the more detailed recommendations listed below in sections B–E, "Prudent Practices" expresses certain general principles, including the following:

1. *It is prudent to minimize all chemical exposures.* Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2, 10). Skin contact with chemicals should be avoided as a cardinal rule (198).

2. *Avoid underestimation of risk.* Even for substances of no known significant hazard, exposure should be minimized; for work with substances which present special hazards, special precautions should be taken (10, 37, 38). One should assume that any mixture will be more toxic than its most toxic component (30, 103) and that all substances of unknown toxicity are toxic (3, 34).

3. *Provide adequate ventilation.* The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).

4. *Institute a chemical hygiene program.* A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6, 11). Its recommendations should be followed in academic teaching laboratories as well as by full-time laboratory workers (13).

5. *Observe the PELs, TLVs.* The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rests at all levels (6, 11, 21) including the:

1. *Chief executive officer,* who has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene (7, 11).

2. *Supervisor of the department or other administrative unit,* who is responsible for chemical hygiene in that unit (7).

3. *Chemical hygiene officer(s),* whose appointment is essential (7) and who must:

(a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);

(b) Monitor procurement, use, and disposal of chemicals used in the lab (8);

(c) See that appropriate audits are maintained (8);

(d) Help project directors develop precautions and adequate facilities (10);

(e) Know the current legal requirements concerning regulated substances (50); and

(f) Seek ways to improve the chemical hygiene program (8, 11).

4. *Laboratory supervisor,* who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:

(a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);

(b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment (21, 171);

(c) Know the current legal requirements concerning regulated substances (50, 231);

(d) Determine the required levels of protective apparel and equipment (156, 160, 162); and

(e) Ensure that facilities and training for use of any material being ordered are adequate (215).

5. *Project director or director of other specific operation,* who has primary responsibility for chemical hygiene procedures for that operation (7).

6. *Laboratory worker,* who is responsible for:

(a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and

(b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. *Design.* The laboratory facility should have:

(a) An appropriate general ventilation system (see C4 below) with air intakes and exhausts located so as to avoid intake of contaminated air (194);

(b) Adequate, well-ventilated stockrooms/storerooms (218, 219);

(c) Laboratory hoods and sinks (12, 162);

(d) Other safety equipment including eyewash fountains and drench showers (162, 169); and

(e) Arrangements for waste disposal (12, 240).

2. *Maintenance.* Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continuing appraisal and be modified if inadequate (11, 12).

3. *Usage.* The work conducted (10) and its scale (12) must be appropriate to the physicial facilities available and, especially, to the quality of ventilation (13).

4. *Ventilation*—(a) *General laboratory ventilation.* This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).

(b) *Hoods.* A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp. 201–206 for a discussion of hood design, construction, and evaluation.

(c) *Other local ventilation devices.* Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate exhaust duct (207).

(d) *Special ventilation areas.* Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure (209).

(e) *Modifications.* Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate (12, 193, 204).

(f) *Performance.* Rate: 4–12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).

(g) *Quality.* General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194, 195); airflow into and within the hood should not be excessively turbulent (200); hood face velocity should be adequate (typically 60–100 lfm) (200, 204).

(h) *Evaluation.* Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every 3 months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp. 195–198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

D. Components of the Chemical Hygiene Plan

1. Basic Rules and Procedures (Recommendations for these are given in section E, below)

2. Chemical Procurement, Distribution, and Storage

(a) *Procurement.* Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved (215, 216). No container should be accepted without an adequate identifying label (216). Preferably, all substances should be received in a central location (216).

(b) *Stockrooms/storerooms.* Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity (218–19).

Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).

(c) *Distribution.* When chemicals are hand carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible (223).

(d) *Laboratory storage.* Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom (225–6, 229).

3. Environmental Monitoring

Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices (12) or when a highly toxic substance is stored or used regularly (e.g., 3 times/week) (13).

4. Housekeeping, Maintenance, and Inspections

(a) Cleaning. Floors should be cleaned regularly (24).

(b) Inspections. Formal housekeeping and chemical hygiene inspections should be held at least quarterly (6, 21) for units which have frequent pesonnel changes and semiannually for others; informal inspections should be continual (21).

(c) *Maintenance.* Eye wash fountains should be inspected at intervals of not less than 3 months (6). Respirators for routine use should be inspected periodically by the laboratory supervisor (169). Safety showers should be tested routinely (169). Other safety equipment should be inspected regularly. (*e.g.*, every 3–6 months) (6, 24, 171). Procedures to prevent restarting of out-of-service equipment should be established (25).

(d) *Passageways.* Stairways and hallways should not be used as storage areas (24). Access to exits, emergency equipment, and utility controls should never be blocked (24).

5. Medical Program

(a) *Compliance with regulations.* Regular medical surveillance should be established to the extent required by regulations (12).

(b) *Routine surveillance.* Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable (11, 50).

(c) *First aid.* Personnel trained in first aid should be available during working hours and an emergency room with medical personnel should be nearby (173). See pp. 176–178 for description of some emergency first aid procedures.

6. Protective Apparel and Equipment

These should include for each laboratory:

(a) Protective apparel compatible with the required degree of protection for substances being handled (158–161);

(b) An easily accessible drench-type safety shower (162, 169);

(c) An eyewash fountain (162);

(d) A fire extinguisher (162–164);

(e) Respiratory protection (164–9), fire alarm and telephone for emergency use (162) should be available nearby; and

(f) Other items designated by the laboratory supervisor (156, 160).

7. Records

(a) Accident records should be written and retained (174).

(b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations (7).

(c) Inventory and usage records for high-risk substances should be kept as specified in sections E3e below.

(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations (12).

8. Signs and Labels

Prominent signs and labels of the following types should be posted:

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers (28);

(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards (27, 48);

(c) Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits (27) and areas where food and beverage consumption and storage are permitted (24); and

(d) Warnings at areas or equipment where special or unusual hazards exist (27).

9. Spills and Accidents

(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure (200), evacuation, medical care, reporting, and drills (172).

(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).

(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).

(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit (8, 28).

10. Information and Training Program

(a) Aim: To assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs (5, 15).

(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169).

Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6).

Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.

(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations (217).

(d) Frequency of Training: The training and education program should be a regular, continuing activity—not simply an annual presentation (15).

(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources (14).

11. *Waste Disposal Program.*

(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals (5).

(b) Content (14, 232, 233, 240): The waste disposal program should specify how waste is to be collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations (244).

(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 27).

Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (228).

(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals (14).

(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241).

Indiscriminate disposal by pouring waste chemicals down the drain (14, 231, 242) or adding them to mixed refuse for landfill burial is unacceptable (14).

Hoods should not be used as a means of disposal for volatile chemicals (40, 200).

Disposal by recycling (233, 243) or chemical decontamination (40, 230) should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the sub programs mentioned above, these should include the rules listed below.

1. General Rules

The following should be used for essentially all laboratory work with chemicals:

(a) *Accidents and spills*—Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172).

Ingestion: Encourage the victim to drink large amounts of water (178).

Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33).

Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24 33). See pp. 233–237 for specific clean-up recommendations.

(b) *Avoidance of "routine" exposure:* Develop and encourage safe habits (23); avoid unnecessary exposure to chemicals by any route (23);

Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199).

Inspect gloves (157) and test glove boxes (208) before use.

Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres (209).

(c) *Choice of chemicals:* Use only those chemicals for which the quality of the available ventilation system is appropriate (13).

(d) *Eating, smoking, etc.:* Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities (23, 24).

Avoid storage, handling or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 228).

(e) *Equipment and glassware:* Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware (25). Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur (25). Use equipment only for its designed purpose (23, 26).

(f) *Exiting:* Wash areas of exposed skin well before leaving the laboratory (23).

(g) *Horseplay:* Avoid practical jokes or other behavior which might confuse, startle or distract another worker (23).

(h) *Mouth suction:* Do not use mouth suction for pipeting or starting a siphon (23, 32).

(i) *Personal apparel:* Confine long hair and loose clothing (23, 158). Wear shoes at all times in the laboratory but do not wear sandals, perforated shoes, or sneakers (158).

(j) *Personal housekeeping:* Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day (24).

(k) *Personal protection:* Assure that appropriate eye protection (154–156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154).

Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159).

Use appropriate (164–168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164–5), inspecting the respirator before use (169).

Use any other protective and emergency apparel and equipment as appropriate (22, 157–162).

Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155).

Remove laboratory coats immediately on significant contamination (161).

(l) *Planning:* Seek information and advice about hazards (7), plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation (22, 23).

(m) *Unattended operations:* Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation (27, 128).

(n) *Use of hood:* Use the hood for operations which might result in release of toxic chemical vapors or dust (198–9).

As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm (13).

Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200).

Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off" (200).

(o) *Vigilance:* Be alert to unsafe conditions and see that they are corrected when detected (22).

(p) *Waste disposal:* Assure that the plan for each laboratory operation includes plans and training for waste disposal (230).

Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24).

Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances

(231); or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).

(q) *Working alone:* Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous (28).

2. Working with Allergens and Embryotoxins

(a) *Allergens* (examples: diazomethane, isocyanates, bichromates): Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity (35).

(b) *Embryotoxins* (34–5) (examples: organomercurials, lead compounds, formamide): If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact.

Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made.

Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container.

Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity

Examples: diisopropylflurophosphate (41), hydrofluoric acid (43), hydrogen cyanide (45).

Supplemental rules to be followed in addition to those mentioned above (Procedure B of "Prudent Practices", pp. 39–41):

(a) *Aim:* To minimize exposure to these toxic substances by any route using all reasonable precautions (39).

(b) *Applicability:* These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities (39).

(c) *Location:* Use and store these substances only in areas of restricted access with special warning signs (40, 229).

Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to prevent their discharge with the hood exhaust (40).

(d) *Personal protection:* Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate) (39). Always wash hands and arms immediately after working with these materials (40).

(e) *Records:* Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved (40, 229).

(f) *Prevention of spills and accidents:* Be prepared for accidents and spills (41).

Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39).

Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper (40).

If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) *Waste:* Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40).

Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with Chemicals of High Chronic Toxicity

(Examples: dimethylmercury and nickel carbonyl (48), benzo-a-pyrene (51), N-nitrosodiethylamine (54), other human carcinogens or substances with high carcinogenic potency in animals (38).)

Further supplemental rules to be followed, in addition to all these mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance) (47). (Procedure A of "Prudent Practices" pp. 47–50).

(a) *Access:* Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all people with access are aware of the substances being used and necessary precautions (48).

(b) *Approvals:* Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor (48).

(c) *Non-contamination/Decontamination:* Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood (49). Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area (49, 50).

Decontaminate the controlled area before normal work is resumed there (50).

(d) *Exiting:* On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck (49).

(e) *Housekeeping:* Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder (50).

(f) *Medical surveillance:* If using toxicologically significant quantities of such a substance on a regular basis (*e.g.*, 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance (50).

(g) *Records:* Keep accurate records of the amounts of these substances stored (229) and used, the dates of use, and names of users (48).

(h) *Signs and labels:* Assure that the controlled area is conspicuously marked with warning and restricted access signs (49) and that all containers of these substances are appropriately labeled with identity and warning labels (48).

(i) *Spills:* Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available (233–4).

(j) *Storage:* Store containers of these chemicals only in a ventilated, limited access (48, 227, 229) area in appropriately labeled, unbreakable, chemically resistant, secondary containers (48, 229).

(k) *Glove boxes:* For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water (48). For a positive pressure glove box, thoroughly check for leaks before each use (49). In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood (49).

(l) *Waste:* Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel (49, 50, 233).

5. Animal Work with Chemicals of High Chronic Toxicity

(a) *Access:* For large scale studies, special facilities with restricted access are preferable (56).

(b) *Administration of the toxic substance:* When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters (56).

(c) *Aerosol suppression:* Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood) (55, 56).

(d) *Personal protection:* When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator) (56).

(e) *Waste disposal:* Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products (238); otherwise, package the waste appropriately for burial in an EPA-approved site (239).

F. Safety Recommendations

The above recommendations from "Prudent Practices" do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, we list below page references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35–6)

2. Electrically powered laboratory apparatus: (179–92)
3. Fires, explosions: (26, 57–74, 162–4, 174–5, 219–20, 226–7)
4. Low temperature procedures: (26, 88)
5. Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75–101)

G. Material Safety Data Sheets

Material safety data sheets are presented in "Prudent Practices" for the chemicals listed below. (Asterisks denote that comprehensive material safety data sheets are provided).

*Acetyl peroxide (105)
*Acrolein (106)
*Acrylonilrile (107)
Ammonia (anhydrous) (91)
*Aniline (109)
*Benzene (110)
*Benzo[a]pyrene (112)
*Bis(chloromethyl) ether (113)
Boron trichloride (91)
Boron trifluoride (92)
Bromine (114)
*Tert-butyl hydroperoxide (148)
*Carbon disulfide (116)
Carbon monoxide (92)
*Carbon tetrachlonde (118)
*Chlorine (119)
Chlorine trifluoride (94)
*Chloroform (121)
Chloromethane (93)
*Diethyl ether (122)
Diisopropyl fluorophosphate (41)
*Dimethylformamide (123)
*Dimethyl sulfate (125)
*Dioxane (126)
*Ethylene dibromide (128)
*Fluorine (95)
*Formaldehyde (130)
*Hydrazine and salts (132)
Hydrofluoric acid (43)
Hydrogen bromide (98)
Hydrogen chloride (98)
*Hydrogen cyanide (133)
*Hydrogen sulfide (135)
Mercury and compounds (52)
*Methanol (137)
*Morpholine (138)
*Nickel carbonyl (99)
*Nitrobenzene (139)
Nitrogen dioxide (100)
N-nitrosodiethylamine (54)
*Peracetic acid (141)
*Phenol (142)
*Phosgene (143)
*Pyridine (144)
*Sodium azide (145)
*Sodium cyanide (147)
Sulfur dioxide (101)
*Trichloroethylene (149)
*Vinyl chloride (150)

Appendix B to § 1910.1450—References (Non-Mandatory)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do not imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory. (a) Materials for the development of the Chemical Hygiene Plan:

1. American Chemical Society. Safety in Academic Chemistry Laboratories. 4th edition. 1985.
2. Fawcett, H.H. and W. S. Wood. Safety and Accident Prevention in Chemical Operations. 2nd edition. Wiley-Interscience. New York. 1982.
3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory. Charles C. Thomas Publisher. Springfield IL. 1978.
3. Green, Michael E. and Turk, Amos. Safety in Working with Chemicals. Macmillan Publishing Co., NY. 1978.
5. Kaufman, James A., Laboratory Safety Guidelines. Dow Chemical Co., Box 1713. Midland. MI 48640. 1977.
6. National Institutes of Health. NIH Guidelines for the Laboratory use of Chemical Carcinogens. NIH Pub. No. 81–2385. GPO. Washington. DC 20402. 1981.
7. National Research Council. Prudent Practices for Disposal of Chemicals from Laboratories. National Academy Press. Washington. DC. 1983.
8. National Research Council. Prudent Practices for Handling Hazardous Chemicals in Laboratories. National Academy Press. Washington. DC. 1981.
9. Renfrew, Malcolm. Ed., Safety in the Chemical Laboratory. Vol. IV. *J. Chem. Ed.*, American Chemical Society. Easlon. PA. 1981.
10. Steere, Norman V., Ed., Safety in the Chemical Laboratory. *J. Chem. Ed.* American Chemical Society. Easlon. PA. 18042. Vol. I. 1967. Vol. II. 1971. Vol. III 1974.
11. Steere, Norman V., Handbook of Laboratory Safety. the Chemical Rubber Company Cleveland. OH. 1971.
12. Young, Jay A., Ed., Improving Safety in the Chemical Laboratory. John Wiley & Sons. Inc. New York. 1987.

(b) Hazardous Substances Information:

1. American Conference of Governmental Industrial Hygienists. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes. P.O. Box 1937 Cincinnati. OH 45201 (latest edition).
2. Annual Report on Carcinogens. National Toxicology Program U.S. Department of Health and Human Services. Public Health Service. U.S. Government Printing Office. Washington. DC. (latest edition).
3. Best Company. Best Safety Directory. Vols. I and II. Oldwick. N.J., 1981.
4. Bretherick, L., Handbook of Reactive Chemical Hazards. 2nd edition. Butterworths. London. 1979.
5. Bretherick, L., Hazards in the Chemical Laboratory. 3rd edition. Royal Society of Chemistry. London. 1986.
6. Code of Federal Regulations. 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office. Washington. DC 20402 (latest edition).
7. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. World Health Organization Publications Center. 49 Sheridan Avenue. Albany. New York 12210 (latest editions).
8. NIOSH/OSHA Pocket Guide to Chemical Hazards. NIOSH Pub. No. 85–114. U.S. Government Printing Office. Washington. DC. 1985 (or latest edition).
9. Occupational Health Guidelines. NIOSH/OSHA NIOSH Pub. No. 81–123 U.S. Government Printing Office. Washington. DC. 1981.
10. Patty, F.A., Industrial Hygiene and Toxicology. John Wiley & Sons. Inc., New York. NY (Five Volumes).
11. Registry of Toxic Effects of Chemical Substances. U.S. Department of Health and Human Services. Public Health Service. Centers for Disease Control. National Institute for Occupational Safety and Health. Revised Annually. for sale from Superintendent of Documents U.S. Govt. Printing Office. Washington. DC 20402.
12. The Merck Index: An Encyclopedia of Chemicals and Drugs. Merck and Company Inc. Rahway. N.J., 1976 (or latest edition).
13. Sax, N.I. Dangerous Properties of Industrial Materials. 5th edition. Van Nostrand Reinhold. NY., 1979.
14. Sittig, Marshall. Handbook of Toxic and Hazardous Chemicals. Noyes Publications. Park Ridge. NJ. 1981.

(c) Information on Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation 16th edition Lansing. MI. 1980.
2. American National Standards Institute. Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2–1979 American National Standards Institute. N.Y. 1979.
3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids. Professional Safety pp 15–18. April 1980.
4. National Fire Protection Association. Fire Protection for Laboratories Using Chemicals NFPA–45. 1982.

Safety Standard for Laboratories in Health Related Institutions. NFPA. 56c. 1980.

Fire Protection Guide on Hazardous Materials. 7th edition. 1978.

National Fire Protection Association. Batterymarch Park. Quincy. MA 02269.

5. Scientific Apparatus Makers Association (SAMA). Standard for Laboratory Fume Hoods. SAMA LF7–1980. 1101 16th Street. NW., Washington. DC 20036.

(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI). 1430 Broadway. New York. NY 10018.
2. American Society for Testing and Materials (ASTM). 1916 Race Street. Philadelphia. PA 19103.

(Approved by the Office of Management and Budget under control number 1218–0131)

[FR Doc. 90–1717 Filed 1–30–90: 8:45 am]

BILLING CODE 4510–26–M

Appendix 3

Glossary of Terms

Action Level	A concentration designated in 29 CFR Part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, that initiates certain required activities such as exposure monitoring and medical surveillance.
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.
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	Refers 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).
Chemical Hygiene Officer	A person designated by the employer who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene & Safety Plan.
Chemical Hygiene and Safety Plan	A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in the particular workplace.
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)
combustible gas	(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or (ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4° C) regardless of the pressure at 70°F (21.1°C): or (iii) A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8 °C) as determined by ASTM D-323-72.
combustible liquid	Any liquid having a flashpoint at or above 100°F but below 200°F.
compressed gas	A gas or mixture of gases in a container having an absolute pressure of 40 or more psi at room temperature.
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.
decomposition	The breakdown of a material into a simpler compound by chemical reaction, decay, heat, or other process.

density	The mass of a substance per unit volume. The density of a liquid substance is usually compared to water, which has a density of 1; the density of a gas is usually compared to air. Substances that float on water have densities of less than 1; substances that sink in water have densities greater than 1.
dermal	Refers to skin.
dermatitis	An inflammation of the skin, which can be caused by irritation (chemical, physical, or mechanical) or allergic reaction.
designated area	An area that may be used for work with "select carcinogens, " reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.
dose	The amount of a substance received during exposure.
epidemiology	The branch of medical science that deals with the incidence, distribution, and control of disease in a population.
explosive	A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.
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. Note the Uniform Fire Code uses a cut off of 140°F, which qualifies more liquids as "flammable."
flashpoint	The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite.

formula	The molecular composition of a chemical compound written in scientific symbols. Water is H_2O; hydrochloric acid is HCl.
g/kg	Grams per kilogram. A measurement 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.
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 muccous 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).
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.
laboratory-type hood	A device located in a laboratory, enclosure on five sides with a moveable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.
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^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.
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 of 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 assist OSHA by conducting research and investigations.
NTP	National Toxicology Program. Publishes "Annual Report on Carcinogens," listing substances either known or anticipated to be carcinogens.
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	Refers to the sense of smell.
oral	Refers 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.
OSP	Operational Safety Procedure. A written procedure describing a particularly hazardous operation, explaining the potential hazards, and detailing the methods of mitigating those hazards. The OSP requires EH&S review.
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.
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 measurement 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 measurement 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 million parts of air.
psi	Pounds per square inch, a unit of pressure measurement used with compressed gases, etc.
pulmonary	Refers to the lungs.

pyrophoric	A chemical that can catch on fire spontaneously in air at or below 130° F.
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 substance may explode.
reproductive toxins	Are chemicals that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).
respiratory protective equipment	Air-cleaning or air-supply respirators that protect against toxic materials in the air.
route of entry	The means by which a toxic substance enters the body. For example, absorption through the skin, inhalation, ingestion. May also be called mode of entry.
secondary container	A container into which laboratory personnel transfer material from the vendor supplied container.
select carcinogen	means any substance that meets one of the following criteria: (i) It is regulated by OSHA as a carcinogen; or (ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or (iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or (iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals.
sensitizer	A substance that can cause an allergic reaction, which usually appears after repeated exposure.

solubility in water	Indicates 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.
SSP	Specific Safety Procedure. A brief, two-page, written safety prodedure that lists the hazardous substances used in an operation (or several similar operations), and outlines the control measures that are to be used. SSPs are used as the basic method for declaring the safety procedures for a specific lab or shop. They do not necessarily require EH&S review.
STEL	Short Term Exposure Limit: The maximum concentration allowed in a continuous, 15-minute exposure. There may be no more than 4 such exposures each day with at least 1 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.
target organ effects	Effects on specific organs of the body caused by exposure to a hazardous chemical.
teratogen	A chemical or physical agent capable of producing malformation(s) in developing embryo or fetus.

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: 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: 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	A relative measure of the adverse biological effects that can result from exposure to a harmful substance.
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.
vapor	The gas given off by a liquid or solid at room temperature.
ventilation	Circulation and exchange of air and the method by which this is accomplished.
vertigo	A state of dizziness, and possibly disorientation.
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 a liquid that evaporates at room temperature. Very volatile liquids, such as gasoline, form vapors (evaporate) quickly and are a breathing hazard.
water-reactive	A chemical that reacts with water to release a flammable or toxic gas.

Appendix 3

Glossary of Terms

Appendix 4

The Facility Notebook
and
Specific Safety Procedures (SSPs)

Appendix 4

The Facility Notebook and Specific Safety Procedures (SSPs)

Facility Notebooks

Lawrence Berkeley Laboratory is responsible for complying with all relevant laws and regulations to maintain a safe and healthy environment for its administrators, scientists, support staff, and visitors. One set of regulations, DOE Order 5480.19, Conduct of Operations, requires the Laboratory to establish a minimum level of uniformity and consistency in its daily operations. The intent of the Order is to assure that operations at DOE facilities are managed, organized, and conducted at an acceptable level of safety. To meet this objective, the Laboratory is implementing the Facility Notebook. The Facility Notebook provides a mechanism for facility administrators to convey facility-specific information on operational policies and procedures, and for facility users to document their adherence to these requirements.

Facility Notebooks will be used in all work environments that have environmental, health and/or safety considerations. Most laboratory and shop work environments have chemical, biological, and/or physical hazards that warrant the need for Facility Notebooks. On the other hand, an administrative office or computer support service area probably does not have significant physical or chemical hazards, and does not require a Facility Notebook. Note that certain occupational illnesses and injuries (e.g., back strains, repetitive stress injuries at computer workstations, etc.) are prevalent throughout any work force but do not, in and of themselves, require a Facility Notebook for the area. However, if significant physical labor is part of the job description for a work force, management might opt to include safety protocols in their Facility Notebook.

The purpose of the Facility Notebook is to provide an organized body of facility-specific information to assist (1) LBL staff in the safe conduct of their operations, and (2) compliance auditors in their review of facility documentation. It is the logical tool for satisfying the OSHA requirement for hazard determinations and facility-specific chemical hygiene procedures.

Implementation of the LBL Chemical Hygiene and Safety Plan (CHSP)

While the LBL CHSP provides the framework for chemical hygiene procedures, the *Laboratory Standard is not fully implemented until facility-specific chemical hygiene information is provided.* Facility-specific hazard information and written safety procedures are to be provided by each LBL facility and placed within the Facility Notebook. The Notebook has standardized sections for descriptions of facility organization, communication methods, emergency protocols, training, etc. The Notebook serves to provide the following site-specific information *required* by the OSHA Laboratory Standard:

- Facility description and chemical hazard identification;
- Operator responsibilities;
- Lab/Shop-Specific Safety Procedures (SSPs) for routine operations using hazardous chemicals;
- Operational Safety Procedures (OSPs) for all extremely hazardous operations (those utilizing toxic gases, high radiation, etc.);
- Chemical hazard information;
- Recordkeeping; and
- Emergency protocols.

One section deals with the ***Handling of Hazardous Materials***, and it is this section that will be discussed in greater detail here because it entails the use of the two-page Specific Safety Procedure, or "SSP."

Specific Safety Procedures (SSPs)

For most operations and procedures, the SSP will suffice to document safety procedures. For very hazardous operations and procedures, a more detailed Operational Safety Procedure (OSP) is necessary. Both procedures are to be kept with or within the Facility Notebook. The two basic types of written safety procedures are described in greater detail in Section C of this Plan.

Whereas an OSP must be submitted to, reviewed by, and approved by the applicable Safety Review Subcommittee and the Division Director, an SSP is intended as an internal document. It is to be reviewed by the Principal Investigator/Supervisor at least annually and followed by all personnel performing the specific tasks/operations for which it was written.

The SSP has eight sections for descriptions/discussions:

I. **The Procedure/Operation** (e.g., protein extraction, painting, electroplating)
II. **Hazardous Materials** (Identification of the hazardous materials utilized in the operation/procedure)
III. **Particularly Hazardous Materials/Agents** (Identification of the most hazardous agents in terms of innate toxicity and the potential for exposure)
IV. **Hazard Analysis** (An analysis describing all *potential* hazards inherent in the use, storage, and manipulation of these substances)
V. **Controls** (The intended control measures, i.e., administrative, engineering, and/or personal protective equipment)
VI. **Medical Surveillance** (Reference to pertinent medical surveillance protocols)
VII. **Spill Response/ Decontamination** (Provisions for waste handling, spill clean-up, decontamination, etc.)
VIII. **Waste Handling** (Where waste will be placed, the types of waste, etc.)

How To Fill Out the SSP

General Information

At a minimum, a SSP is required for every operation/procedure using chemicals. An OSP is required for extremely hazardous operations. One or more SSPs may be necessary for each work area; and, similar procedures may be lumped together on the same SSP. Furthermore, standardized SSPs for common laboratory operations/procedures may be shared among supervisors as long as the details accurately reflect what is practiced.

Project Review Forms, used by the EH&S Radiation Protection Group, are similar in function and may substitute for the SSP if already in use, or for new start-up projects requiring EH&S review. EH&S review is required for all uses of radioactive substances; EH&S review is not required for chemical use (in the absence of radioactives) unless the written procedure is an OSP.

How To Fill Out the SSP, cont.

List all personnel authorized to work on a project or in a specified area. Remember, all personnel assigned to any area/project must have received the appropriate training. Also, all personnel named to work with radioactivity or radioactive materials must have submitted a completed LBL Radiation Workers Form RL-6583 to EH&S.

SSPs, Section-By-Section:

I. Procedure/Operation

Examples of operations and procedures requiring SSPs include:

- Any hazardous chemical operation not requiring an OSP
- Processes that utilize hazardous chemicals at certain phases of the operation (e.g., some steps in tissue culturing and protein extractions, and the use of high pressure liquid chromatography)
- Use of Class 2 laser systems
- Use of sealed radioactive sources and radionuclides

II. Hazardous Materials

From the onset, recognize that the definition of "what" is hazardous varies significantly with the particular EH&S regulation or policy. For emergency response purposes (such as the Hazardous Materials Management Plan, or "Business Plan") and environmental protection (e.g., waste management, air quality, etc.), almost everything is considered to be potentially hazardous. For occupational safety, the list of hazardous materials is somewhat less lengthy, but complicated by the types of hazards present and the severity of those hazards. The Chemical Hygiene and Safety Plan identifies specific types of hazardous chemicals, such as carcinogens.

Procurement of certain types of hazardous materials is controlled by the Purchasing Department, with assistance from the Industrial Hygiene Group and Radiation

How To Fill Out the SSP (Section II cont.)

Assessment Group. Orders for drugs and the drug precursors require special approval prior to purchasing. Similarly, radioactive substances and acutely hazardous materials (e.g., toxic gases, radioactive chemicals) also require pre-approval prior to delivery.

An exhaustive chemical inventory is conducted each year for all of LBL. At this time, the inventory is housed on the EMS database, which is available for DOS users through the computer network. Do not attempt to establish a threshold quantity for reporting because agency thresholds are based on the entire LBL site and not a single facility. This task can be conducted on an on-going basis or periodically, but must be done at least annually. The EH&S Division coordinates the annual LBL inventory of chemicals, radionuclides, and wastes.

For each SSP, identify *all* chemicals, biohazardous agents, radioactive substances, and human and animal tissues/products that may be used. You may want to attach a printout of all or part of your chemical inventory when preparing the SSP.

For the purposes of this Plan and the SSP, a hazardous chemical is a chemical that can potentially pose a health hazard and/or a physical hazard. The term "health hazard" includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, liver toxins, kidney toxins, nerve toxins, agents that act on the hematopoietic (blood-forming) system, and agents that damage the lungs, skin, eyes, or mucus membranes.

[Appendices A and B of the Hazard Communication Standard (included in this CHSP as Appendix 1) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous. A list of definitions explaining basic hazardous chemical terms is provided in Appendix 3 of this Plan.]

How To Fill Out the SSP, cont.

III. Particularly Hazardous Materials/Agents

Toxins

The OSHA Laboratory Standard dictates that provisions be in place providing additional employee protection for work with "particularly hazardous substances," described as "select carcinogens, reproductive toxins, and substances with a high degree of acute toxicity." Carcinogens and reproductive toxins are discussed in Sections G.2 and G.3 of this Plan. Consult Appendix 11 for a composite list of OSHA's Select Carcinogens. Consult Appendix 13 for a list of reproductive toxins.

Don't overlook these select carcinogens commonly used in operations and procedures conducted at LBL:

benzene	chloroform
acrylamide	aniline and benzidine dyes
formaldehyde	perchloroethylene
methylene chloride	trichloroethylene

Don't overlook these common reproductive toxins:

carbon disulfide	ethylene oxide
dinitrobenzene	lead and lead compounds
ethylene glycol monoethyl ether	mercury and mercury compounds
ethylene glycol monomethyl ether	toluene

High acute toxicity substances are defined as those substances such as hydrogen cyanide, hydrogen sulfide, and nitrogen dioxide which "may be fatal or cause damage to target organs as a result of a single exposure or exposures of short duration." High acute toxicity substances include substances that are capable of causing intense irritation that can result in pulmonary edema (fluid and swelling in the lungs), chemical asphyxia, and systemic (body-wide) poisoning. As it happens, many substances in this high acute toxicity category are toxic gases, which are discussed in Section G.4. Use of these substances requires the preparation of an OSP.

How To Fill Out the SSP (Section III cont.)

Isotopes

For each isotope, list: (1) the maximum quantity per use, (2) the maximum quantity per shipment container, (3) the possession limit, and (4) the chemical and physical forms. NOTE: If you list any radioactive substances, you must send a copy of the form to the Radiation Assessment Group for their review.

Potential Biohazards

List all human blood, blood products (e.g., plasma, buffy coat, packed cells), body fluids, tissues, and infectious agents. Use of all except the latter requires that workers receive Blood Biosafety Training (EHS-35) pursuant to the OSHA Bloodborne Pathogen Rule.

IV. Hazard Analysis

Hazard analysis, or hazard determination, is an evaluation made of the chemicals present in a workplace to determine if they are hazardous. Note that the hazard analysis must be made regardless of the potential for exposure. If there is potential for exposure, other than in minute, trace, or exempt cases (e.g., use of commercially prepared kits within which all the reagents are self-contained), then a hazard determination must be made. The hazard determination may declare that the potential for exposure is low and therefore the risk is low, and that additional control measures are not needed, but the exercise is still conducted and written down in the SSP.

A hazard analysis is not required for hazardous waste (e.g. soil and water samples), or for consumer products that contain hazardous substances if it can be demonstrated that the products are used in the same manner in the workplace as they are in normal consumer use (such that no greater exposure results). However, employees are reminded to use good judgment when using all chemicals, even common household bleach.

How To Fill Out the SSP (Section IV cont.)

Describe any special hazards of the project such as the use of volatile or dispersible radioactive materials, the mechanical manipulation of hazardous materials that might increase the likelihood of aerosol generation, the use of pressurized vessels, and intentional chemical reactions that result in heat and/or gas releases, etc.

V. Controls

Exposures

Exposures by inhalation of airborne contaminants (gases, vapors, fumes, dusts, and mists) must not exceed (1) the levels listed in the latest edition of Threshold Limit Values (TLVs) of Airborne Contaminants published by the American Conference of Governmental Industrial Hygienists, (2) OSHA Permissible Exposure Limits (PELs), which are comparable to the TLVs, and (3) the ACGIH and/or OSHA Short Term

Exposure Limits (STELs). These occupational exposure limits are normally published on the manufacturer's Material Safety Data Sheets or available through the Industrial Hygiene Group.

In addition, chemicals can gain entry into the body via the skin and by ingestion. The routes of potential exposure for each type of chemical varies (e.g., some chemicals are more prone to skin absorption than others). Good hygiene protocols summarized in the SSP must address all potential routes of exposure for the chemicals being used.

Selection of Control Measures

Employee exposures to potential hazards can be controlled through the following basic approaches:

- Administrative controls (e.g., specific work practices, area controls, etc.)
- Engineering controls (e.g., fume hoods)
- Personal protective equipment (e.g., gloves, lab coats, safety glasses)

How To Fill Out the SSP (Section V cont.)

All three of these approaches may be used for a single procedure depending upon the circumstances. The control measures appropriate for the particular operation or procedure being conducted depend on a number of factors, including the volatility of the substance, if the substance can be absorbed through the skin (e.g., glycol ethers), and how much of the substance is being used over a time period.

In all cases of potentially harmful exposure, feasible engineering or administrative controls must first be established. In cases where respiratory protective equipment, alone or with other control measures, is required to protect the employee, the protective equipment must be approved by the Industrial Hygiene Group for each specific use. [Refer to Sections G and I of his Plan for more information on assessing hazards to determine which controls are best.]

The following factors impact the selection of controls:

- Length of employee exposures (full shift vs. short-term)
- Types of substances being handled or used including the hazardous properties and physical and chemical properties
- The nature of the operation or procedure (i.e., how easily are aerosols or vapors generated).
- Presence of existing controls to reduce exposures
- Number of employees involved
- Quantities of chemical being handled
- Routes of exposure (i.e., how the chemical enters the body)
- Occupational exposure limits

The Laboratory Standard allows flexibility in assessing the hazards presented in using particularly hazardous substances and choosing the control measures that best mitigate those hazards. The only baseline requirement for working with particularly hazardous substances is that consideration be given to the following provisions and that they be utilized when appropriate:

How To Fill Out the SSP , cont.

(1) establishment of a designated area (e.g., a room, section of a room, or hood);
(2) use of containment devices (e.g., a fume hood);
(3) establishment of contaminated waste removal procedures; and
(4) establishment of decontamination procedures.

(1) Administrative Controls

"Control areas" are required for the use of radioactive materials; similarly, "designated areas" (or "regulated areas") are required for the use of certain toxins. These area designations are merely a type of administrative control. Area posting, demarcations with floor tape or chains, access control, authorized use limitations, log-in procedures, etc. are all administrative control measures. Specific work practices that are required for safety assurance are also a type of administrative control, and a separate section of the SSP form (V-4) is available to describe these measures.

Requisite to any restricted area is the requirement that personnel working in the area be trained. Appendix 14 provides a check list to help staff ensure that all training topics have been covered. [A separate section of the Facility Notebook is assigned to outline training requirements and to provide documentation of the training.]

Establish designated areas to restrict carcinogen use/storage areas to authorized personnel. Post the areas and be sure that all containers of carcinogens bear a warning label. Do the same thing for reproductive toxins and substances having high levels of acute toxicity (e.g., toxic gases). Remember that maintenance and emergency personnel must be advised of the potential problems and hazards before entering these work or storage areas. [The use of designated areas is discussed in Section F.2 of this Plan, "Administrative Controls."]

How To Fill Out the SSP (Section V, cont.)

(2) Engineering Controls

Fume hoods or equivalent containment devices must be considered for handling "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity. Circumstances that may require the use of containment devices when using particularly hazardous chemicals include procedures where (1) the chemicals are volatile, (2) aerosol generation is possible, and (3) manipulations or chemical reactions could result in uncontrolled releases. In addition, if employees experience health effects or if the results of exposure monitoring establish that significant employee exposures are possible, a containment device is required.

Generally, the following procedures *require* a hood:

- Diluting concentrated acids and bases
- Using volatile toxic substances
- Using select carcinogens, reproductive toxins, or highly toxic compounds
- Conducting procedures that generate particulates (e.g., dust) or liquid aerosols (e.g., when vortexing) of even moderately toxic chemicals or potentially infectious materials (e.g., human blood)
- Synthesizing or reacting chemicals
- Using odiferous compounds (even if they are relatively safe)
- Using both infectious agents and hazardous chemicals together (requires a properly equipped biological safety cabinet).

Glove boxes are the norm for work with radioactive substances, and biosafety cabinets are often utilized for some radioactive isotopes and potentially infectious agents. List these types of controls. Also, describe any shielding equipment, warning devices, detectors, etc. that provide safety controls.

How To Fill Out the SSP (Section V, cont.)

[See "Hazard Control Measures" (Section F of this Plan) for a more information on the use of hoods; see "Exposure Monitoring," (Section I) for a discussion on hazard assessment and criteria for monitoring.]

(3) Personal Protective Equipment

Lab coats are standard for laboratory workers; and, hand protection is usually needed. Other types of personal protective equipment include safety glasses, safety goggles, face shields, boots, booties, Tyveks, lead aprons, hearing protection devices, and rubber aprons.

Consider the substances being used when specifying gloves. Know which chemicals being used are absorbed through the skin and assign gloves appropriate to the task. Often, more than one type of glove is necessary to protect workers for all procedures and/or operations conducted in an area. Consult Appendix 6 for help in selecting the appropriate gloves.

Specify the use of splash guards and rubber aprons for dispensing large amounts of toxins and corrosives.

Respirators are assigned through the Industrial Hygiene Group only, so if you feel that their use is appropriate, please contact the Respirator Program Coordinator at Ext. 4028.

(4) Specific Work Practices

This type of administrative control is listed separately on the SSP form because good work practices are critical in controlling exposures. Examples of specific work practices that are appropriate for many operations/procedures are listed below:

- Discard used gloves after each use and immediately after any obvious contact with a carcinogen. (Remember that the use of gloves often promotes the spread of contamination because workers fail to change them often enough.)

How To Fill Out the SSP (Section V, cont.)

- Transfer toxins in tightly closed containers placed within a durable outer container.
- Dissolve finely divided powdered carcinogens, if possible, into a liquid. This reduces the possibility of generating an aerosol.
- Use mixtures that are as dilute as possible.
- Keep all containers of highly volatile substances and/or toxic substances sealed when not in use.
- Don a lead apron and radiation badge.
- Wash hands between each patient.

VI. Medical Surveillance

A complete, confidential medical examination is required of all new career employees and those temporary workers hired for periods exceeding three months. Periodic examinations are offered every year at no cost to the employee. All employees are strongly encouraged to participate because it (1) establishes for them a baseline health status (valuable in detecting changes); (2) helps identify "at-risk" workers who may need better protection; (3) identifies those potentially exposed to certain toxic substances who may benefit from medical surveillance; and, (4) provides a good level of free, preventative medicine. Students, pregnant workers, and others who are concerned about their potential exposures are also eligible to contact Health Services for a medical consultation.

"Medical surveillance," which is medical monitoring to protect workers from specific hazards, is required under certain circumstances and for certain substances. Generally, employees identify the hazards in their assigned work areas during the medical evaluation. It is crucial that Health Services be notified of all changes in work assignments, work hazards, and incidents that may have resulted in significant exposures. Consult Section J of this Plan for more information.

How To Fill Out the SSP (Section VI, cont.)

All laboratories and shops must participate in a Carcinogen Exposure Assessment Survey. A Carcinogen Exposure Assessment Survey Form (Appendix 12) is to be completed by the Principal Investigator or Laboratory/Shop Supervisor to aid the Industrial Hygiene Group in assessing the potential for on-going and projected exposures to carcinogens. Principal investigators and Lab/Shop Supervisors are to track and submit the names of all personnel using carcinogens.

Refer to Health Services anyone who reports experiencing possible symptoms of exposure, anyone who asks for a medical consultation, and anyone suffering an illness or injury as a result of an accident. Pregnant workers should also make an appointment with Health Services.

VII. Spill Response/Decontamination

Generally, employees are instructed to contact EH&S (the Fire Department or the Division Office) when spills occur. However, other remedial actions might also be appropriate (e.g., extinguishing ignition sources, vacating the area, closing the sash, etc.). Specify on the SSP these pocedure-specific actions.

Small chemical spills are often handled at the scene by the regular staff, especially tiny spills/drips of a few mililiters or so. Small spills may be overlooked because workers don't recognize the importance in cleaning them up, or are unfamiliar with the best methods for doing so. Specify on the SSP what workers should do when tiny spills/drips occur (e.g., "Wipe with a paper towel and dispose in the hazwaste can, then rinse with water," "Call the Fire Dept. regardless of quantity," whatever). Another section of the Facility Notebook ("Emergency Procedures") deals with emergencies. General instructions for major spills can be listed in this section, as well as on the SSP.

Specific decontamination procedures may or may not be required. Decontamination is more than spill cleanup; decontamination may be required even when no known spill or release has occurred. For example, decontamination procedures are

How To Fill Out the SSP (Section VII, cont.)

warranted for the use of any carcinogen that could leave residual powders, dusts, or films. Decontamination may not be necessary for highly volatile substances (such as methylene chloride) when used in a hood because residual materials are unlikely.

When writing clean-up procedures for carcinogens or other highly toxic substances that are dusts, specify the use of a wet mop or vacuum cleaner equipped with a high efficiency particulate air (HEPA) filter. Do not dry sweep or dry mop toxic dusts.

To facilitate decontamination, specify that work surfaces (stainless steel or plastic trays) be covered with absorbent paper having a moisture-proof lining, or other impervious material. This can be a specified work practice under "Controls."

Protective covering materials are to be decontaminated or disposed of as hazardous waste.

Include protocols for decontaminating contaminated equipment. This is especially applicable for dusts and powders, and potentially biohazardous substances.

VIII. Waste Handling

List the anticipated waste types that will result from the operation/procedure:

- hazardous waste
- radioactive waste
- mixed (hazardous and radioactive) waste
- medical/biohazardous

Describe the waste handling procedures for the particularly hazardous substances (e.g., where they will be transferred, how they will be segregated and stored, and how they will be labeled). List the location of the Satellite Accumulation Area (SAA) that will be used.

Note: Separate sections of the Facility Notebook are provided to address waste handling and waste minimization.

SAMPLE
Specific Safety Procedure (SSP)
(p. 1 of 2, SSP # 4)

FACILITY: NONEXISTENT BUILDING DIVISION: LIFE SCIENCE DIVISION

BLDG. NO: 18 ROOM NO.(S): 11, 14 PI/ SUPER. INITIALS: TR DATE: 3/2/92

PRINCIPAL INVESTIGATOR/SHOP SUPERVISOR: MAX DONALD EXT: 6333

ALTERNATE RESPONSIBLE INDIVIDUAL: SUE SMITH EXT: 6334

I. Procedure/Operation *(describe)*:

Fixation of biologic tissue samples for microscopy.

II. Hazardous Materials (*Identify all radioactive substances biohazardous agents, chemicals, human blood products):*

- Formaldehyde, 37% solution (formalin)
- Methanol
- Acetone

III. Particularly Hazardous Materials/Agents Involved:

Materials	Quantity/Duration of Use
• Formaldehyde (a "select carcinogen")	• 500 ml/at one time every 2 wks.

IV. Hazard Analysis (*describe how the particularly hazardous materials/agents are used and how potential skin or inhalation exposure might occur):*
Exposures to formaldehyde will be kept as low as possible because all chemical dispensing, tissue fixing, and handling of newly fixed tissues will be conducted in the fume hood. Skin absorption will be prevented by wearing suitable gloves.

SAMPLE SSP continued

(p. 2 of 2 SSP # 4)

V. Controls:

(1) Administrative *(e.g. controlled areas for radiation, designated or regulated areas for carcinogens, storage requirements, worker rotation, specific training, etc.):*
All users must have received training in the generation of hazardous wastes, the generation of medical waste, Chemical Hygiene & Safety Training, and bench training. Carcinogen use is limited to the hood and the hood is posted to this effect. Store acetone & methanol. in flam. cabinet

(2) Engineering *(e.g. hoods, biosafety cabinets, etc.):*
Formalin solutions are to be used and dispensed in the laboratory fume hood to minimize worker exposure. Formalin may not be used in the biosafety cabinet.

(3) Personal Protective Equipment *(e.g. gloves, aprons, lab coats, respirators, etc.):*
- protective eyewear (e.g., safety glasses with side shields, goggles, or faceshield)
- lab coat, or lab coat and apron when dispensing large quantities (> 1 liter)
- neoprene or nitrile gloves ("Best" gloves for delicate work with tissue slides)

(4) Specific Work Practices *(e.g. type of disinfectant, use of centrifuge cups, leak checks, logging, etc.)*
- Decant waste in the hood prior to transfer to the WAA.
- Do not remove newly fixed tissues from the hood for at least two hours after fixing them. • Store flammables in flammable storage cabinets.
- Dispose of soiled gloves in the sealed dry waste container for hazardous waste to prevent "off-gassing." • Keep containers tightly closed.

VI. Medical Surveillance *(If appropriate)*:
Fill out a Carcinogen Exposure Assessment Survey form and return it to the Industrial Hygiene Group. This will identify all staff members who work with carcinogens. Also, refer anyone to Health Services who reports experiencing possible symptoms of exposure, including dermal sensitization.

VII. Spill response/decontamination:
In the event of a spill, shut off nearby ignition sources. If the spill is small, wear suitable personal protective equipment, contain the spill with absorbent clean-up material, and dispose of waste in the hazardous waste can. For large spills, contact EH&S.

VIII. Waste Handling *(define types generated, where deposited, etc.)*:
Follow protocols in PUB-3092 for generating hazardous waste. Label the formalin can with "Waste formaldehyde - Flammable, Carcinogen."

LAB/SHOP
SPECIFIC SAFETY PROCEDURE (SSP)
(p. 1 of 2, SSP #____)

FACILITY:_____ DIVISION:_____

BLDG. NO:_____ ROOM NO.(S):_____ PI/ SUPER. INITIALS:_____ DATE:_____

PRINCIPAL INVESTIGATOR/SHOP SUPERVISOR:_____EXT:_____

ALTERNATE RESPONSIBLE INDIVIDUAL:_____ EXT.:_____

I. Procedure/Operation *(describe)*:

_____

_____

I. Hazardous Materials (*Identify all radioactive substances, biohazardous agents, chemicals, human blood products):*

_____

_____

_____

_____

_____

III. Particularly Hazardous Materials/Agents Involved:

Materials	Quantity/Duration of Use

IV. Hazard Analysis (*describe how the particularly hazardous materials/agents are used and how potential skin or inhalation exposure might occur):*

_____

_____

_____

_____

_____

V. Controls:

(1) Administrative *(e.g. controlled areas for radiation, designated or regulated areas for carcinogens, storage requirements, worker rotation, specific training, etc):*

(2) Engineering *(e.g. hoods, biosafety cabinets, etc):*

(3) Personal Protective Equipment *(e.g. gloves, aprons, lab coats, respirators, etc.):*

(4) Specific Work Practices *(e.g. type of disinfectant, use of centrifuge cups, leak checks, logging, etc.)*

VI. Medical Surveillance *(If appropriate)*:

VII. Spill response/decontamination:

VIII. Waste Handling *(define types generated, where deposited, etc.)*:

Appendix 5

University of California Purchase Requisition

REQUESTED BY	BLDG. ROOM	DELIVERY TO BLDG. RM.	NOTIFY EXT.	HOLD FOR ACCT./J.O.

APPROVED BY	ACCOUNT NO.	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]RIZATION $10,000 [ ] $50,000 [ ] OVER [ ] SB [ ] BB [ ]

UNIVERSITY OF CALIFORNIA

PURCHASE REQUISITION

FOR CONTRACT NO. DE-AC03-76SF00098 WITH THE DEPARTMENT OF ENERGY

SEND WITH YELLOW, GREEN & PINK COPY TO PURCHASING

BUYER [redacted] CODE	ORDER NO.	REQ DATE DATE NEEDED
COST NOT TO EXCEED REFER BIDS TO	REQ. NO. 106208	TERMS: FROM RECEIPT OF GOODS OR INVOICE WHICHEVER IS LATER.

SHADED AREA FOR PURCHASING USE ONLY.

SELLER

Street

City State

Placed Date Contact

HAZARD REVIEW - At least one box must be checked:

[ ] Chemical	[ ] Laser	[ ] Service Contracts
[ ] Radiological	[ ] Microwave	[ ] Other Hazards
[ ] Biological	[ ] X-Ray	[ ] No Hazards

DATE MATERIAL RECEIVED:	PACKING LIST NO.
DATE OF INSPECTION	RECEIVAL & INSPECTION CERTIFIED BY:
CARRIER	DELIVERY RECEIPT NUMBER

COLUMNS BELOW FOR PURCHASING, RECEIVING AND ACCOUNTING.

REQUISITIONERS MAY USE PRICE COLUMNS IF TOTAL ORDER ESTIMATE EXCEEDS $1000.00

SHIP BY	SHIP FROM	F.O.B.	PROMISED DELIVERY TO CARRIER

ITEM NO.	LAB CATALOG NO. IF APPLICABLE	ITEM, SPECIFICATIONS, CATALOG REFERENCE	QUANTITY	UNIT PRICE	TOTAL PRICE	QUANTITY ACCEPTED AS ORDERED
[redacted]						
[redacted]						

REMARKS:

7600-55438
[redacted] REV. 10/85)

Authorized By

Appendix 6

Glove Selection Guides

Appendix 6

Glove Selection Guides

The Right Glove for the Job

The first step in choosing the right glove is determining your primary concern. Do you need protection from hazardous chemicals? Is dexterity crucial to your work? Is product protection of utmost importance?

Different glove materials offer different kinds of protection. Neoprene provides chemical/oil resistance while nitrile adds abrasion resistance to that protection. Vinyl gives you economical flexibility as a natural rubber alternative. Natural rubber latex offers inherent elasticity and resiliency, plus the dexterity needed in food processing or pharmaceutical manufacturing.

Because a materials suitability may be affected by either degradation or permeation, both factors must also be considered when selecting appropriate gloves. Degradation is the reduction in one or more of physical properties of a material due to chemical contact. Exposed gloves may swell, get harder or softer, stiffen or weaken or become brittle. Permeation is the passage of a chemical material even if the material is not susceptible to chemical attack. Permeation can occur even if there is no visible damage to the gloves being worn. Since there is usually no indication that a glove has been permeated, the person wearing gloves to handle hazardous chemicals can get a false sense of security.

The selection of appropriate gloves and other pieces of Chemical Protective Clothing (CPC) is generally done after consulting one or more chemical degradation guides. This appendix contains three such guides:

Guide #1	the physical properties of several materials.
Guide #2	the degradation properties of several materials.
Guide #3	the permeation properties of several materials.

The following listing will help you understand the various glove related terms used in the guides:

Natural Rubber: A material (also called latex) that is inherently elastic and resilient, plus resists acids, alkalies, salts and ketones. Natural rubber gloves are suited for food processing, electronics assembly and laboratory chemical handling.

Neoprene: A synthetic rubber developed as an oil-resistant substitute for natural rubber. It also resists a broad range of chemicals. Neoprene gloves are used in petrochemical, degreasing and refining applications, and when handling acids, caustics, alcohols and solvents.

Nitrile: A synthetic rubber with superior puncture and abrasion resistance in addition to chemical protection. Nitrile gloves are suited for stripping and degreasing, as well as acid etching and chemical washing.

PVC: Also known as polyvinyl chloride or vinyl, PVC is a plastic material that resists acids and alcohols, but not petroleum products. Vinyl gloves are used for intricate assembly work, food processing, laboratory, research, and pharmaceutical menu.

Viton: A specialy fluoroelastomer which has excellent resistance to oils, fuels, lubricants, most mineral acids, hydraulic fluids and aliphatic and aeromatic hydrocarbons.

CPE: This chlorinated polyethylene has increased resistance to oil, ozone, heat and chemicals. It also provides low permeability to gases.

Supported: A supported glove has a fabric liner that is coated with a polymer. The liner is generally knit, and can be palm-coated or fully coated. Supported gloves deliver more durable hand protection.

Unsupported: Refers to gloves produced by dipping a glove form directly into a compound, yielding a glove that is 100% compound. Unsupported gloves offer better tactile sensitivity and dexterity.

CHEMICAL RESISTANCE CHART

This Chemical Resistance Chart is offered as a general guide to chemical attack. The ratings are based upon data from laboratory tests and published literature from the various manufacturers of rubber and polymers.

To select the proper glove for your chemical handling application, you must test to determine which liquid-proof type is most suitable. First determine the chemical and physical conditions present, then choose the glove with the highest performance ratings for those conditions.

You are now ready to test your selection under actual use conditions. You must determine suitability based on your own performance requirements.

Special Note: All chemicals are potentially hazardous, and should therefore be handled with care. Many chemicals are highly toxic, or are considered known or suspected human carcinogens including some of those listed in the chart. The chart indicates only comparative resistance to the degrading effect of these chemicals. Permeation resistance is not considered in these ratings. Permeation can occur even if there is no visible damage to the glove.

As a general rule, gloves made by the cement dip process exhibit a greater resistance to permeation than gloves made by the latex dip process. Therefore, it is recommended that you select a cement dip glove for evaluation in applications involving the handling of toxic or carcinogenic (known or suspected) chemicals. All Viton, butyl, and natural rubber gloves made by North Hand Protection are manufactured by the cement dip process.

The information contained in this chart is advisory only. North assumes no responsibility for the suitability of particular user glove selections.

Key to Chemical Chart:

E. Excellent — Fluid has no effect
G. Good — Fluid has minor effect
F. Fair — Fluid has moderate effect
P. Poor — Fluid has severe effect, ranging from moderate to complete destruction
Blank — No data or insufficient evidence

Physical Performance Chart

PHYSICAL CHARACTERISTICS	NITRILE	BUTYL	NATURAL RUBBER	PVC	VITON
Abrasion Resistance	E	G	G	G	G
Cut Resistance	E	G	E	P	G
Puncture (Snag) Resistance	E	G	E	G	G
Flexibility	E	G	E	G	G
Heat Resistance	G	G	F	P	G
Ozone Resistance	F	G	P	E	E
Tensile Strength	E	G	E	F	G
Low Gas Permeability	P	E	F	P	E

Note Products in these categories vary in capabilities. Laboratory tests are necessary for specific recommendations.

	UNSUPPORTED				SUP-PORTED
CHEMICAL	VITON	NITRILE	BUTYL	NATURAL RUBBER	PVC
A					
Acetaldehyde	P	F	E	F	F
Acetic Acid	P	G	G	G	G
Acetone	P	P	E	G	P
Acrylonitrile	F	P	G	F	P
Aluminum Chloride	E	E	E	E	E
Ammonium Hydroxide	G	F	E	G	E
Amyl Acetate	P	P	E	F	P
Amyl Alcohol	G	G	E	G	—
Aniline	G	P	G	P	G
Animal Fats	E	E	G	P	G
B					
Benzaldehyde	P	P	E	F	F
Benzene	G	F	P	P	P
Benzyl Alcohol	E	P	G	P	—
Benzyl Chloride	E	P	F	P	—
Butane	E	E	P	P	P
Butyl Acetate	P	P	G	P	P
Butyl Alcohol	E	E	G	E	G
Butyraldehyde	P	P	G	P	G
C					
Calcium Hypochlorite	E	G	E	G	—
Carbolic Acid	E	P	G	P	—
Carbon Tetrachloride	E	G	P	P	P
Castor Oil	E	E	G	E	F
Chlorine (Dry)	G	P	F	P	—
Chlorine (Wet)	G	F	F	F	—
Chloroacetone	P	P	G	P	—
Chlorobenzene	E	P	P	P	P
Chloroform	E	P	P	P	P
Chromic Acid	E	P	P	P	G
Citric Acid	E	E	E	E	E
Cottonseed Oil	E	E	F	P	G
Creosote	E	G	P	P	G
Cutting Oil	E	E	F	F	F
Cyclohexane	E	E	P	P	F
Cyclohexanol	E	G	P	P	F
D					
Diacetone Alcohol	P	P	G	P	P
Dibenzyl	P	P	G	P	—
Dibutyl Phthalate	F	P	F	P	—
Diethylamine	P	F	G	F	F
Di-Isobutyl Ketone	—	P	E	G	P
Di-Isocyanate	—	G	—	P	F
Dimethyl Formamide	P	F	E	P	P
Dioxane	P	P	G	P	P
E					
Epoxy Resins	P	E	E	E	E
Ethyl Acetate	P	P	G	P	P
Ethyl Alcohol	G	E	E	E	G
Ethyl Ether	P	F	G	P	P
Ethyl Formate	E	P	G	P	P
Ethylene Dichloride	G	P	F	P	P
Ethylene Glycol	E	E	E	E	E
Ethylene Trichloride	E	P	F	P	—
F					
Fluorine	G	F	F	F	—
Formaldehyde	P	F	E	F	G

CHEMICAL	UNSUPPORTED VITON	NITRILE	BUTYL	NATURAL RUBBER	SUPPORTED PVC
F					
Formic Acid	F	F	E	E	E
Freon 11-12-21-22					
Freon 11	G	G	P	P	—
Freon 12	E	G	G	G	—
Freon 21	P	P	P	P	—
Freon 22	P	P	E	E	—
Furfural	P	P	G	P	P
G					
Gasoline	E	E	P	P	P
Glycerin	E	E	E	E	F
H					
Hexane	E	E	P	P	F
Hydraulic Fluid-Petroleum Base	E	E	P	P	G
Hydraulic Fluid-Ester Base	F	P	G	P	P
Hydrobromic Acid	E	P	E	E	—
Hydrochloric Acid 37%	E	G	E	G	G
Hydrofluoric Acid	G	F	G	F	F
Hydrogen Peroxide	E	F	G	F	F
Hydroquinone	G	F	P	G	F
I					
Isobutyl Alcohol	E	G	E	E	G
Iso-Octane	E	E	P	P	P
Isopropyl Alcohol	E	G	E	E	G
K					
Kerosene	E	E	P	P	F
L					
Lactic Acid	E	E	E	E	G
Lard	E	E	F	P	—
Linseed Oil	E	E	G	P	F
Lubricating Oils (Petroleum)	E	E	P	P	—
M					
Maleic Acid	E	P	P	P	G
Methyl Acetate	P	P	G	P	—
Methyl Alcohol	P	E	E	E	F
Methyl Bromide	E	G	F	F	P
Methyl Cellosolve	P	F	G	P	—
Methylene Chloride	G	P	F	P	P
Methyl Ethyl Ketone (M.E.K.)	P	P	E	G	P
Methyl Formate	—	P	G	P	—
Methyl Isobutyl Ketone	P	P	G	F	F
Methylamine	—	F	G	F	F
Methyl Methacrylate	P	P	F	P	F
Mineral Oil	E	E	P	P	F
Monoethanolamine	P	P	G	G	G
Morpholine	—	P	G	F	G
Muriatic Acid	—	G	E	G	G
N					
Naphtha	E	E	P	P	P
Nitric Acid — Concentrated	G	P	F	P	F
Nitric Acid — Diluted	G	F	F	F	G

CHEMICAL	UNSUPPORTED VITON	NITRILE	BUTYL	NATURAL RUBBER	SUPPORTED PVC
N					
Nitric Acid — Red Fuming	F	P	P	P	P
Nitrobenzene	G	F	P	P	P
Nitromethane	P	P	G	G	P
O					
Octyl Alcohol	E	G	G	G	F
Oleic Acid	G	F	P	P	F
Olive Oil	E	E	G	P	F
Oxalic Acid	E	G	E	G	G
P					
PCBs	E	F	P	P	P
Paint Remover	G	G	P	F	P
Pentane	E	E	P	P	P
Perchloric Acid	E	P	G	P	P
Perchloroethylene	E	F	P	P	P
Phenol	E	P	G	P	G
Phosphoric Acid	E	G	E	G	P
Pickling Solution	F	P	F	P	G
Picric Acid	E	G	G	G	G
Pine Oil	E	G	P	P	F
Plating Solutions — Chrome	E	E	E	G	E
Potassium Hydroxide (50%)	F	G	E	G	E
Printing Ink	—	E	—	G	F
Propane	E	E	P	P	F
Propyl Acetate	P	P	G	P	F
Propyl Alcohol	E	E	E	E	G
Propylene	E	P	P	P	—
S					
Skydrol 500	F	P	G	P	P
Sodium Hydroxide (50%)	G	G	E	E	E
Sodium Hypochlorite	E	G	E	G	—
Soybean Oil	E	E	F	P	—
Stearic Acid	—	G	G	G	G
Stoddard Solvent	E	E	P	P	F
Styrene	G	P	P	P	P
Sulfuric Acid (Diluted)	E	G	G	G	G
Sulfuric Acid (Concentrated)	E	P	G	P	F
T					
Tannic Acid	E	E	E	E	E
Tetrahydrofuran	P	P	G	P	P
Toluene	E	F	P	P	P
Toluene Di-Isocyanate	P	P	G	P	P
Trichlorethylene	E	F	P	P	P
Tricresyl Phosphate	G	P	E	P	P
Triethanol Amine	P	F	G	G	G
Trinitrotoluene	G	P	P	P	F
Tung Oil	E	E	F	P	F
Turbine Oil	E	G	P	P	P
Turpentine	E	E	P	P	F
V					
Vegetable Oil	E	E	E	P	F
Vinyl Chloride	G	—	—	—	—
X					
Xylene	E	F	P	P	P

CHEMICAL	PVC		PVC/NITRILE		NITRILE		NATURAL RUBBER		NEOPRENE	
	Breakthrough Time	Steady State Rate	Breakthrough Time	Steady State Rate	Breakthrough Time	Steady State Rate	Breakthrough Time	Steady State Rate	Breakthrough Time	Steady State Rate
Acetic Acid (16N)	4 hrs.	2	6 hrs.	0	6 hrs.	0	2 hrs.	–	6 hrs.	–
Acetone	18 min.	90	¼ hr.	52	⅓ hr.	80	6 min.	10	6 min.	12
Ammonium Hydroxide (22°Be)	¾ hr.	–	3 hrs.	–	6 hrs.	0	2 hrs.	–	6 hrs.	0
Amyl Acetate	½ hr.	8	50 min.	7	⅔ hr.	5	⅛ hr.	10	¼ hr.	11
Aniline	4 hrs.	1.4	6 hrs.	0	2½ hrs.	5	1 hr.	1	½ hr.	2
Benzene	½ hr.	40	¾ hr.	30	⅓ hr.	150	11 min.	66	¼ hr.	93
Butyl Acetate	20 min.	12	⅔ hr.	10	1⅓ hrs.	15	8 min.	36	¼ hr.	12
N-Butyl Alcohol (N-Butanol)	2 hrs.	2.5	6 hrs.	0	6 hrs.	0	2 hrs.	2	6 hrs.	0
Chlorothene	½ hr.	20	50 min.	16	2 hrs.	100	8 min.	150	⅛ hr.	130
Chromic Acid (10N)	6 hrs.	0	6 hrs.	0	6 hrs.	0	1⅙ hrs.	–	1¼ hrs.	–
Cyclohexane	⅔ hr.	36	3 hrs.	2	6 hrs.	0	6 min.	340	6 min.	180
Cyclohexanol	6 hrs.	0	6 hrs.	0	6 hrs.	0	25 min.	12	3 hrs.	10
Di-Isobutyl Ketone	1 hr.	1.4	1¼ hrs.	0.5	4¾ hrs.	5	¼ hr.	97	¼ hr.	75
Dimethyl Formamide	1 hr.	23	1½ hrs.	22	1 hr.	20	1 hr.	120	8 min.	16
Dimethyl Sulfoxide	50 min.	1	1⅓ hrs.	0.8	4⅓ hrs.	0.9	1⅓ hrs.	120	6 hrs.	0
Ethyl Acetate	20 min.	13	½ hr.	8	½ hr.	11	11 min.	9	⅛ hr.	8
Ethyl Alcohol (Ethanol, Grain Alcohol)	2½ hrs.	1	6 hrs.	0	6 hrs.	0	1½ hrs.	1	2 hrs.	0.5
Ethylene Glycol	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0
Ethyl Ether	20 min.	350	25 min.	310	2½ hrs.	14	10 min.	260	⅛ hr.	205
Furfural	1 hr. 10 min.	18	⅔ hr.	24	55 min.	26	¼ hr.	5	½ hr.	3
N-Hexane	25 min.	45	1½hrs.	7	6 hrs.	0	5 min.	125	⅔ hr.	96
Heptane	½ hr.	30	3 hrs.	3	6 hrs.	0	6 min.	117	¾ hr.	83
Hydrochloric Acid (1.16 sp. Gr.)	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0
Isobutyl Alcohol (Isobutanol)	2 hrs.	0.75	4 hrs.	0.8	6 hrs.	0	2 hrs.	0.75	6 hrs.	0
Isopropyl Alcohol	2hrs.10min.	2	6 hrs.	0	6 hrs.	0	1½ hrs.	2.1	2 hrs.	0.8
Methyl Alcohol (Methanol, Wood Alcohol)	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0
Methylene Chloride	6 min.	580	12 min.	440	3 hrs.	900	6 min.	300	5 min.	300
Methyl Ethyl Ketone (MEK)	16 min.	120	¼ hr.	101	⅓ hr.	82	6 min.	170	7 min.	120
Methyl Isobutyl Ketone	½ hr.	165	½ hr.	130	1⅔ hrs.	140	¼ hr.	70	¼ hr.	90
Monoethanolamine (Ethanolamine)	2 hrs.	1.3	5 hrs.	0.7	6 hrs.	0	4½ hrs.	1.1	6 hrs.	0
Nitric Acid (1.40 sp. Gr.)	3¾ hrs.	–	4½ hrs.	–	4 hrs.	–	2 hrs.	–	2 hrs.	–
N-Octane	55 min.	18	1¾ hrs.	12	6 hrs.	0	⅓ hr.	20	7 hrs.	36
Octyl Alcohol	6 hrs.	0	6 hrs.	0	6 hrs.	0	¾ hr.	1.7	6 hrs.	0
Oxalic Acid (water saturated solution)	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0
N-Pentane	⅓ hr.	35	1¼ hrs.	15	6 hrs.	0	5 min.	152	½ hr.	111
Perchloric Acid (1N)	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0
Perchloroethylene	¾ hr.	19	6⅛ hrs.	15	4 hrs.	1	6 min.	100	7 min.	95
Phenol	1⅓ hrs.	–	2 hrs.	–	⅔ hr.	–	35 min.	–	⅔ hr.	–
Phosphoric Acid (1.7 sp. Gr.)	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0
Potassium Hydroxide (30% solution)	6 hrs.	0	6 hrs.	0	6 hrs.	0	1⅓ hrs.	–	3 hrs.	–
N-Propyl Alcohol (N-propanol)	2 hrs.	1.5	6 hrs.	0	6 hrs.	0	1⅙ hrs.	1.5	1½ hrs.	1
Sodium Hydroxide (50% solution)	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0
Sodium Hypochlorite (30% solution)	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0
Sodiumhyposulfite (saturated solution)	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0	6 hrs.	0
Styrene	⅓ hr.	36	⅔ hr.	31	½ hr.	122	10 min.	58	⅛ hr.	86
Sulfuric Acid (1.83 sp. Gr.)	1¾ hrs.	–	4 hrs.	–	6 hrs.	0	1⅓ hrs.	–	2½ hrs.	–
Toluene	½ hr.	71	⅔ hr.	61	1 hr.	55	9 min.	106	9 min.	83
Trichloroethylene	⅓ hr.	209	½ hr.	207	⅓ hr.	184	6 min.	210	8 min.	193
Xylene	⅔ hr.	62	¾ hr.	55	1⅔ hr.	50	7 min.	74	8 min.	68

Chemical Resistance Selector Chart

	Coated Work Gloves						Molded Handwear			
	Neoprene and python gloves	Multi-purpose gloves	Utility gloves	Flexible vinyl plastic gloves	Ripple-texture gloves	Super-flexible vinyl plastic gloves	Natural-latex gloves	Latex-nitrile gloves	Synthetic bayprene gloves	Baytex gloves
ALCOHOLS										
Methanol/Butyl Alcohol/ Glycerine/Ethanol/ Isopropanol	E	E	E	E	G	E	G	E	E	G
CAUSTICS										
Ammonium hydroxide 38%/ Sodium hydroxide 50%/ Potassium hydroxide 50%	E	E	E	E	E	E	E	E	E	E
CHLORINATED SOLVENTS										
Carbon tetrachloride/Perchlor-ethylene/Trichlorethylene	G	F	F	F	NR	F	NR	E	G	NR
KETONES										
Methyl ethyl ketone/Methyl isobutyl ketone/Acetone	G	NR	NR	NR	G	NR	G	G	G	G
PETROLEUM SOLVENTS										
White gasoline/Naphtha/ Mineral thinner/Kerosene	E	G	G	E	F	G	F	E	E	F
ORGANIC ACIDS										
Citric/Formic/Tannic/Acetic	E	E	E	E	E	E	E	E	E	E
INORGANIC ACIDS										
Hydrochloric 38%/Hydrochloric 10%/Sulfuric 10%/Nitric 10%	E	E	E	E	G	E	G	E	E	G
Sulfuric 98%/Nitric 70%	F	G	G	G	NR	G	NR	G	F	NR
Chromic	E	G	G	E	NR	G	NR	E	E	NR
HYDROCARBONS										
Stoddard solvent/Toluene/ Benzene/Xylene	G	F	F	G	NR	F	NR	G	G	NR
Coal tar distillate	E	F	F	G	NR	F	NR	E	E	NR
Styrene	F	G	G	G	F	G	F	G	F	F
MISCELLANEOUS										
Lacquer thinner	F	F	F	G	NR	F	NR	G	F	NR
Cutting oil	E	E	E	E	F	E	F	E	E	F
Battery acid	E	E	E	E	G	E	G	E	E	G
Phenol	E	G	G	G	G	G	G	E	E	G
Insecticides	E	E	E	E	F	E	F	E	E	F
Printing ink	E	E	E	E	F	F	F	E	E	F
Dyestuffs	E	E	E	E	E	E	E	E	E	E
Pentane	G	E	E	E	F	E	F	E	G	F
Formaldehyde	E	E	E	E	E	E	E	E	E	E
Vegetable oil	E	E	E	E	G	E	G	E	E	G
Animal fat	E	E	E	E	G	E	G	E	E	G
Acrylonitrile	E	G	G	E	E	G	E	E	E	E
Steam	E	E	E	E	E	E	E	E	E	E
Aniline	E	E	E	E	E	E	E	E	E	E
Hydraulic fluid	E	E	E	E	F	E	F	E	E	F
Turpentine	G	E	E	E	F	E	F	E	G	F
Linseed oil	E	G	G	E	NR	G	NR	E	E	NR
Soy bean oil	E	G	G	E	F	G	F	E	E	F
Carbon disulfide	NR	F	F	F	G	F	G	F	NR	G
Creosote	G	G	G	G	F	G	F	E	G	F
Paint and varnish remover	F	F	F	F	NR	F	NR	E	F	NR

E = Excellent G = Good F = Fair NR = Not Recommended

Catalog No.	Description	Unit
	COVERALL, STEEL BLUE, DACRON, POLYESTER AND COTTON, 2 WAY ZIPPER, 2 CHEST POCKETS, ELASTICIZED WAIST INSERTS, PANTS HAVE 2 SIDE AND 2 BACK POCKETS, PLEATED BACK	
	SIZE	
8415-70616	40L	EA
8415-70617	42S	EA
8415-70618	42R	EA
8415-70619	42L	EA
8415-70620	44R	EA
8415-70621	44L	EA
8415-70622	46R	EA
8415-70623	46L	EA
	GLOVES, BUTYL RUBBER, SMOOTH, 14 IN. LONG, 32 MIL THICK, NORTH HAND PROTECTION NO. B-324	
	SIZE	
8415-70065	8	PR
8415-70066	9	PR
8415-70067	10	PR
8415-70068	11	PR
	GLOVES, CANVAS, COTTON, HEAVY, BOSS	
	SIZE OZ. MFR. NO.	
8415-28272	MENS LARGE 8 13021	PR
8415-47819	MENS LARGE 10 15021	PR
8415-28273	GLOVES, CANVAS, LEATHER PALM, LARGE, BOSS 9565	PR
8415-66175	GLOVE, COTTON, 9 OZ. NATURAL REVERSIBLE JERSEY, CAN BE TURNED INSIDE OUT AND WORN ON OPPOSITE HAND, MENS LARGE, CENTURY GLOVE NO. FF8506M-L	PR
8415-28274	GLOVES, COTTON, WHITE, MORTICIANS, REVERSIBLE, LARGE SIZE, CARDINAL GLOVE 605-L	PR
	GLOVES, COWHIDE, GUNN CUT, COUNTRY SQUIRE, BOSS NO. 5000	
8415-58101	MEDIUM	PR
8415-58102	LARGE	PR
	GLOVES, DISPOSABLE LATEX, SURGEONS TYPE, CLASS 100 CLEANROOM GRADE, 50 PAIR PER PACKAGE, AMERICAN SCIENTIFIC PROD. MFR.	
	SIZE MFR. NO.	
8415-68195	6 G7224-41	PG
8415-68196	7 G7224-43	PG
8415-68197	8 G7224-45	PG
8415-68198	9 G7224-47	PG
	GLOVES, DRY BOX, NEOPRENE GAUNTLET TYPE, 32 IN. LONG, SIZE 9-3/4, NORTH	
	CUFF IN. INCHES THICK MFR. NO.	
8415-28307	5 .015 5N-1532-975	PR
8415-28306	5 .030 5N-3032-975	PR
8415-62373	5 .015 5N-1532-S8-975	PR
8415-28308	8 .015 8N-1532-975	PR
8415-64593	8 .015 8N1532	PR
8415-28303	8 .030 8N-3032-975	PR
8415-45714	7-8 .015 7N-1532-975	PR
8415-57874	7 .030 7NY3032	PR
8415-45713	8 .030 8N-3032-975	PR
	GLOVES, LATEX RUBBER, BUFF EMBOSSED, GLOVER SL-866	
	SIZE	
8415-41576	8, MEDIUM	PR
8415-41577	9, LARGE	PR
	GLOVES, LATEX RUBBER, FLOCK LINED, 12 TO 14 IN. LENGTH, PLAYTEX	
	SIZE MFR. NO.	
8415-28311	7, SMALL 834	PR
8415-28312	8, MEDIUM 834	PR
8415-28313	9, LARGE 834L	PR

Catalog No.	Description	Unit
	GLOVES, LATEX RUBBER, FLOCK LINED, 12 TO 14 IN. LENGTH, PLAYTEX	
	SIZE — MFR. NO.	
8415-49806	10, EXTRA LARGE — 834XL	PR
	GLOVES, LEATHER, CREAM GRAIN COWHIDE, NAPA GLOVE CO.	
	SIZE	
8415-49220	9, MEDIUM	PR
8415-49219	10, LARGE	PR
8415-50328	11, EXTRA LARGE	PR
8415-66439	12	PR
8415-66440	13	PR
	GLOVES, LEATHER, GOATSKIN, WOMANS, NAPA GLOVE CO. 600 PG	
	SIZE	
8415-64074	8	PR
8415-64075	9	PR
	GLOVES, MILLED NEOPRENE, HEAVY DUTY, NON-SLIP GRIP	
	SIZE — IN. LONG — MFR./NO.	
8415-28314	9 — 14 — PIONEER N-54	PR
8415-28315	10 — 12 — PIONEER N-54	PR
8415-28316	10 — 18 — CHARCO N-198-R	PR
	GLOVES, MILLED NEOPRENE, LIGHT DUTY, NON-SLIP GRIP, 11 INCH LONG, PIONEER OR CHARCO	
	SIZE	
8415-28321	7 - 7-1/2, SMALL	PR
8415-28322	8 - 8-1/2, MEDIUM	PR
8415-28323	9 - 9-1/2, LARGE	PR
8415-28277	GLOVES, NEOPRENE COATED, HEAVY DUTY, WITH 12 IN. GAUNTLET	PR
	GLOVES, NEOPRENE, SMOOTH, 11 IN. LONG, 18 MIL THICK, EDMONT NO. 29-870	
	SIZE	
8415-70045	7 - 7-1/2	PR
8415-70046	8 - 8-1/2	PR
8415-70047	9 - 9-1/2	PR
8415-70048	10	PR
8415-70049	11	PR
	GLOVES, NEOPRENE, EMBOSSED, 12 IN. LONG, 19 MIL THICK, EDMONT NO. 29-875	
	SIZE	
8415-70050	8 - 8-1/2	PR
8415-70051	9 - 9-1/2	PR
8415-70052	10	PR
8415-70053	11	PR
	GLOVES, NITRILE, EMBOSSED, 15 IN. LONG, 22 MIL THICK, EDMONT NO. 37-165	
	SIZE	
8415-70054	7 - 7-1/2	PR
8415-70055	8 - 8-1/2	PR
8415-70056	9 - 9-1/2	PR
8415-70057	10	PR
8415-70058	11	PR
8415-56208	GLOVES, PLASTIC, TEXTURED, NONSTERILE, SINGLE, LARGE SIZE, 50/BOX, TOMAC NO. 22798-060	BX
	GLOVES, POLYETHYLENE, DISPOSABLE, W/LONG WRIST PROTECTION, 100/BOX, WILLSON "WILGARD" NO. 35-112 (FOR EITHER HAND)	
	SIZE	
8415-28282	SMALL	BX
8415-28283	MEDIUM	BX
8415-28284	LARGE	BX

Catalog No.	Description	Unit
8415-47982	GLOVES, POLYETHYLENE, DISPOSABLE, 3 MIL THICK, LARGE SIZE, 100/PG, HANDGARD PLASTICSMITH, INC.	PG
8415-58247	GLOVES, POLYETHYLENE, SHOULDER LENGTH, LARGE SIZE, 1-3/4 MIL., HANDGARD CATALOG NO. VET-S, 50 GLOVES/ROLL	RO

GLOVES, POLYVINYL ALCOHOL COATED WITH FABRIC LINERS, EDMONT-WILSON

Catalog No.	SIZE	MFR. NO.	Unit
8415-65688	SMALL	15-561	PR
8415-65687	LARGE	15-552	PR

GLOVES, PYLOX, 72 GLOVES/BOX, PIONEER V-5 QUIXAM

Catalog No.	SIZE	HAND	NO.	Unit
8415-64607	MEDIUM	LEFT	405125	BX
8415-64608	MEDIUM	RIGHT	405225	BX
8415-64609	LARGE	LEFT	405133	BX
8415-64610	LARGE	RIGHT	405232	BX

GLOVES, PYLOX, SHEER WEIGHT, TISSUE THIN, 10-1/2 IN. LONG, PIONEER MODEL V-10

Catalog No.	SIZE	Unit
8415-28285	MEDIUM	PR
8415-28286	LARGE	PR

GLOVES, PYLOX, PIONEER NO. V-20

Catalog No.	SIZE	Unit
8415-28287	MEDIUM	PR
8415-28288	LARGE	PR

GLOVES, SILVER SHIELD, 15 IN. LONG, 3 MIL THICK, 10 PRS./PKG., NORTH HAND PROTECTION

Catalog No.	SIZE	MFR. NO.	Unit
8415-70073	SMALL	SS104S	PG
8415-70074	MEDIUM	SS104M	PG
8415-70075	LARGE	SS104L	PG

GLOVES, SOLVENT RESISTANT, NBR (BUNA-N) RUBBER, 12 IN. LONG, EDMONT-WILSON

Catalog No.	SIZE	MFR.NO.	Unit
8415-62773	8	37-155	PR
8415-62770	10	37-155	PR
8415-62771	8	37-175, SOFT-LINED STYLE	PR
8415-62772	10	37-175, SOFT-LINED STYLE	PR

GLOVES, SURGEONS, LATEX DISPOSABLE, CLASS 100 CLEAN ROOM GRADE, AMBIDEXTROUS, 100 PER PKG., 10 PKGS. PER CASE, PACIFIC CLEAN ROOM SUPPLY

Catalog No.	SIZE	NO.	Unit
8415-70862	SMALL	LPF 95	CS
8415-70863	MEDIUM	LPF 9M	CS
8415-70864	LARGE	LPF 9L	CS

GLOVES, SURGEONS, LATEX WITH PINKED CUFF, WITHOUT POWDER ON OUTSIDE, CHLORINATED, 9 TO 12 MILS THICKNESS, EDMONT-WILSON

Catalog No.	SIZE	Unit
8415-53044	8	PR
8415-53046	9	PR

GLOVES, SURGICAL, NATURAL LATEX RUBBER, BROWN, AMERICAN PHARMASEAL

Catalog No.	SIZE	Unit
8415-28333	6-1/2	PR
8415-28334	7	PR
8415-28335	7-1/2	PR
8415-28336	8	PR
8415-28337	8-1/2	PR
8415-28338	9	PR

Catalog No.	Description	Unit
8415-68206	GLOVES, SURGICAL, RUBBER, SIZE 6, TRAVENOL 2D7151, AMERICAN PHARMASEAL NO. P8060	PR
	GLOVES, SYNTHETIC RUBBER, SURETY	
	WEIGHT / SIZE	
8415-28318	LIGHT / 9	PR
8415-28319	MEDIUM / 10	PR
8415-28320	MEDIUM / 11	PR
	GLOVES, UNSUPPORTED RUBBER, EMBOSSED, 13 IN. LONG, 18 MIL THICK, EDMONT NO. 36-124	
	SIZE	
8415-70060	7 - 7-1/2	PR
8415-70061	8 - 8-1/2	PR
8415-70062	9 - 9-1/2	PR
8415-70063	10	PR
8415-70064	11	PR
8415-70059	GLOVES, VINYL COATED, HEAVY DUTY PVC, 14 IN. LONG, MENS SIZE, EDMONT NO. 24-364	PR
	GLOVES, VINYL DISPOSABLE, 50 PR/BAG, OAK RUBBER 96	
	SIZE	
8415-64993	SMALL	PR
8415-64994	MEDIUM	PR
8415-64995	LARGE	PR
	GLOVES, VINYL IMPREGNATED COTTON, EDMONT-WILSON	
	SIZE / MFR. NO.	
8415-43820	MENS MEDIUM / 51-327	PR
8415-28275	MENS LARGE / 51-327	PR
8415-28276	WOMENS MEDIUM / 51-321	PR
	GLOVES, VINYL IMPREGNATED COTTON, FOAM INSULATED, WITH ELASTIC WRIST, EDMONT-WILSON 31-791	
	SIZE	
8415-57262	MEDIUM	PR
8415-57263	LARGE	PR
	GLOVES, VITON MATERIAL, FOR HANDLING PCB AND OTHER TOXIC MATERIALS, 10 MIL THICK, 11 IN. LONG, NORTON NO. F-101	
	SIZE	
8415-69377	8	PR
8415-69378	9	PR
8415-69379	10	PR
	GLOVES, VITON MATERIAL, FOR HANDLING PCB AND OTHER TOXIC MATERIALS, 14 IN. LONG, 12 MIL THICK, NORTON NO. F-124	
	SIZE	
8415-69380	8	PR
8415-69381	9	PR
8415-69382	10	PR
8415-70072	GLOVES, VITRON MATERIAL, 14 INCH LONG, 12 MIL THICK, SIZE 11, NORTH HAND PROTECTION NO. F-124	PR
	GLOVES, WELDING	
8415-68055	ELK HIDE LEATHER, LARGE SIZE, NAPA GLOVE NO. 67WT	PR
8415-28279	SPLIT LEATHER, SIZE 10, STEEL GRIP SC 13475	PR
8415-28280	LEATHER, CLUTE PATTERN, GAUNTLET CUFF, SIZE 10-1/2, NO. 1101	PR
8415-51008	TERRI-CORD, HEAT AND FLAME RESISTANT	PR
8415-70680	GLOVE, ZETEX, HEAT RESISTANT, NON-ASBESTOS, 14 IN., LINED WITH 10 OZ. WOOL, SARGENT WELCH CO. NO. S-40257-10	PR
8415-71339	GLOVE, ZETEX PLUS, HEAT RESISTANT, NON-ASBESTOS, 14 IN., NEWTEX INDUSTRIES, INC. NO. 20112-1400-ZP, (THESE ARE TO REPLACE 8415-70680)	PR

	Catalog No.	Description	Unit
	8415-28351	LINER, SAFETY HAT, COLD WEATHER HEAD AND EAR PROTECTION, MSA KD 86092	EA
	8415-28355	SLEEVE, PROTECTIVE, VINYL, 18 INCH WITH ELASTIC IN WRIST END ONLY, EDMONT-WILSON 54-103	PR
C2	8415-68718	SWEATSHIRT, PULLOVER, WITH HOOD (NO ZIPPERS), SIZE X-LARGE, COLORS GRAY OR BLUE, 50% COTTON	EA
		SWEAT SHIRTS, WHITE OR GRAY, CREW NECK, WITH LONG RAGLAN SLEEVES, HEAVY WEIGHT	
C	8415-43350	50% OR BETTER COTTON, MEDIUM	EA
C	8415-43351	90% OR BETTER COTTON, LARGE	EA
C	8415-43352	90% OR BETTER COTTON, EXTRA LARGE	EA
		T-SHIRTS, CREWNECK, WHITE, 100% COMBED COTTON, WITH NYLON REINFORCED NECK	
		SIZE	
C	8415-56062	MEDIUM	EA
C	8415-56064	LARGE	EA
C	8415-56066	EXTRA-LARGE	EA
		UNDERPANTS, THERMAL, EXTRA HEAVYWEIGHT, 100% COTTON, HEALTH KNIT STYLE 9055D	
		SIZE	
C	8415-56070	MEDIUM	EA
C	8415-56071	LARGE	EA
C	8415-56072	EXTRA LARGE	EA
		UNDERSHIRTS, THERMAL, EXTRA HEAVYWEIGHT, 100% COTTON, HEALTH KNIT STYLE 9055L	
		SIZE	
C	8415-56067	MEDIUM	EA
C	8415-56068	LARGE	EA
C	8415-56069	EXTRA LARGE	EA
		UNDERSHORTS, WHITE COTTON, BOXER TYPE, ELASTIC TOPS	
		SIZE	
C	8415-56074	28 TO 30 SMALL	EA
C	8415-56076	32 TO 34 MEDIUM	EA
C	8415-56078	36 TO 38 LARGE	EA
C	8415-65229	40 TO 42 EXTRA LARGE	EA

GROUP-CLASS 8430 FOOTWEAR

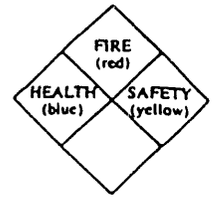
	8430-45692	BOOTIES, CLEAR PLASTIC, ANKLE HIGH WITH TWO SNAPS, HEAVY SOLES, MENS LARGE SIZE	PR
		BOOTIES, YELLOW PLASTIC, .006 IN. TOP, .008 IN. SOLE	
		SIZE IN. LONG	
	8430-28360	SMALL 12	PR
	8430-28361	LARGE 13	PR
	8430-68502	EXTRA LARGE 14	PR
		BOOTIES, WHITE PLASTIC FILM, DISPOSABLE	
		SIZE	
	8430-65662	LARGE	PR
	8430-70613	EXTRA LARGE	PR
	8430-68199	SHOE COVER, DISPOSABLE, NON-WOVEN FABRIC, CLASS 100 CLEANROOM GRADE, ONE SIZE FITS ALL, 50 PAIR/PACKAGE, AMERICAN SCIENTIFIC NO. A6100-10	PG
C	8430-62628	SOCKS, CREW, STRETCH, WHITE COTTON, CUSHION FOOT, NYLON REINFORCED HEEL AND TOE, SIZE 10 TO 13	PR

Appendix 7

Labeling Information

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) LABELS

	Identification of Health Hazard Color Code: Blue		Identification of Flammability Color Code: Red		Identification of Reactivity (Stability) Color Code: Yellow
	Type of Possible Injury		**Susceptibility of Materials to Burning**		**Susceptibility to Release of Energy**
4	Materials which on very short exposure could cause death or major residual injury even though prompt medical treatment were given.	4	Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily.	4	Materials which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.
3	Materials which on short exposure could cause serious temporary or residual injury even though prompt medical treatment were given.	3	Liquids and solids that can be ignited under almost all ambient temperature conditions.	3	Materials which in themselves are capable of detonation or explosive reaction but require a strong initiating source or which must be heated under confinement before initiation or which react explosively with water.
2	Materials which on intense or continuous exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.	2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.	2	Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. Also materials which may react violently with water or which may form potentially explosive mixtures with water.
1	Materials which on exposure would cause irritation but only minor residual injury even if no treatment is given.	1	Materials that must be preheated before ignition can occur.	1	Materials which in themselves are normally stable, but which can become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently.
0	Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material.	0	Materials that will not burn.	0	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.



Catalog No.	Description	Unit
4270-34810	LENS, WELDING, GLASS, CLEAR, PLASTIC COATED, 2 X 4-1/4 IN., THERMACOTE-WELCO	EA
4270-44547	LENS, WELDING, PLASTIC COVER PLATE, PLASTIC, CLEAR, 2 X 4-1/4 IN., U.S. SAFETY SERVICE	EA
4270-46369	SAFETY GLASSES CLEANING PAPER, NO SILICONE, 760 SHEETS PER PKG	PG
4270-46368	SAFETY GLASSES CLEANING STATION, HEAVY DUTY, COMPLETE, AMERICAN OPTICAL	EA
4270-61422	WELDERS MASK GOGGLES, WITH 50MM ROUND LENSES, SOFT SIDES, AMERICAN OPTICAL NO. 486B	PR

GROUP-CLASS 4280 SAFETY LABELS, SIGNS AND TAGS

LABEL, FOR HAZARD AREA I.D. SYSTEM, SELF-ADHESIVE, LAB SAFETY SUPPLY

	LEGEND	NUMBER	
4280-71381	AUTHORIZED PERSONNEL ONLY	RA-596-32	EA
4280-71382	DO NOT ENTER	RA-596-4	EA
4280-71383	NO SMOKING	RA-596-5	EA
4280-71384	WEAR SAFETY GOGGLES	RA-596-6	EA
4280-71385	NO EATING OR DRINKING	RA-596-7	EA
4280-71386	KEEP OUT	RA-596-8	EA
4280-71387	WEAR FACE PROTECTION	RA-596-9	EA
4280-71388	RESPIRATOR REQUIRED	RA-596-10	EA
4280-71389	WEAR SAFETY GLASSES	RA-596-11	EA
4280-71390	CORROSIVE MATERIALS	RA-596-12	EA
4280-71391	TOXIC CHEMICALS	RA-596-13	EA
4280-71392	FLAMMABLE SOLVENTS	RA-596-14	EA
4280-71393	HAZARD RATING	RA-596-15	EA
4280-71394	HIGH VOLTAGE	RA-596-17	EA
4280-71395	ELECTRICAL HAZARD	RA-596-18	EA
4280-71396	ULTRAVIOLET LIGHT	RA-596-19	EA
4280-71397	EXPLOSIVE	RA-596-20	EA
4280-71398	MICROWAVE RADIATION	RA-596-21	EA
4280-71399	LASER LIGHT	RA-596-22	EA
4280-71400	WEAR PROTECTIVE CLOTHING	RA-596-23	EA
4280-71401	INFECTIOUS AGENT	RA-596-24	EA
4280-71402	BIOHAZARD	RA-596-25	EA
4280-71403	CANCER HAZARD	RA-596-26	EA
4280-71404	RADIOACTIVE MATERIAL	RA-596-27	EA
4280-71405	PROTECTIVE EQUIPMENT, HAZARD RATING	RA-596-35	EA
4280-71406	TOXIC GAS	RA-596-16	EA
4280-71407	RADIATION HAZARD	RA-596-28	EA
4280-71408	LABORATORY ANIMALS	RA-596-29	EA
4280-71409	EAR PROTECTION REQUIREED	RA-596-30	EA
4280-71410	CHEMICAL STORAGE AREA	RA-596-31	EA

4280-67348	LABEL, HAZARD CONTROL, (H-C HOOD SURVEY - SATISFACTORY - UP TO - INCHES FROM FACE PLATE - CHECKED BY), SELF-STICKING, WRITE-ON SURFACE, WATER/WEATHER PROOF, BLACK ON WHITE OR BLACK ON YELLOW, APPROX. 3-1/2 X 1-1/2 IN.	EA

LABEL, HAZARDOUS AND RADIOACTIVE MIXED WASTE, BLACK ON YELLOW, TYVEK MATERIAL, 200 PER ROLL

	INCHES	
4280-70977	6 X 6	EA
4280-71111	6 X 6, SITE 300 ONLY, 100 PER ROLL	EA
4280-70978	7 X 11	EA

4280-71357	LABEL, HAZARD IDENTITY WRITE-ON, IDENTIFY CHEMICALS, WITH NAME, OWNER, DATE AND HAZARD RATING, 1-1/2 X 3-7/8 IN., 1000/ROLL, LAB SAFETY RA-706	RO

Catalog No.	Description	Unit
	LABEL, HAZARD RATING CHEMICAL, COLOR-CODED, FILL IN INFORMATION, SELF-ADHESIVE, 100 PER PAD, LAB SAFETY	
	IN. NO.	
4280-71352	2 X 2 RA-552	PD
4280-71353	4 X 4 RA-553	PD
	LABEL, HAZARD RATING, POLYESTER OVERLAY TO PROTECT LABELS, SELF-ADHESIVE, 100 PER PAD, LAB SAFETY	
	IN. NO.	
4280-71354	2-1/2 X 2-1/2 RA-554	PD
4280-71355	4-1/2 X 4-1/2 RA-555	PD
	LABEL, HAZARDOUS RETENTION TANK WASTE, BLACK ON YELLOW, TYVEK MATERIAL, 200 PER ROLL	
	INCHES	
4280-70981	6 X 6	EA
4280-71113	6 X 6, SITE 300 ONLY, 100 PER ROLL	EA
4280-70982	7 X 11	EA
	LABEL, HAZARDOUS WASTE, RED AND WHITE, TYVEK MATERIAL, 200 PER ROLL	
	INCHES	
4280-70983	6 X 6	EA
4280-71110	6 X 6, SITE 300 ONLY, 100 PER ROLL	EA
4280-70984	7 X 11	EA
	LABEL, RADIOACTIVE WASTE, BLACK ON YELLOW, TYVEK MATERIAL, 200 PER ROLL	
	INCHES	
4280-70979	6 X 6	EA
4280-71112	6 X 6, SITE 300 ONLY, 100 PER ROLL	EA
4230-70980	7 X 11	EA
	LABEL, SAFETY, CARCINOGENIC HAZARDS, PRESSURE SENSITIVE, BLACK LEGEND ON RED BACKGROUND, 100 PER ROLL	
4280-64467	DANGER CARCINOGENIC WASTE, 5 X 6 IN.	RO
4280-64462	DANGER CHEMICAL CARCINOGEN, 1 X 3 IN.	RO
	LABEL, SAFETY, CAUTION, PRESSURE SENSITIVE, WATER-PROOF, BLACK LEGEND ON YELLOW BACKGROUND, 7 X 4 INCH	
4280-69388	A-9 ALUMINUM CUTTING TOOL FLUID----	EA
4280-69389	COOL-TOOL CUTTING OIL----	EA
4280-69958	**LABEL, SAFETY, CAUTION, PRESSURE SENSITIVE ADHESIVE, LEGEND (CAUTION - HOT SURFACE), BLACK LETTERS ON YELLOW BACKGROUND, .002 IN. THICK BRIGHT SILVER MAYLAR, 2-1/2 X 3-1/2 INCHES**	EA
	LABEL, SAFETY, CAUTION, PRESSURE SENSITIVE ADHESIVE, CAUTION - IN YELLOW LETTERS ON BLACK BACKGROUND LEGEND - IN BLACK LETTERS ON YELLOW BACKGROUND	
	SIZE-IN. LEGEND - CAUTION	
4280-69974	1.5 X 1 - MULTIPLE POWER SOURCES TEST FOR ALL VOLTAGES, 25/PKG.	PG
4280-67194	2 X 3-1/2 - WEAR EYE PROTECTION WHILE OPERATING	EA
4280-67092	3 X 5 - DO NOT STORE FOOD OR BEVERAGE IN THIS REFRIGERATOR	EA
4280-67091	3 X 5 - EQUIPMENT CONTAINS PCB	EA
4280-64646	3 X 5 - (LEGEND SPACE BLANK)	EA
4280-67088	4 X 5-1/2 - SINK CONNECTED TO SANITARY SEWER	EA
4280-67081	4 X 7 - ACID WASTE ONLY	EA
4280-67080	4 X 7 - CAUSTIC (BASE) WASTE ONLY	EA
4280-67079	4 X 7 - ORGANIC WASTE SOLVENTS ONLY	EA
4280-69975	4.5 X 3 - MULTIPLE POWER SOURCES TEST FOR ALL VOLTAGES, 25/PKG.	PG
4280-64647	7 X 10 - (LEGEND SPACE BLANK)	EA

Catalog No.	Description	Unit

LABEL, SAFETY, CAUTION, LEGEND - "DO NOT TURN OFF/ON-OFF", SELF-ADHERING PAPERBOARD, COLOR ORANGE
INCHES

4280-34900	1-1/8 X 4-5/8	EA
4280-50172	2-1/2 X 5-1/4	EA

4280-67090	LABEL, SAFETY, CHEMICAL HAZARDS, SELF-ADHERING, LEGEND NON-PCB, 3 X 5 IN., WHITE LEGEND ON BLUE BACKGROUND	EA

LABEL, SAFETY, CHEMICAL HAZARDS, SELF-ADHERING, CAUTION - CONTAINS POLYCHLORINATED BIPHENYLS (PCBS), HCL CO.
INCH

4280-64776	1 X 2	EA
4280-64775	6 X 6	EA

LABEL, SAFETY, CHEMICAL HAZARDS, WATERPROOF PLASTIC COATED FABRIC MATERIAL, SELF-ADHERING, BLACK LEGEND ON YELLOW BACKGROUND

	SIZE/IN.	LEGEND	
4280-45113	2 X 3	ACETONE	EA
4280-45114	4 X 7	ACETONE	EA
4280-46521	2 X 3	ACIDS-GENERAL AND MISCELLANEOUS	EA
4280-46522	4 X 7	ACIDS-GENERAL AND MISCELLANEOUS	EA
4280-51249	3 X 5	E-ALCOHOL	EA
4280-51250	4 X 7	E-ALCOHOL	EA
4280-51251	4 X 7	M-ALCOHOL	EA
4280-34846	3/4 X 1-1/2	CONTAINS BERYLLIUM	EA
4280-53190	2 X 3	ETHYL ALCOHOL, 190 PROOF	EA
4280-53191	2 X 3	ETHYL ALCOHOL, 200 PROOF	EA
4280-45120	4 X 7	GASOLINE	EA
4280-45133	2 X 3	ISOPROPYL ALCOHOL	EA
4280-46518	4 X 7	ISOPROPYL ALCOHOL	EA
4280-46519	2 X 3	KEROSINE	EA
4280-45122	4 X 7	KEROSENE	EA
4280-51256	4 X 7	LACQUER THINNER	EA
4280-45123	2 X 3	MERCURY	EA
4280-45124	4 X 7	MERCURY	EA
4280-45125	2 X 3	METHYL ETHYL KETONE	EA
4280-45126	4 X 7	METHYL ETHYL KETONE	EA
4280-51257	3 X 5	PERCHLOROETHYLENE	EA
4280-45127	2 X 3	PERCHLOROETHYLENE	EA
4280-46523	2 X 3	POISONS AND OTHER MISC. SOLUTIONS	EA
4280-46525	2 X 3	WARNING-FLAMMABLE VAPOR HARMFUL	EA
4280-46526	4 X 7	SOLVENTS GENERAL	EA
4280-51258	4 X 7	TOLUENE	EA
4280-45130	2 X 3	TRICHLOROETHYLENE	EA
4280-46520	4 X 7	TRICHLOROETHYLENE	EA
4280-45131	2 X 3	1-1-1 TRICHLOROETHANE	EA
4280-45132	4 X 7	1-1-1 TRICHLOROETHANE /METHYL CHLOROFORM VYTHENE/	EA
4280-71125	6 X 6	PCB CONTAMINATED, CONTAINS 5 TO LESS THAN 500 PPM	EA
4280-71126	6 X 6	NON-PCB, CONTAINS LESS THAN 5 PPM	EA

LABEL, SAFETY CHEMICAL HAZARDS, WATER PROOF PLASTIC COATED SELF-ADHERING, BLACK LEGEND ON YELLOW BACK GROUND

	LEGEND	IN.	
4280-67676	FLUOROCARBON TF SOLVENT	2 X 3	EA
4280-67677	FLUOROCARBON TF SOLVENT	4 X 7	EA

LABEL, SAFETY, CHEMICAL HAZARDS W/SYMBOL, PLASTIC COATED, SELF-ADHERING, BLACK LEGEND ON YELLOW BACKGROUND

	LEGEND	IN.	
4280-45117	BENZENE	2 X 3	EA
4280-45118	BERYLLIUM	2 X 3	EA
4280-45119	CARBON TETRACHLORIDE	2 X 3	EA

4280-67347	LABEL, SAFETY, DANGER, PRESSURE SENSITIVE, WATER-PROOF, WRITEABLE (DANGER - CANCER-SUSPECT AGENT, DATE - COMPOUND - CONCENTRATION), DANGER - IN WHITE LETTERS IN RED OVAL FIELD ON BLACK BACKGROUND, LEGEND IN BLACK LETTERS ON WHITE BACKGROUND, 1 X 3 IN.	EA

Catalog No.	Description	Unit

LABEL, SAFETY, DANGER, FOR SWITCHES, SELF-ADHERING PAPERBOARD, UPPER LEGEND-DANGER, IN WHITE LETTERS ON RED FIELD ON BLACK BACKGROUND, LOWER LEGEND-DO NOT TURN ON, IN BLACK LETTERS ON WHITE BACKGROUND.

	INCH	
4280-34899	1-1/8 X 4-1/2	EA
4280-34901	2-1/2 X 5-1/4	EA

LABEL, SAFETY, DANGER, PRESSURE SENSITIVE ADHESIVE, DANGER - IN WHITE LETTERS IN RED OVAL FIELD ON BLACK BACKGROUND, LEGEND IN BLACK LETTERS ON WHITE BACKGROUND

	SIZE-IN.	LEGEND - DANGER	
4280-70012	7 X 10	- ASBESTOS, CANCER AND LUNG DISEASE HAZARD, AURTHORIZED PERSONNEL ONLY, RESPIRATOR AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA	EA
4280-65094	3 X 5	- CONTAINS ASBESTOS FIBERS, AVOID CREATING DUST, CANCER AND LUNG DISEASE HAZARD	EA
4280-67479	3 X 5	- EXPOSED LIVE ELECTRICAL PARTS BEHIND THIS ENCLOSURE-KEEP OUT	EA
4280-67480	3 X 5	- EXPOSED LIVE ELECTRICAL PARTS PARTS LOCATED HERE - KEEP AWAY	EA
4280-64638	1 X 1-1/2	- HIGH VOLTAGE	EA
4280-64639	2 X 3	- HIGH VOLTAGE	EA
4280-64640	3 X 5	- (LEGEND SPACE BLANK)	EA
4280-64641	3 X 5	- HIGH VOLTAGE - UNAUTHORIZED PERSONNEL KEEP OUT	EA
4280-64642	4 X 7	- THIS MACHINE STARTS AUTOMATICALLY - KEEP CLEAR	EA
4280-64643	7 X 10	- (LEGEND SPACE BLANK)	EA
4280-64644	7 X 10	- HIGH VOLTAGE - UNAUTHORIZED PERSONNEL KEEP OUT	EA

4280-34906	LABEL, SAFETY, GENERAL PURPOSE, SELF-ADHERING PLASTIC CLOTH, WHITE LETTERS ON RED BACKGROUND, LEGEND - KEEP CLEAR AT ALL TIMES, 6 X 9 IN.	EA

LABEL, SAFETY, GENERAL PURPOSE, SELF-ADHERING VINYL PLASTIC, PER USASI SPEC Z53.1 AND Z35.1, THE MABI CO.

	SIZE-INCHES	QUANTITY PER SHT	LEGEND	
4280-57575	1-1/8 X 4-1/2	4	120 VOLTS	SH
4280-57576	1-1/8 X 4-1/2	4	208 VOLTS	SH
4280-57577	1-1/8 X 4-1/2	4	240 VOLTS	SH
4280-57578	1-1/8 X 4-1/2	4	480 VOLTS	SH
4280-57574	2-1/4 X 4-1/2	2	DANGER HIGH VOLTAGE	SH
4280-57579	2-1/4 X 9	1	DOOR INTERLOCKED	SH

LABEL, SAFETY, GENERAL PURPOSE, SELF-ADHERING VINYL PLASTIC, PER USASI SPEC Z53.1 AND Z35.1, THE MABI CO., 50 PER ROLL

	SIZE-IN.	LEGEND	
4280-57569	1-1/2 X 3	DANGER HIGH VOLTAGE	RO
4280-57570	5/8 X 3	120 VOLTS	RO
4280-57571	5/8 X 3	208 VOLTS	RO
4280-57572	5/8 X 3	240 VOLTS	RO
4280-57573	5/8 X 3	480 VOLTS	RO

LABEL, SAFETY, NOTICE, PRESSURE SENSITIVE ADHESIVE, NOTICE - IN WHITE LETTERS ON BLUE BACKGROUND LEGEND - IN BLACK LETTERS ON WHITE BACKGROUND

	SIZE-IN.	LEGEND - NOTICE	
4280-64649	3 X 5	- (LEGEND SPACE BLANK)	EA
4280-67087	4 X 5-1/2	- SINK CONNECTED TO WASTE RETENTION SYSTEM	EA
4280-64651	4 X 7	- NO OBSTRUCTION WITHIN 36 IN.	EA
4280-64652	7 X 10	- (LEGEND SPACE BLANK)	EA

LABEL, SAFETY, PLASTIC FILM, 3 IN. X 1000 FT. ROLLS, YELLOW COLOR, BLACK LETTERING, GRIFFOLYN (BANNER GUARD)

	LEGEND - CAUTION	
4280-65028	- CONSTRUCTION AREA	RL
4280-71073	- HIGH VOLTAGE	RO
4280-65029	- HARD HAT AREA	RL

Catalog No	Description	Unit
4280-70084	LABEL, SAFETY, HAZARDOUS WASTE, SELF-ADHESIVE, 6 X 6 INCHES, VINYL WITH ULTRA VIOLET INK TO GUARD AGAINST FADING, 2-COLOR, DARK RED AND BLACK LETTERING ON WHITE BACKGROUND	EA
4280-56938	LABEL, SAFETY, HIGH VOLTAGE, PRESSURE SENSITIVE, STANDARD COLOR - LETTERS IN RED ON WHITE AND BLACK BACKGROUND. LETTERS 1 IN. HIGH SIZE 5-1/4 X 2-1/2 IN., 100 PER PAD, THE MABI CO.	PD
4280-70085	LABEL, SAFETY, WASTE CONTINUATION, SELF-ADHESIVE, 6 X 6 INCHES, VINYL WITH ULTRA VIOLET INK TO GUARD AGAINST FADING, 1-COLOR, BLACK LETTERS ON WHITE BACKGROUND	EA
4280-67086	LABEL, SAFETY, PRESSURE SENSITIVE, ARROWS (DIRECTIONAL), 1/4 X 1 IN., BLACK ARROWS ON YELLOW BACKGROUND, 81 ARROWS PER SHEET	SH
4280-70758	LABEL, PRESSURE SENSITIVE, LEGEND - DO NOT RETURN THIS CHEMICAL TO STORES - YELLOW BACKGROUND WITH BLACK LETTERING, 1 IN. HIGH X 2 IN. LONG, 100/RO	RO
4280-67084	LABEL, SAFETY, PRESSURE SENSITIVE, 1-1/2 X 3-5/8 IN., LEGEND H.C. HOOD SURVEY UNSATISFACTORY, BLACK ON WHITE AND YELLOW BACKGROUND	EA
4280-67083	LABEL, SAFETY, PRESSURE SENSITIVE, 3 X 3-1/2 IN., LEGEND H.C. HOOD SURVEY - SATISFACTORY AVERAGE FACE VELOCITY, BLACK ON WHITE BACKGROUND, 3 LABELS PER SHEET	SH
4280-67082	LABEL, SAFETY, PRESSURE SENSITIVE, 4-1/2 X 3-1/2 IN., LEGEND H.C. HOOD SURVEY - SATISFACTORY UNDER FOLLOWING CONDITIONS, BLACK ON WHITE BACKGROUND, 2 LABELS PER SHEET	SH
4280-67085	LABEL, SAFETY, PRESSURE SENSITIVE, 4-1/2 X 3-1/2 IN., LEGEND H.C. HOOD SURVEY - SATISFACTORY UNDER FOLLOWING CONDITIONS, BLACK ON YELLOW BACKGROUND, 2 LABELS PER SHEET	SH
4280-56959	LABEL, SAFETY, RADIOACTIVE MATERIAL ISOTOPE, WITH RADIATION SYMBOL, ATOMIC PRODUCTS CORP., N.Y., CAT. NO. WT-12, 1 X 2 IN.	RO
4280-56957	LABEL, SAFETY, RADIOACTIVE MATERIAL, LEGEND - CAUTION CONTAMINATION HAZARD - DO NOT TOUCH - RADIOACTIVE MATERIAL - WITH RADIATION SYMBOL, 2-1/4 X 9 IN.	EA
	LABEL, SAFETY, SELF-ADHERING, VINYL PLASTIC, SUN AND RAIN RESISTANT, PERMANENT COLORS	
	SIZE-IN. LEGEND	
4280-58027	10 X 14 EXIT	EA
4280-58028	14 X 6-1/2 EXIT (WITH ARROW LEFT)	EA
4280-58029	14 X 6-1/2 EXIT (WITH ARROW RIGHT)	EA
4280-58031	14 X 3-1/2 FIRE EXTINGUISHER (WITH ARROW DOWN)	EA
4280-58035	10 X 7 NOTICE - EMERGENCY USE ONLY	EA
4280-34849	LABEL, TAPE, PRESSURE SENSITIVE, 1-3/4 X 5 IN., PEEL OFF, LEGEND - RADIATION SYMBOL, 500 LABELS PER PACKAGE	PG
4280-34844	LABEL, TAPE, SELF-ADHERING, YELLOW, 3/4 IN. HIGH, 1 IN. WIDE X 180 FT LONG, MAGENTA IMPRINT RADIOACTIVE WITH SYMBOL, LENGTH OF IMPRINT 3-1/2 IN.	RO
4280-69620	LABEL, TELEPHONE, EMERGENCY PHONE NUMBER AND LOCATION, 2 IN. WIDE X 1-7/8 IN. HIGH, 250 LABELS PER ROLL	RO
4280-63326	SIGN, ADMINISTRATIVE ESCORT, BARRICADE, /VISITOR UNCLASSIFIED DISCUSSIONS ONLY/ 18 X 24 IN., W/ PLASTIC LEGS, PORT-A-CADE SALES MODEL P-24	EA

Catalog No.	Description	Unit

SIGN, FOR HAZARD AREA I.D. SYSTEM, RIGID VINYL, LAB SAFETY SUPPLY

	LEGEND	NUMBER	
4280-71378	CAUTION	RA-596-33	EA
4280-71379	DANGER	RA-596-43	EA
4280-71380	NOTICE	RA-596-53	EA

4280-34831 SIGN, HAZARD CONTROL, 10 X 14 IN. WHITE PAPERBOARD, HAZARDS CONTROL CIRCULAR SYMBOL AND LEGEND, HAZARDS CONTROL PRINTED IN BLACK ACROSS TOP EDGE — EA

4280-71351 SIGN, HAZARDOUS MATERIALS CLASSIFICATION, NFPA RATING, SELF-ADHESIVE VINYL, 8 X 11 IN., LAB SAFETY RA-7171 — EA

SIGN, NOTICE TO SMOKERS

4280-62874	NO SMOKING PLEASE, 9 X 5-1/16 IN., PLASTIC, LEGEND IN BLACK AND WHITE, 2 TAPE STRIPS ON BACK TO ADHERE TO WALL, UNFRAMED ROUND CORNERS	EA
4280-62218	THANK YOU FOR NOT SMOKING HERE	EA
4280-62219	SMOKERS PLEASE SIT NEAR ROOM EXHAUST OR REFRAIN FROM SMOKING, ETC.	EA

4280-65435 SIGN, REPOSITORY, FOR PLACEMENT IN REPOSITORY HANDLES TO INDICATE OPEN OR CLOSED CONDITION, FIRST SIDE - RED BACKGROUND COLOR W/LEGEND (OPEN) IN WHITE COLOR, REVERSE SIDE - WHITE BACKGROUND COLOR W/LEGEND (CLOSED) IN RED LETTERING — EA

SIGN, SAFETY, CAUTION, 7 X 10 X 0.080 IN., PLASTIC MATERIAL, STANDARD CAUTION FORMAT AND COLOR - CAUTION - IN YELLOW LETTERS ON BLACK BACKGROUND, LEGEND IN BLACK LETTERS ON YELLOW BACKGROUND

	LEGEND	
4280-64628	- ARC WELDING - DO NOT WATCH ARC	EA
4280-67812	- CAUTION-FLOOR LOAD LIMIT NOT TO EXCEED (BLANK) LBS./SQ FT.	EA
4280-64629	- NO LANDING - DO NOT OPEN DOOR	EA

4280-64634 SIGN, SAFETY, CAUTION, 10 X 14 IN. 0.080 IN. THICK PLASTIC MATERIAL, STANDARD CAUTION FORMAT AND COLORS - CAUTION - IN YELLOW LETTERS ON BLACK BACKGROUND, LEGEND IN BLACK LETTERS ON YELLOW BACKGROUND, LEGEND - EYE HAZARD AREA - DO NOT ENTER WITHOUT EYE PROTECTION — EA

4280-67822 SIGN, SAFETY, CAUTION, 10 X 14 IN., WEATHERPROOF PLASTIC, CAUTION IN YELLOW LETTERS ON BLACK FIELD, LASER SYMBOL IN BLACK ON YELLOW FIELD, LEGEND - AVOID LASER BEAM - IN BLACK LETTERS ON YELLOW FIELD, EMED CO. — EA

SIGN, SAFETY, CAUTION, 10 X 14 IN., WATER-PROOF, WITH 1/4 IN. MTG. HOLES AT EACH CORNER, CAUTION IN YELLOW LETTERS ON BLACK BACKGROUND, LEGEND TO BE 1-1/2 IN. BLOCK LETTERING IN BLACK LETTERS ON YELLOW BACKGROUND

	LEGEND - CAUTION	
4280-67345	-CANCER-SUSPECT AGENT-AUTHORIZED PERSONNEL ONLY	EA
4280-67346	-POTENTIAL CANCER HAZARD-AUTHORIZED PERSONNEL ONLY	EA

SIGN, SAFETY, CAUTION, 30 GAGE METAL, BAKED ENAMEL FINISH, CAUTION IN YELLOW LETTERS ON BLACK BACKGROUND, LEGEND IN BLACK LETTERS ON YELLOW BACKGROUND

	INCH	LEGEND - CAUTION	
4280-67034	7 X 10	- BLANK	EA
4280-67033	10 X 14	- CONSTRUCTION AREA -HARD HATS REQUIRED	EA
4280-67515	10 X 14	- CONSTRUCTION AREA -RESTRICTED ENTRY-AUTHORIZED PERSONNEL ONLY	EA
4280-67035	10 X 14	- OXYGEN GAS-NO SMOKING, FLAMES OR SPARK PRODUCING EQUIPMENT	EA

4280-34841 SIGN, SAFETY, 10 X 7 IN., CAUTION-EYE PROTECTION REQUIRED IN THIS AREA, BLACK LETTERS ON YELLOW BACKGROUND, 30 GAGE METAL, BAKED ENAMEL FINISH — EA

Catalog No.	Description	Unit
4280-70363	SIGN, SAFETY, DANGER, 7 IN. X 5 IN., SELF ADHESIVE BACK, LEGEND: DANGER - CONFINED SPACE - ATHOSPHERE MAY BE HARMFUL TO LIFE - DO NOT ENTER WITHOUT CONTACTING THE HAZARDS CONTROL SAFETY TEAM AT. DANGER IN WHITE ON RED OVAL BACKGROUND FRAMED IN BLACK, LEGEND LETTERS IN BLACK ON WHITE BACKGROUND	EA
	SIGN, SAFETY, DANGER, 10 IN. X 7 IN., 20 GAGE STEEL, SIGN TO HAVE WORD DANGER IN WHITE ON RED OVAL BACKGROUND, FRAMED IN BLACK, LEGEND LETTERS BLACK (SIMILAR TO STONEHOUSE SIGN NO. 138-C) LEGEND - DANGER	
4280-70362	- CONFINED SPACE - ATMOSPHERE MAY BE HARMFUL TO LIFE - DO NOT ENTER WITHOUT CONTACTING HAZARDS CONTORL SAFETY TEAM AT:	EA
4280-52680	- HIGH VOLTAGE- ENTRY BY AUTHORIZED PERSONNEL ONLY	EA
4280-52681	- HIGH VOLTAGE, DO NOT TOUCH	EA
	SIGN, SAFETY, DANGER, 10 X 7 IN., 30 GAGE METAL, BAKED ENAMEL FINISH, STANDARD DANGER FORMAT - DANGER - IN WHITE LETTERS IN RED OVAL FIELD ON BLACK BACKGROUND. LEGEND IN BLACK LETTERS ON WHITE BACKGROUND, WITH 1/4 IN. MTG HOLES LEGEND - DANGER	
4280-64615	- PRESSURE TEST - KEEP OUT	EA
4280-64616	- THIS MACHINE STARTS AUTOMATICALLY - KEEP CLEAR	EA
4280-64617	- HAZARDOUS WORK AREA - DO NOT ENTER WITHOUT AUTHORIZED ESCORT	EA
4280-64618	- (LEGEND SPACE BLANK)	EA
	SIGN, SAFETY, DANGER, 10 X 14 IN., 30 GAGE METAL, BAKED ENAMEL FINISH, STANDARD DANGER FORMAT - DANGER - IN WHITE LETTERS IN RED OVAL FIELD ON BLACK BACKGROUND. LEGEND IN BLACK LETTERS ON WHITE BACKGROUND, WITH 1/4 IN. MTG HOLES LEGEND - DANGER	
4280-64619	- HIGH VOLTAGE- ENTRY BY AUTHORIZED PERSONNEL ONLY	EA
4280-64620	- HIGH VOLTAGE - KEEP OUT	EA
4280-64623	- OVERHEAD WORK - HARD HATS REQUIRED	EA
4280-64624	- (LEGEND SPACE BLANK)	EA
4280-67821	SIGN, SAFETY, DANGER, 14 X 10 IN., WEATHERPROOF PLASTIC, DANGER IN WHITE LETTERS ON RED FIELD, LASER SYMBOL IN RED ON WHITE FIELD, LEGEND - AVOID BEAM AND ALL REFLECTIONS - IN BLACK LETTERS ON WHITE FIELD, EMED CO.	EA
	SIGN, SAFETY/NOTICE, PLASTIC MATERIAL, LEGEND IN BLACK LETTERS ON WHITE BACKGROUND, 10 X 14 X 0.080 IN. LEGEND	
4280-64636	- SAFETY FIRST - EYE PROTECTION REQUIRED IN ALL LABORATORIES AND SHOPS, SAFETY FIRST IN WHITE LETTERS ON GREEN BACKGROUND	EA
4280-64637	- NOTICE - NO ENTRY UNLESS AUTHORIZED, NOTICE IN WHITE LETTERS ON BLUE BACKGROUND	EA
	SIGN, SAFETY, 7 X 17 IN., SEMI-RIGID, .125 IN. POLYETHYLENE, ULTRA VIOLET INHIBITOR COATING, DIRECT SAFETY CO. LEGEND - SAFETY NO.	
4280-69370	- EYEWASH P09-384	EA
4280-69371	- SHOWER P09380	EA
4280-61526	SIGN, SAFETY, WATER QUALITY AND USE, 4 IN WIDE X 3 IN. HIGH, "NOTICE - DEIONIZED WATER, DO NOT USE FOR DRINKING, COOKING OR WASHING"	EA
	SIGN, TAPE, LETTERING, LETERON, FOR INDOOR/OUTDOOR USE, TO BE USED ONLY WITH LETERON SIGN SYSTEM	

	COLOR	IN. WIDE	X FT. LONG	NO.	
4280-70284	BLACK	6.00	50	TW 600	RO
4280-70285	WHITE	6.00	50	TW 600	RO
4280-70286	BLACK	4.50	50	TW 450	RO
4280-70287	WHITE	4.50	50	TW 450	RO
4280-70288	BLACK	3.00	50	TW 300	RO

Catalog No.	Description	Unit
	SIGN, TAPE, LETTERING, LETERON, FOR INDOOR/OUTDOOR USE, TO BE USED ONLY WITH LETERON SIGN SYSTEM	
	COLOR / IN. WIDE / FT. X LONG / NO.	
4280-70289	WHITE 3.00 50 TW 300	RO
4280-70290	BLACK 1.75 25 TW 200	RO
4280-70291	WHITE 1.75 25 TW 200	RO
4280-70809	SIGN, WARNING, COMPUTER TERMINAL, READS ON BOTH SIDES, NONSENSITIVE UNCLASSIFIED, SENSITIVE UNCLASSIFIED, CONFIDENTIAL, SECRET, AND SANITIZED, DOE CENTER FOR SECURITY-LANL, NM87545, NOTE: ITEM PROVIDED BY DOE CENTER FOR COMPUTER SECURITY-LANL, FREE OF CHARGE)	EA
4280-70892	SIGN, WARNING, "NOT AN EXIT", IN RED BLOCK LETTERS 2-1/2 INCHES ON WHITE BACKGROUND, 11-1/2 X 8 IN. ROUNDED EDGES, PRESSURE SENSITIVE, VINYL COATED WATERPROOF, MARZETTA NO. 221N	EA
4280-71009	TAG, FALL PROTECTION EQUIPMENT - TO BE ATTACHED TO BODY HARNESSES, SAFETY WAIST BELTS, SAFETY LANYARDS, AND FALL PROTECTION DEVICES (SALA BLOCKS)	EA
	TAG, PAPERBOARD, 4 X 8 IN., 3-PART MANIFOLD, STRING ATTACHED, SERIALLY NUMBERED, PRINTED BOTH SIDES	
	COLOR / LEGEND	
4280-71326	RED DANGER DO NOT OPERATE	EA
4280-71327	YELLOW NEED OF REPAIR	EA
	TAG, SAFETY, BOTH SIDES PRINTED, PAPERBOARD MATERIAL WITH CORD ATTACHED, 2-1/2 IN. X 5-1/4 IN.	
	LEGEND	
4280-50173	CAUTION - DO NOT TURN ON-OFF (ON ONE SIDE), DO NOT OPERATE (ON OTHER SIDE), BLACK LETTERS ON YELLOW	EA
4280-34903	DANGER - DO NOT TURN ON (ON ONE SIDE) DANGER, DO NOT TURN ON-HANDS OFF (ON OTHER SIDE) BLACK AND RED LETTERS ON WHITE TAG	EA
	TAG, SAFETY, DANGER, FOR CIRCUIT BREAKERS, PAPERBOARD MATERIAL WITH ROUND CENTER CUTOUT TO FIT OVER SWITCH ACTUATOR, IMPRINTED BOTH SIDES WITH WHITE LETTERS ON RED BACKGROUND, UPPER LEGEND-DANGER, BOTTOM LEGEND-DO NOT OPERATE MEN WORKING	
	INCH	
4280-41784	1-1/2 X 1-3/4	EA
4280-41785	2-3/8 X 3-3/8	EA
4280-34845	TAPE, HAZARD STRIPE, 1-1/2 IN. WIDE WITH ALTERNATING 2 IN. WIDE BLACK AND YELLOW DIAGONAL STRIPES, REFLECTIVE BACKING, WESTLINE STOCK HZ-102-C, 5 YDS PER ROLL	RO

Appendix 8

Chemical Storage Guidelines

Appendix 8
Chemical Storage Guidelines

Storage Classes

Storage of reactive chemicals by class (rather than alphabetically) ensures that individual chemicals receive the proper storage measures warranted by their reactivity. Incompatibilities between classes can be anticipated and protected against. Alphabetizing within a group, then, is acceptable. An added benefit to this type of storage is that knowledge of a chemical's reactivity is respected inside the storeroom and out. Once one recognizes a chemical's reactive class in the storeroom, the carry-over of this information to everyday laboratory exposure increases one's safety awareness.

Acids

Segregate acids from active metals such as sodium, potassium, magnesium, etc.
Segregate oxidizing acids from organic acids, flammable and combustible materials.
Segregate acids from chemicals which could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulfide, calcium carbide, etc.
Segregate acids from bases.

Bases

Segregate bases from acids, metals, explosives, organic peroxides and easily ignitable materials.

Solvents (Flammable and Halogenated Solvents)

Store in approved safety cans or cabinets.
Segregate from oxidizing acids and oxidizers.
Keep away from any source of ignition: heat, sparks, or open flames.

Oxidizers

Store in a cool, dry place.
Keep away from combustible and flammable materials.
Keep away from reducing agents such as zinc, alkali metals, and formic acid.

Cyanides
Segregate from acids and oxidizers.

Water Reactive Chemicals
Store in a cool, dry place away from any water source.
Have a Class D fire extinguisher available in case of fire.

Pyrophoric Substance
(Materials which will react with the air to ignite when exposed, e.g., white phosphorus.)
Store in a cool, dry place making provisions for an airtight seal.

Light Sensitive Chemicals
Store in amber bottles in a cool, dry, dark place.

Peroxidizable Chemicals
Store in airtight containers in a dark, cool, and dry place.
Label containers with receiving, opening, and disposal dates.
Periodically test for the presence of peroxides.

Toxic Chemicals
Store according to the nature of the chemical, using appropriate security where necessary.

(From "Safe Chemical Storage: A Pound of Prevention is Worth a Ton of Trouble" by David Pipitone and Donald Hedberg, Journal of Chemical Education, Volume 59, Number 5, May 1982 and "Fire Protection Guide on Hazardous Materials," NFPA, 1978.)

Chemical Incompatibilities

1. Know the properties of the chemicals you use.

The chemical incompatibilities discussed on the following pages are by no means exhaustive. As result, it is crucial for laboratory personnel to thoroughly research the properties of the chemicals they are using. Material Safety Data Sheets (MSDS's) all have sections on chemical incompatibility. While the quality of (MSDS's) varies from one manufacturer to another, they should serve as a primary resource for information on avoiding contact with incompatible compounds. A more detailed reference is the Handbook of Reactive Chemical Hazards, which can be ordered through Bretherick's Publishers.

2. Avoid mixing incompatible waste materials.

A number of serious laboratory accidents, have occurred when people have poured incompatible waste materials into hazardous waste containers. Use separate waste containers for each type of waste. Consult Appendix Six for more information on waste disposal.

3. Store incompatible chemicals separately.

Common storage problems in laboratories which could lead to mixing of incompatible chemicals. The most serious of these is the storage of acids (especially oxidizing acids) with flammable solvents. Contact of a concentrated oxidizing acid with a flammable solvent would likely result in a fire or an explosion. This is not an unlikely scenario in the event of an earthquake. Storage of chemicals in alphabetical order on shelves often results in incompatible chemicals being stored together. For example, alphabetical arrangement could result in hydrogen peroxide (a strong oxidizer) being stored next to hydrazine (a very strong reducer).

Examples of Incompatible Chemicals

Chemical	*Is Incompatible With*
Acetic Acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric and sulfuric acid
Alkali and alkaline earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium, potassium)	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury (in manometers, for example), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrates, sulfur, finely divided organic combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids

Chemical	*Is Incompatible With*
Bromine	See chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metails, sulfur, finely divided organic or combustible materials
Chromic acid & chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	All other chemicals

Chemical	*Is Incompatible With*
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, combustible materials
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrates	Acids
Nitroparaffins	Inorganic gases, amines
Oxalic acid	Silver, mercury

Chemical	*Is Incompatible With*
Oxygen	Oils, grease, hydrogen: flammable liquids, solids or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalies, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate (see also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartartic acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts

Chemical	*Is Incompatible With*
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
Tellurides	Reducing agents

From: "Safety in Academic Chemistry Laboratories," American Chemical Society

Chemical Compatibility Matrix

	Acids, Inorganic	Acids, Oxidizing	Acids, Organic	Alkalis (Bases)	Oxidizers	Poisons, Inorganic	Poisons, Organic	Water Reactives	Organic Solvents
Acids, Inorganic			X	X		X	X	X	X
Acids, Oxidizing			X	X		X	X	X	X
Acids, Organic	X	X		X	X	X	X	X	
Alkalis (Bases)	X	X	X				X	X	X
Oxidizers			X				X	X	X
Poisons, Inorganic	X	X	X				X	X	X
Poisons, Organic	X	X	X	X	X	X			
Water Reactives	X	X	X	X	X	X			
Organic Solvents	X	X		X	X	X			

☒ = not compatible

☐ = compatible (unless otherwise indicated)

Appendix 9

Select Carcinogens

Appendix 9

Select Carcinogens

(Pursuant to the OSHA Laboratory Standard, 29 CFR 1910.1450)

A. OSHA Regulated Carcinogens (29 CFR 1910.1000, Subpart Z)

2-acetylaminofluorene
acrylonitrile
4-aminodiphenyl
inorganic arsenic
asbestos
benzene
benzidine and its salts
1,2-dibromo-3-chloropropane
3,3'-dichlorobenzidine and its salts
4-dimethylaminoazobenzene
ethylene oxide
formaldehyde
alpha-naphthylamine
beta-naphthylamine
4-nitrobiphenyl
N-nitrosodimethylamine
beta-propiolactone
bis-chloromethyl ether
methyl chloromethyl ether
ethyleneimine
vinyl chloride (and polyvinyl chloride)

B. I.A.R.C. Identified Carcinogens[a]

Group 1 "Agents that are Carcinogenic to Humans"

aflatoxins production
4-aminobiphenyl
analgesic mixtures containing phenacetin
arsenic and arsenic compounds
asbestos
auramine, manufacture of
azathioprine
benzene
benzidine
betel quid with tobacco
N,N-bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)

bis(chloromethyl) ehter and chloromethyl ether (technical-grade)
boot and shoe manufacture and repair
1,4-butanediol
dimethanesulphonate (Myleran)
chlorambucil
1-(2-chloroethyl)-3(4-methylcyclohexyl)-1-nitrosourea (methyl-CCNU)
chromium compounds, hexavalent
coal gasification
coal-tar pitches
coal-tars
coke production
cyclophosphamide
ciethylstilboestrol
drionite
furniture and cabinet making
haematite mining, underground, with exposure to radon
iron and steel founding
isopropyl alcohol manufacture, strong-acid process
magenta, manufacture of
melphalan
8-methoxypsoralen (methoxsalen) plus ultraviolet radiation
mineral oils, untreated and mildly-treated
MOPP (combined therapy with nitrogen mustard, vincristine, procarbazine and prednisone) and other combined chemotherapy including alkylating agents.
mustard gas (sulphur mustard)
2-naphthylamine
nickel and nickel compounds
oestrogen replacement therapy
oestrogens, nonsteroidal
oestrogens, steroidal
oral contraceptives, combined
oral contraceptives, sequential
the rubber industry
shale-oils
soots
talc containing asbestiform fibers
tobacco products, smokeless
tobacco smoke
treosulphan
vinyl chloride

Group 2A:"Agents that are Probably Carcinogenic to Humans"

acrylonitrile
adriamycin
androgenic (anabolic) steroids

benz[a]anthracene
benzidine-based dyes
benzo[a]pyrene
beryllium and beryllium compounds
bischloroethyl nitrosourea (BCNU)
cadmium and cadmium compounds
1(2-chlorethyl)-3-cyclohexyl-1-nitrosourea (CCNU)
cisplatin
creosotes
dibenz[a,h]anthracene
diethyl sulphate
dimethylcarbamoyl chloride
dimethyl sulphate
epichlorohydrin
ethylene dibromide
ethylene oxide
n-ethyl-n-nitrosourea
formaldehyde
5-methoxypsoralen
4,4'-methylene bis(2-chloroaniline) (MOCA)
N-methyl-N'-nitro-n-nitrosoguanidine (MNNG)
N-methyl-n-nitrosourea
nitrogen mustard
N-nitrosodiethylamine
N-nitrosodimethylamine
phenacetin
polychlorinated biphenyls
procarbazine hydorchloride
propylene oxide
silica, crystalline
styrene oxide
tris(1-aziridinyl)phosphine sulphide (Thiotepa)
tris(2,3-dibromopropyl) phosphate
vinyl bromide

Group 2B:"Agents that are Possibly Carcinogenic to Humans"

a-alpha, C (2-amino-9H-pyrido[2,3-b]indole)
acetaldehyde
acetamide
acrylamide AF-2 [2{2-furyl}-3-(5-nitro-2-furyl) acrylamide]
para-aminoazobenzene
ortho-aminoazotoluene
2-amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole
amitrole
ortho-anisidine

aramite
auramine, technical-grade
azaserine
benzo[b]fluoranthene
benzo(j)fluoranthene
benzo[k]fluoranthene
benzyl violet 4B
bitumens, extracts of steam-refined and air-refined
bleomycins
bracken fern
1,3-butadiene
butylated hydroxyanisole (BHA)
beta-butyrolactone
carbon-black extracts
carbon tetrachloride
carpentry and joinery
carrageenan, degraded
chloramphenicol
chlordecone (Kepone)
alpha-chlorinated toluenes
chloroform
chlorophenols
chlorophenoxy herbicides
4-chloro-ortho-phenylenediamine
para-chloro-ortho-toluidine
citrus red no. 2
para-cresidine
cycasin
dacarbazine
daunomycin
DDT
n,n'-diacetylbenzidine
2,4-diaminoanisole
4,4'-diaminodiphenyl ether
2,4-diaminotoluene
dibenz[a,h]acridine
dibenz[a,j]acridine
7H-dibenzo[c,g]carbazole
dibenzo[a,e]pyrene
dibenzo[a,h]pyrene
dibenzo[a,l]pyrene
1,2-dibromo-3-chloropropane
para-dichlorobenzene
3,3'-dichlorobenzidine
3,3'-dichloro-4,4'-diaminodiphenyl ether
1,2-dichloroethane

dichloromethane
1,3-dichloropropene (technical-grade)
diepoxybutane
di(2-ethylhexyl)phthalate
1,2-diethyldrazine
diglycidyl resorcinol ether
dihydrosafrole
3,3'-dimethoxybenzidine (ortho-dianisidine)
para-dimethylaminoazobenzene trans-2[(dimethylamino)methylimino]-5[2(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole
3,3'-dimethylbenzidine (ortho-tolidine)
1,1-dimethylhydrazine
1,2-dimethylhydrazine
1,4-dioxane
ethyl acrylate
ethylene thiourea
ethyl methanesulphonate 2'-2-Formylhydrazino(-4'-5nitro-2-furyl) thiazole
glu-P-1 (2-amino-6-methyldipyrido[1,2-a:3', 2'-d]imidazole)
glu-P-2 (2-aminodipyrido[1,2-a:3', 2'-d]imidazole)
glycidaldehyde
griseofulvin
hexachlorobenzene
hexachlorocyclohexanes
hexamethylphosphoramide
hydrazine
indeno[1,2,3-cd]pyrene
IQ (2-amino-3-methylimidazo[4,5-f]quinoline)
iron-dextran complex
lasiocarpine
lead and lead compounds, inorganic
mea-alpha-c (2-amino-3-methyl-9H-pyrido[2,3-b]indole)
medroxyprogesterone acetate
merphalan
2-methylaziridine
methylazoxymethanol and its acetate
5-methylchrysene
4,4'-methylene bis(2-methylaniline)
4,4'-methylenedianiline
methyl methanesulphonate
2-methyl-1-nitroanthraquinone (uncertain purity)
n-methyl-n-nitrosourethane
methylthiouracil
metronidazole
mirex
mitomycin C
monocrotaline

5-(morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone
Nafenopin
Niridazole
5-nitroacenaphthene
nitrofen (technical-grade)
1- [(5-nitrofurfurylidene)amino]-2-imidazolidinone
N-N- [4(5-nitro-2-furyl)-2-thiazolyl]acetamide
nitrogen mustard N-oxide
2-nitropropane
N-nitrosodi-n-butylamine
N-nitrosodiethanolamine
N-nitrosodi-n-propylamine
3-(N-nitrosomethylamino)propionitrile
4-(N-nitrosomethylamino)-1(3-pyridyl)-1-butanone (NNK)
N-nitrosomethylethylamine
N-nitrosomethylvinylamine
N-nitrosomorpholine
N'-nitrosonornicotine
N-nitrosopiperidine
N-nitrosopyrrolidine
N-nitrososarcosine
oil orange SS
panfuran S (containing dihydroxymethylfuratrizine)
phenazopyridine hydrochloride
phenobarbital
phenoxybenzamine hydrochloride
phenytoin
polybrominated biphenyls
ponceau MX
ponceau 3R
potassium bromate
progestins
1,3-propane sultone
b-propiolactone
propylthiouracil
saccharin
safrole
sodium ortho-phenylphenate
sterigmatocystin
streptozotocin
styrene
sulfallate
2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD)
tetrachloroethylene
thioacetamide
4,4'thiodianiline

thiourea
toluene diisocyanates
ortho-toluidine
toxaphene (polychlorinated camphenes)
trp-P-1 (3-Amino-1,4-dimethyl-5H-pyrido[4,3-b]indole)
trp-P-2 (3-Amino-1-methyl-5H-pyrido[4,3-b]indole)
trypan blue
uracil mustard
urethane

C. NTP Identified Carcinogens [b]

Group 1. "Substances Known to be Carcinogens"

4-aminobiphenyl
analgesic mixtures containing phenacetin
arsenic and certain arsenic compounds
asbestos
azathioprine
benzene
benzidine
bis(chloromethyl)ether and technical grade chloromethyl methyl ether
1,4-butanediol dimethylsulfonate (Myleran)
chlorambucil
chromium and certain chromium compounds
conjugated estrogens
cyclophosphamide
diethylstilbestrol
melphalan
methoxsalen with ultra-violet A therapy (PUVA)
mustard gas
2-naphthylamine
thorium dioxide
vinyl chloride

Group 2. "Substances Reasonably Anticipated to be Carcinogens"

2-acetylaminofluorene
acrylonitrile
adriamycin
aflatoxins
2-aminoanthraquinone
o-a minoazotoluene
1-amino-2-methylanthraquinone
amitrole
o-anisidine hydrochloride

benzotrichloride
beryllium and certain beryllium compounds
bischloroethyl nitrosourea
1,3-butadiene
cadmium and certain cadmium compounds
carbon tetrachloride
chlorendic Acid
chlorinated paraffins (C12 60% chlorine)
1-(2chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)
chloroform
3-chloro-2-methylpropene
4-chloro-o-phenylenediamine
c.1. basic red 9 monohydrochloride
p-cresidine
cupferron
dacarbazine
DDT
2,4-diaminoanisole sulfate
2,4-diaminotoluene
1,2-dibromo-3-chloropropane
1,2-dibromoethane (EDB)
1,4-dichlorobenzene
3,3'-dichlorobenzidine and 3,3'-dichlorobenzidinedihydrochloride
1,2-dichloroethane
dichloromethane (methylene chloride)
1,3-dichloropropene (technical grade)
diepoxybutane
di(2-ethylhexyl)phthalate
diethy sulfate
diglycidyl resorcinol ether
3,3'-dimethoxybenzidine
4-dimethylaminozobenzene
3, 3'-dimethylbenzidine
dimethylcarbamoyl chloride
1,1-dimethylhydrazine
dimethyl sulfate
dimethylvinyl chloride
1, 4-dioxane
direct black 38
direct blue 6
epichlorochydrin
estrogens (not nonjugated): estradiol-17(beta)
estrogens (not nonjugated): estrone
estrogens (not nonjugated): ethinylestradiol
estrogens (not nonjugated): mestranol
ethyl acrylate

ethylene oxide
ethylene thiourea
formaldehyde (gas)
hexachlorobenzene
hexamethylphosphoramide
hydrazine and hydrazine sulfate
hydrazobenzene
iron dextran complex
kepone (chlordecone)
lead acetate and lead phosphate
lindane and other hexachlorocyclohexane isomers
2-methylaziridine (Propyleneimine)
4,4'-methylenebis (2-chloroaniline) (MBOCA)
4,4'-methylenebis(n,n-dimethyl) benzenamine
4,4'-methylenedianiline and its dihydrochloride
metronidazole
Michler's ketone
Mirex
nickel and certain nickel compounds
nitrilotriacetic acid
5-nitro-o-anisidine
nitrofen
nitrogen mustard hydrochloride
2-nitropropane
N-nitrosodi-N-butylamine
N-nitrosodiethanolamine
N-nitrosodiethylamine
N-nitrosodimethylamine
p-nitrosodiphenylamine
n-nitrosodi-n-propylamine
N-nitroso-N-ethylurea
N-nitroso-N-methylurea
N-nitrosomethylvinylamine
N-nitrosomorpholine
N-nitrosonornicotine
N-nitrosopiperidine
N-nitrosopyrrolidine
N-nitrososarcosine
norethisterone
4,4'-oxydianiline
oxymetholone
phenacetin
phenazopyridine hydrochloride
phenoxybenzamine hydrochloride
phenytoin
polybrominated biphenyls

polychlorinated biphenyls
polycyclic aromatic hydrocarbons, 15 listings:
- benz(a)anthracene
- benzo(b)fluoranthene
- benzo(j)fluoranthene
- benzo(k)fluoranthene
- benzo(a)pyrene
- dibenz(a,h)acridine
- dibenz(a,j)acridine
- dibenz(a,h)anthracene
- 7h-dibenzo(c,g)carbazole
- dibenzo(a,e)pyrene
- dibenzo(a,h)pyrene
- dibenzo(a,i)pyrene
- dibenzo(a,l)pyrene
- indeno(1,2,3-cd)pyrene
- 5-methylchrysene

procarbazine hydrochloride
progesterone
1,3-propane sultone
(beta)-propiolactone
propylene oxide
propylthiouracil
reserpine
saccharin
safrole
selenium sulfide
streptozotocin
sulfallate
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)
tetrachloroethylene (perchloroethylene)
thioacetamide
thiourea
toluene diisocyanate
o-toluidine and o-toluidine hydrochloride
toxaphene
2,4,6-trichlorophenol
tris (1-aziridinyl)phosphine sulfide
tris (2,3-dibromopropyl)phosphate
urethane

---

[a] IARC (International Agency for Research on Cancer) lists from 1987 monographs.

[b] NTP (National Toxicology Program) lists from the "Fourth Annual Report on Carcinogens," 1985.

Appendix 10

ACGIH Carcinogens

Appendix 10

ACGIH Carcinogens*

A1 Carcinogens

4-aminodiphenyl
asbestos
- amosite
- chrysotile
- crocidolite
- other forms

benzidine
bis(chloromethyl)ether
chromite ore processing
chromium (VI) compounds, certain water insoluble
coal tar pitch volatiles, benzene solubles
nickel sulfide roasting
4-nitrodiphenyl
vinyl chloride
zinc chromates

A2 Carcinogens

acrylamide
acrylonitrile
antimony trioxide production
arsenic trioxide production
benzene
benzo(a)pyrene
beryllium
1,3-butadiene
carbon tetrachloride
chloroform
chloromethyl methyl ether
chrysene
3,3'-bichlorobenzidine
bimethyl carbamoyl chloride
1,1-dimethylhydrazine
dimethyl sulfate
ethyl acrylate
ethylene dibromide
ethylene oxide

ACGIH A2 Carcinogens, continued

formaldehyde
hexachlorobutadiene
hydrazine
lead chromate
methylene chloride
4,4'-methylene bis(2-chloroaniline) ["MBOCA"]
4,4'-methylene dianiline
methyl hydrazine
methyl iodide
2-nitropropane
n-nitrosodimethylamine
n-phenyl-beta-naphthylamine
phenylhydrazine
propane sultone
b-propiolactone
propylene imine
o-tolidine
o-toluidine
p-toluidine
vinyl bromide
vinyl cyclohexene dioxide
xylidine

---

*ACGIH is the American Conference of Governmenal Industrial Hygienists.

"A1" designates a *confirmed human carcinogen*: a substance, or substances associated with industrial processes, recognized to have carcinogenic potential.

"A2" designates a *suspected human carcinogen*: a substance or substances associated with industrial processes, which are suspect of inducing cancer, based on either limited epidemiological evidence or demonstration of carcinogenesis in one or more animal species by appropriate methods.

Note: Italicized entries (four of the listings) are not included in the current OSHA Select Carcinogen List (Appendix 9).

Appendix 11

Composite Working Select Carcinogen List

COMPOSITE WORKING SELECT CARCINOGEN LIST

CHEMICAL	SYNONYM	CAS
ACETALDEHYDE		602-87-9
ACETAMIDE		60-35-5
2-ACETYLAMINOFLUORENE	N-FLUOREN-2YL ACETAMIDE	53-96-3
ACRYLAMIDE		79-06-1
ACRYLONITRILE		107-13-1
ADRIAMYCIN		23214-92-8
AF-2 [2(2-FURYL)-3-(5-NITRO-2-FURYL) ACRYLAMIDE		3688-53-7
AFLATOXINS		1402-68-2
A-ALPHA, C (2-AMINO-9H-PYRIDO[2,3-B]INDOLE)	AMINO-ALPHA-CARBOLINE	26148-68-5
1-AMINO-2-METHYLANTHRAQUINONE		82-28-0
2-AMINO-5-(5-NITRO-FURYL)-1,3,4-THIADIAZOLE		712-68-5
2-AMINOANTHRAQUINONE		117-79-3
AMINOAZOBENZENE	PARA-AMINOAZOBENZENE; PHENYLAZOANILINE	60-09-3
O-AMINOAZOTOLUENE	2-AMINO-5-AZOTOLUENE	97-56-3
AMINOAZOTOLUENE	ORTHO-AMINOAZOTOLUENE	97-56-3
4-AMINOBIPHENYL	4-AMINOBIPHENYL	92-67-1
AMITROLE	AMINOTRIAZOLE	61-82-5
ANDROGENIC STEROIDS	ANABOLIC STEROIDS	
ANISIDINE	ORTHO-ANISIDINE	90-04-0
ANISIDINE HYDROCHLORIDE	ORTHO-ANISIDINE HYDROCHLORIDE	134-29-2
ARAMITE	2(P-TERT-BUTYLPHENOXY)-1-METHYLETHYL-2-CHLOROETHYL	140-57-8
ARSENIC		7440-38-2
ARSENIC ACID		7778-38-4
ARSENIC ACID		10102-53-1
ARSENIC ACID, CALCIUM SALT		10103-62-5
ARSENIC ACID, CALCIUM SALT		7778-44-1
ARSENIC ACID, DIAMMONIUM SALT		7784-44-3
ARSENIC ACID, DISODIUM SALT		7778-43-0
ARSENIC ACID, DISODIUM SALT, HEPTAHYDRATE		10048-95-0
ARSENIC ACID, HEMIHYDRATE		7774-41-6
ARSENIC ACID, LEAD SALT		7645-25-2
ARSENIC ACID, LEAD(2+) SALT(1:1)		7784-40-9
ARSENIC ACID, LEAD(2+) SALT(2:3)		3687-31-8
ARSENIC ACID, MAGNESIUM SALT		10105-50-1
ARSENIC ACID, MONOPOTASSIUM SALT		7784-41-0
ARSENIC ACID, MONOSODIUM SALT		101003-60-3
ARSENIC ACID, SODIUM SALT		7631-89-2
ARSENIC ACID, TRICESIUM SALT		6436-62-1
ARSENIC CHLORIDE		7784-34-1
ARSENIC IODIDE		7784-45-4
ARSENIC PENTOXIDE		1303-28-2
ARSENIC SULFIDE		56320-22-0
ARSENIC SULFIDE		1303-33-9
ARSENIC TRIOXIDE		1327-53-3
ARSENIC(II) BROMIDE		7784-33-0
ARSENIC(V) ACID, TRISODIUM SALT, HEPTAHYDRATE		64070-83-3
ARSENIOUS ACID, CALCIUM SALT		27152-57-4
ARSENIOUS ACID, COPPER(II) SALT(1:1)		10290-12-7
ARSENIOUS ACID, MONOSODIUM SALT		7784-46-5
ARSENIOUS ACID, POTASSIUM SALT		10124-50-2
ARSENIOUS ACID, SODIUM SALT		14080-36-9

CHEMICAL	SYNONYM	CAS
ARSENIOUS ACID, TRISILVER(1+) SALT		7784-08-0
ARSENIOUS ACID, ZINC SALT		10326-24-6
ARSENIOUS TRIFLUORIDE		7784-36-2
ARSONIC ACID, CALCIUM SALT (1:1)		52740-16-5
ASBESTOS		1332-21-4
AURAMINE		492-80-8
AZASERINE		115-02-6
AZATHIOPRINE		446-86-6
BENZ(A)ANTHRACENE		56-55-3
BENZENE		71-43-2
BENZIDINE		92-87-5
BENZO(A)PYRENE		50-32-8
BENZO(B)FLUORANTHENE		205-99-2
BENZO(J)FLUORANTHENE		205-82-3
BENZO(J)FLUORANTHENE		205-82-3
BENZO(K)FLUORANTHENE		207-08-9
BENZOTRICHLORIDE		98-07-7
BENZYL VIOLET 4B		1694-09-3
BERYLLIUM		7440-41-7
BERYLLIUM ALUMINIUM ALLOY		12770-50-2
BERYLLIUM BIS(CARBANATO(2-))DIHYDROXYTRI-		66104-24-3
BERYLLIUM CHLORIDE		7787-47-5
BERYLLIUM FLUORIDE		7787-49-7
BERYLLIUM HYDROGEN PHOSPHATE		13598-15-7
BERYLLIUM HYDROXIDE		13327-32-7
BERYLLIUM OXIDE		1304-56-9
BERYLLIUM SULFATE (1:1)		13510-49-1
BERYLLIUM SULFATE, TETRAHYDRATE		7787-56-6
BIS(2-CHLOROETHYL)-2-NAPHTHAYLAMINE	CHLORNAPHAZINE	494-03-1
BIS(CHLOROMETHYL) ETHER	DICHLORODIMETHYL ETHER	542-88-1
BISCHLOROETHYL NITROSOUREA	BCNU	154-93-8
BITUMENS, EXTRACTS OF STEAM-REFINED AND AIR-REFINE		
BLEOMYCIN		11056-06-7
BRACKEN FERN		
1,3-BUTADIENE	PYRROLYLENE	106-94-0
1,4-BUTANEDIOL DIMETHANESULFONATE	MYLERAN	55-98-1
BUTYLATED HYDROXYANISOLE	BHA; SUSTANE; ANTHRACINE 12	25013-16-5
BETA-BUTYROLACTONE	4-METHYL-2-OXYTANONE	3068-88-0
C.1. BASIC RED9 MONOHYDROCHLORIDE		569-61-9
CADMIUM		7740-43-9
CADMIUM CHLORIDE		10108-64-2
CADMIUM OXIDE		1306-19-0
CADMIUM SULFATE		10124-36-4
CADMIUM SULFIDE		1306-23-6
7H-CARBAZOLE	DIBENZO(C,G)CARBAZOLE	194-59-2
CARBON TERACHLORIDE		56-23-5
CARBON-BLACK EXTRACTS		
CARRAGEENAN, DEGRADED		
CHLORAMBUCIL		305-03-3
CHLORAMPHENICOL		56-75-7
CHLORENDIC ACID		115-28-6
CHLORINATED PARAFFINS (C12 60% CHLORINE)		108171-26-2

CHEMICAL	SYNONYM	CAS
[redacted]-CHLORO-2-METHYLPROPENE		563-47-3
4-CHLORO-O-PHENYLENEDIAMINE		95-83-0
CHLORO-ORTHO-TOLUIDINE	PARA-CHORO-ORTHO-TOLUIDINE	95-69-2
1-(2-CHLOROETHYL)-3(4-METHYLCYCLO-HEXYL)-1-NITROSO	METHYL-CCNU	13909-09-6
1-(2-CHLOROETHYL)-3-CYCLOHEXYL-1-NITROSOUREA	CCNU	13010-47-4
CHLOROFORM	TRICHLOROMETHANE	67-66-3
CHLOROMETHYL METHYL ETHER	METHYL CHLOROMETHYL ETHER; CHLORODIMETHYL ETHER	107-30-2
CHLOROPHENOLS		
CHLOROPHENOXY HERBICIDES		
CHROMATE(1-) HYDROXYOCTAOXODIZINCATED POTASSIUM		11103-86-9
CHROMIC ACID, CALCIUM SALT		13765-19-0
CHROMIC ACID, DISODIUM SALT		7789-00-6
CHROMIC ACID, LEAD(2+) SALT		7775-11-3
CHROMIC ACID, POTASSIUM SALT		7758-97-6
CHROMIC ACID, STRONTIUM SALT		7789-06-2
CHROMIC ACID, ZINC HYDROXIDE HYDRATE		15430-94-6
CHROMIC ACID, ZINC SALT		13530-65-9
CHROMIUM CHLORIDE,		14986-48-2
CHROMIUM DICHLORODIOXO		14977-61-8
CHROMIUM OXIDE (1:2)		1333-8-20
CISPLATIN		15663-27-1
CITRUS RED NO.2		6358-53-8
COAL-TAR PITCHES		65996-93-6
CRESIDINE	PARA-CRESIDINE	120-71-8
CRESIDINE	PARA-CRESIDINE	120-71-8
[redacted]RESOTES		8001-58-9
[redacted]UPFERRON		135-20-6
CYCASIN		14901-08-7
CYCLOPHOSPHAMIDE		50-18-0
DAUNOMYCIN		20830-81-3
DDT		50-29-3
DECARBAZINE		4342-03-4
DI(2-ETHYLHEXYL)PHTHLATE		117-81-7
DIACETYLBENZIDINE	N,N'-DIACETYLBENZIDINE	613-35-4
2,4-DIAMINOANISOLE		615-05-4
2,4-DIAMINOANISOLE SULFATE		39156-41-7
4,4'-DIAMINODIPHENYL ETHER		101-80-4
2,4-DIAMINOTOLUENE		95-80-7
DIBENZ(A,H)ACRIDINE		226-36-8
DIBENZ(A,H)ANTHRACENE		53-70-3
DIBENZ(A,J)ACRIDINE		224-42-0
DIBENZO(A,E) PYRENE		189-64-0
DIBENZO(A,H) PYRENE		192-65-4
DIBENZO(A,J) PYRENE		189-55-9
DIBENZO(A,L) PYRENE		191-30-0
1,2-DIBROMO-3-CHLOROPROPANE	DBCP	96-12-8
1,2-DIBROMOETHANE	ETHYLENE DIBROMIDE	106-93-4
3,3'-DICHLORO-4,4'-DIAMINO-DIPHENYL ETHER		28434-86-8
1,4-DICHLOROBENZENE		106-46-7
DICHLOROBENZENE	PARA-DICHLOROBENZENE	106-46-7
[redacted]3,3'-DICHLOROBENZIDINE		91-94-1
[redacted],3'-DICHLOROBENZIDINE DIHYDROCHLORIDE		612-83-9

CHEMICAL	SYNONYM	CAS
1,2-DICHLOROETHANE	ETHYLENE DICHLORIDE	107-06-2
DICHLOROMETHANE	METHYLENE CHLORIDE	75-09-2
1,3-DICHLOROPROPENE	2-CHLOROALLYL	542-75-6
DIEPOXYBUTANE		1464-53-5
DIETHY SULFATE		64-67-5
DIETHYLSTILBESTROL		56-53-1
DIETHYLSTILBOESTROL		56-53-1
DIGYLCIDYL RESORCINOL ETHER		101-90-6
DIHYDROSAFFROLE		94-58-6
3,3'-DIMETHOXYBENZIDINE	ORTHO-DIANISIDINE	119-90-4
DIMETHYL SULFATE		77-78-1
DIMETHYLAMINOAZOBENZENE	PARA-DIMETHYLAMINOAZOBENZENE	60-11-7
3,3'-DIMETHYLBENZIDINE	ORTHO-TOLUDINE	119-93-7
DIMETHYLCARBAMOYL CHLORIDE		79-44-7
1,1-DIMETHYLHYDRAZINE	DIMAZINE	57-14-7
1,2-DIMETHYLHYDRAZINE	N,N'-DIMETHYLHYDRAZINE	540-73-8
1,4-DIOXANE	P-DIOXANE	123-91-1
DIRECT BLACK 38		1937-37-7
DIRECT BLUE 6		2602-46-2
DMETHYLVINYL CHLORIDE		513-37-1
EPICHLOROHYDRIN		106-89-8
ERIONITE		12510-42-8
ESTRADIOL-17(BETA)		SEQ NO-24-0
ESTRONE		53-16-7
ETHINYLESTRADIOL		57-63-6
ETHYL ACRYLATE		140-88-5
ETHYL METHANESULFONATE	EMS	62-50-0
ETHYL-N-NITROSOUREA	N-ETHYL-N-NITROSOUREA	759-73-9
ETHYLENE OXIDE		75-21-8
ETHYLENE THIOUREA		96-45-7
ETHYLENEIMINE		151-56-4
FORMALDEHYDE		50-00-0
2-(2-FORMYLHYDRAZINO)-4-(5-NITRO-2-FURYL)THIA		3570-75-0
GALLIUM ARSENIDE		1303-00-0
GLU-P-1 (2-AMINO-6-METHYLDIPYRIDO[1,2-A:3',2'-D]I	GLU-P-1	67730-11-4
GLU-P-2 (2-AMINODIPYRIDO-[1,2-A:3',2'-D]IMIDAZOLE)	GLU-P-2	67730-10-3
GLYCIDALDEHYDE		765-34-4
GRISEOFULVIN	SPOROSTATIN	126-07-8
HEXACHLOROBENZENE		118-74-1
HEXACHLOROBUTADIENE		87-68-3
HEXACHLOROCYCLOHEXANES		608-73-1
HEXAMETHYLPHOSPHORAMIDE		680-31-9
HYDRAZINE		302-01-2
HYDRAZINE SULFATE		10034-93-2
HYDRAZOBENZENE		122-66-7
INDENOL(1,2,3-CD)PYRENE		193-39-5
IQ (2-AMINO-3-METHYLIMIDAZO-[4,5-F] QUINOLINE)	2-AMINO-3-METHYLIMIDAZO(4,5-F) QUINOLINE	76180-96-6
IRON DEXTRAN COMPLEX		9004-66-4
KEPONE	CHLORDECONE	143-50-0
LASIOCARPINE		303-34-4
LEAD		7439-92-1
LEAD (II) ARSENITE		10031-13-7

CHEMICAL	SYNONYM	CAS
LEAD (II) PHOSPHATE		7446-27-7
LEAD ACETATE (II), TRIHYDRATE		6080-56-4
LEAD CHROMATE (VI) OXIDE		18454-12-1
LINDANE		58-89-9
MEA-ALPHA-C (2-AMINO-3-METHYL-9H-PYRIDO[2,3-B]INDO	2-AMINO-3-METHYL-A-CARBOLINE	68006-83-7
MEDROXYPROGESTERONE ACETATE	PERLUTEX	71-58-9
MELPHALAN		148-82-3
MERCURY(II) O-ARSENATE		7784-37-4
MESTRANOL		72-33-3
8-METHOXYPSORALEN	8-METHOXYSALEN, METHOXSALEN	298-81-7
8-METHOXYPSORALEN PLUS ULTRAVIOLET RADIATION	METHOXSALEN PLUS ULTRAVIOLET RADIATION;PUVA	
METHYL CHLOROMETHYL ETHER		107-30-2
METHYL METHANESULPHONATE		66-27-3
2-METHYL-1-NITROANTHRAQUINONE		129-15-7
METHYL-N'-NITRO-N-NITROSO-GUANIDINE	MNNG	70-25-7
METHYL-N-NITROSOUREA	N-METHYL-N-NITROSOUREA	684-93-5
METHYL-N-NITROSOURETHANE	N-METHYL-N-NITROSOURETHANE	615-53-2
2-METHYLAZIRIDINE	PROPYLENEIMINE	75-55-8
METHYLAZOXYMETHANOL	1-HYDROXYMETHYL-2-METHYLDITHIMIDE-2-OXIDE	590-96-5
METHYLAZOXYMETHANOL ACETATE		592-62-1
5-METHYLCHRYSENE		3697-24-3
4,4'-METHYLENE BIS(2-CHLOROANILINE)	MOCA;MBOCA	101-44-4
4,4'-METHYLENE BIS(2-METHYLANILINE)		838-88-0
4,4'-METHYLENEBIS(N,N-DIMETHYL)BENZENENAMINE		101-61-1
4,4'-METHYLENEDIANILINE		101-77-9
4,4'-METHYLENEDIANILINE DIHYDROCHLORIDE		13552-44-8
METHYLTHIOURACIL		56-04-2
METRONIDAZOLE		443-48-1
MICHLER'S KETONE	TETRAMETHYLDIAMINOBENZOPHENONE	990-94-8
MIREX	FERRIAMICIDE; DECHLORANE 4070	2385-85-5
MITOMYCIN C		50-07-7
MONOCRORTALINE		315-22-0
MUSTARD GAS	SULFUR MUSTARD	505-60-2
NAFENOPIN		3771-19-5
1-NAPHTHALENE	ALPHA-NAPHTHYLAMINE	134-33-7
2-NAPHTHYLAMINE	BETA-NAPHTHYLAMINE	91-59-8
NICKEL		7440-02-0
NICKEL (II) OXIDE (1:1)		1313-99-1
NICKEL (III) HYDROXIDE		12125-56-3
NICKEL ARSENIDE		12255-80-0
NICKEL ARSENIDE		12256-33-6
NICKEL ARSENIDE SULFIDE		12255-10-8
NICKEL CARBONYL		13443-30-3
NICKEL REFINERY DUST		
NICKEL SULFIDE		12035-72-2
NICKEL(A) ACETATE (1:2)		373-02-4
NICKEL(II) CARBONATE (1:1)		3333-67-3
NICKEL(II) HYDROXIDE		12064-45-7
NIRIDAZOLE		61-57-4
NITRILOTRIACETIC ACID		139-13-9
[4(5,-NITRO-2-FURYL)-2-THIAZOLYL]ACETAMIDE	NIFURADENE	42011-48-3
5-NITRO-O-ANISIDINE		99-59-2

CHEMICAL	SYNONYM	CAS
5-NITROACENAPHTHENE		602-87-9
4-NITROBIPHENYL		92-93-3
NITROFEN		1836-75-5
NITROGEN MUSTARD		51-75-2
NITROGEN MUSTARD HYDROCHLORIDE		55-86-7
NITROGEN MUSTARD N-OXIDE		126-85-2
2-NITROPROPANE		79-46-9
NITROSO-N-ETHYLUREA	N-NITROSO-N-ETHYLUREA	759-73-9
NITROSO-N-METHYLUREA	N-NITROSO-N-METHYLUREA	684-93-5
NITROSODI-N-BUTYLAMINE	N-NITROSODI-N-BUTYLAMINE	924-16-3
NITROSODI-N-PROPYLAMINE	N-NITROSO-N-PROPYLAMINE	621-64-7
NITROSODIETHANOLAMINE	N-NITROSODIETHANOLAMINE	1116-54-7
NITROSODIETHYLAMINE	N-NITROSODIETHYLAMINE	55-18-5
NITROSODIMETHYLAMINE	N-NITROSODIMETHYLAMINE	62-75-9
NITROSODIPHENYLAMINE	PARA-NITROSODIPHENYLAMINE	156-10-5
3-N-NITROSOMETHYLAMINO) PROPIONITRILE		60153-49-3
4-N-NITROSOMETHYLAMINO)-1-(3-PYRIDYL)-1-BUTANONE	NNK	64091-91-4
NITROSOMETHYLETHYLAMINE	N-NITROSOMETHYLETHYLAMINE	10595-95-6
NITROSOMORPHOLINE	N-NITROSOMORPHOLINE	59-89-2
NITROSONORNICOTINE	N-NITROSONORNICOTINE	16543-55-8
NITROSOPIPERIDINE	N-NITROSOPIPERIDINE	100-75-4
NITROSOPYRROLIDINE	N-NITROSOPYRROLIDINE	930-55-2
NITROSOSARCOSINE	N-NITROSOSARCOSINE	13256-22-9
NORETHISTERONE		68-22-4
OIL ORANGE SS	1-(O-TOLYLAZO)-2-NAPHTHOL	2646-17-5
4,4'-OXYDIANILINE	4,4'-OXYDI-ANILINE	101-80-4
OXYMETHOLONE		434-07-1
PANFURAN S (CONTAINING DIHYDROXYMETHYLFURATRIZINE)		794-93-4
PHENACETIN		62-44-2
PHENAZOPYRIDINE HYDROCHLORIDE		136-40-3
PHENOBARBITAL		50-06-6
PHENOXYBENZAMINE HYDROCHLORIDE		63-92-3
PHENYTOIN		57-41-0
POLYBROMINATED BIPHENYL	FIREMASTER FF1	67774-32-7
POLYCHLORINATED BIPHENYL	PCB; AROCLOR 1260	11097-69-1
POLYCHLORINATED BIPHENYL	PCB; AROCLOR 1254	11097-69-1
PONCEAU 3R		3564-09-8
PONCEAU MX		3761-53-3
POTASSIUM BROMATE		7758-01-2
PROCARBAZINE HYDROCHLORIDE		366-70-1
PROGESTERONE		57-83-0
PROGESTINS		
1,3-PROPANE SULTONE		1120-71-4
BETA-PROPIOLACTONE	1,3-PROPIOLACTONE	57-57-8
PROPYLENE OXIDE		75-56-9
PROPYLTHIOURACIL		51-52-5
RESERPINE		50-55-5
SACCHARIN		81-07-2
SAFROLE		94-59-7
SELENIUM SULFIDE		7446-34-6
SHALE-OILS		
SILICA, CRYSTALLINE		

CHEMICAL	SYNONYM	CAS
SODIUM ORTHO-PHENYLPHENATE	2-BIPHENYLOL, SODIUM SALT	132-27-4
STEPTOZOTOCIN		18883-66-4
STERIGMATOCYSTIN		10048-13-2
STYRENE		100-42-5
STYRENE OXIDE		96-09-3
SULFALLATE		95-06-7
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	TCCD	1746-01-6
TETRACHLOROETHYLENE	PERCHLOROETHYLENE	127-18-4
THIOACETAMIDE		62-55-5
4,4'-THIODIANILINE		139-65-1
THIOUREA		62-56-6
THORIUM DIOXIDE		1314-20-1
TOLUENE DIISOCYANATE		548-84-9
TOLUIDINE	ORTHO-TOLUIDINE	95-53-4
TOLUIDINE HYDROCHLORIDE	ORTHO-TOLUIDINE HYDROCHLORIDE	636-21-5
TOXAPHENE	POLYCHLORINATED CAMPHENES	8001-35-2
TRANS-2[(DIMETHYLAMINO)METHYL-IMINO]-5[2(5-NITRO-2	1,3,4-OXADIAZOLE	55738-54-0
TREOSULPHAN		299-75-2
2,4,6-TRICHLOROPHENOL		88-06-2
TRICHLOROTOLUENE		98-07-7
TRIS(1-AZIRIDINYL)PHOSPHINE SULFIDE	THIOTEPA	52-24-4
TRIS(2,3-DIBROMOPROPYL) PHOSPHATE	TRIS	126-72-7
TRP-P-1 (3-AMINO-1,4-DIMETHYL-5H-PYRIDO[4,3-B]INDO		62450-06-0
TRP-P-2 (3-AMINO-1-METHYL-5H-PYRIDO[4,3-B]INDOLE		62450-07-1
TRYPAN BLUE	DIRECT BLUE 14	72-57-1
URACIL MUSTARD		66-75-1
URETHANE		51-79-6
VINYL BROMIDE		593-60-2
VINYL CHLORIDE		75-01-4
VINYL CYCLOHEXENE DIOXIDE		106-87-6
XYLIDINE	2,4-XYLIDENE	95-68-1

Appendix 12

Carcinogen Exposure Assessment Survey Form
&
Industrial Hygiene Hazard Evaluation Form

Carcinogen Exposure Assessment Survey

PI/Supervisor:		Date:			
Assessor:		Building/Room:		EXPOSURE POTENTIAL	
CARCINOGEN USER	CARCINOGENS USED __ Check if inventory list attached	FREQUENCY OF USE/MONTH 0-2 3-10 >10	AVG. QUANTITY/USE 0-100g 101g-1kg >1kg	(a) Inhalation L M H	(b) Skin L M H

(a) Inhalation Exposure Potential

Low: Use is always in vented hoods or glove boxes with appropriate protection (i.e., gloves, lab coat); or in closed containers outside of fume hood; or, substance/material is a non-volatile solid or a dilute solution (e.g. < 0.1%) used in a manner which will not create significant airborne exposures.

Moderate: Substance/material is volatile or a finely divided particulate and is used outside ventilated enclosure for a period of ≤ 1/2 hr./mo.

High: Open containers used outside of vented enclosures where substance/material is volatile or a finely divided particulate and/or the material is used > 1/2 hr./mo.

(b) Skin Exposure Potential: Evaluate this exposure route independently of the inhalation route. Consider (1) the potential for contact with unprotected skin and the potential for surface contamination (e.g., dusts); (2) the frequency of use; and, (3) the chemical's ability to be absorbed through the skin.

Return this information to the Industrial Hygiene Group, MS: 26-109.

LBL INDUSTRIAL HYGIENE GROUP
HAZARD EVALUATION FORM

Name:_____Emp. No:_____Date:_____

Group:_____ Bldg. No:_____Rm:_____Ext:_____

Hazardous Materials / Agents:

Issue / Operations / Condition:

Actions Needed / Taken:

By: _____

IH Haz Eval Frm

Appendix 13

Reproductive Toxins

Appendix 13

Reproductive Toxins*

1. Developmental toxins:

Chemical	*CAS Number*
acetohydroxamic acid	546883
all-trans retinoic acid	302794
alprazolam	28981977
amikacin sulfate	39831555
aminoglutethimide	125848
aminopterin	54626
benomyl	17804352
benzphetamine hydrocholoride	5411223
bischloloroethyl nitrosourea (BNCU) (Carmustine)	154938
bromoxynil	1689845
1,4-butanediol dimethylsulfonate (Busulfan)	55981
carbon disulfide	75150
carboplatin	41575944
chenodiol	474259
chlorcyclizine hydrochloride	1602219
chlorambucil	305033
chlordecone (Kepone)	143500
1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)	13010474
clomiphene citrate	50419
conjugated estrogens	
cyanazine	21725462
cycloheximine	66819
cyclophosphamide (anhydrous)	50180
cyclophosphamide (hydrated)	6055192
cyhexatin	13121705
cytarabine	147944
danazol	17230885
daunorubiciin hydrocholoride	23541506
diethylstilbestrol (DES)	56531
dinocap	39300453
dinoseb	88857
diphenylhydantoin (phenytoin)	54410
doxycycline	564250

Chemical	*CAS Number*
ergotamine tartrate	379793
ethylene glycol monoethyl ether	110805
ethylene glycol monomethyl ether	109864
etoposide	33419420
etretinate	54350480
fluorouracil	51218
fluoxymesterone	76437
flutamide	13311847
halazepam	23092173
hexachlorobenzene	118741
ifosfamide	3778732
iodine-131	24267569
isotretinoin	4759482
lead	
lithium carbonate	554132
lithium citrate	919164
medroxyprogesterone acetate	71589
megestrol acetate	595335
melphalan	148823
menotropins	9002680
mercaptopurine	6112761
mercury and mercury compounds	
methacycline hydrochloride	3963959
methimazole	60560
methotrexate	59052
methotrexate sodium	15475566
methyl mercury	
methyltestosterone	58184
midazolam hydrochloride	59467968
misoprostol	62015398
mitroxantrone hydrochloride	70476823
nafarelin acetate	86220420
netilmicin sulfate	56391572
nitrogen mustard (mercloroethamine)	51752

Chemical	*CAS Number*
nitrogen mustard hydrochloride (mechlorethamine hydrochloride)	55867
norethisterone (norethindrone)	68224
norethisterone (norethindrone)/ethinyl estradiol	68224/57636
norethisterone (norethindrone)/mestranol	68224/72333
norgestrel	6533002
oxytetracycline	79572
paramethadione	115673
penicillamine	52675
pentobarbital sodium	57330
phenacemide	63989
pipobroman	54911
plicamycin	18378897
polychlorinated biphenyls	
procarbazine hydrocholride	366701
propylthiouracil	51525
streptomycin sulfate	3810740
tamoxifen citrate	54965241
temazepam	846504
testosterone enanthate	315377
2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD)	1746016
tetracycline hydrochloride	64755
thalidomide	50351
thioguanine	154427
tobramycin sulfate	49842071
toluene	108883
triazolam	28911015
trilostane	13647353
trimethainone	127480
urofollitropin	26995915
valproate	99661
vinblastine sulfate	143679
vinvristine sulfate	2068782
warfarin	81812

Chemical	*CAS Number*

2. Female reproductive toxins:

aminopterin	54626
anabolic steroids	
carbon disulfide	75150
cyclophosphamide (anhydrous)	50180
cyclophosphamide (hydrated)	6055192
ethylene oxide	75218
lead	

3. Male reproductive toxins:

anabolic steroids	
benomyl	178043252
carbon disulfide	75150
cyclophosphamide (anhydrous)	50180
cyclophosphamide (hydrated)	6055192
1,2-dibromo-3-chloropropane	96128
m-dinitrobenzene	99650
o-dinitrobenzene	528290
p-dinitrobenzene	100254
dinoseb	88857
ethylene glycol monoethyl ether	110805
ethylene glycol monomethyl ether	109864
lead	

*Extracted from the State of California Safe Drinking Water and Toxic Enforcement Act (Proposition 65) list of chemicals known to the State to cause reproductive toxicity.

Note: Many of the listed chemicals are medicines and other chemotherapeutic agents that cause adverse reproductive effects when consumed orally or when injected into the body. The potential for reproductive toxicity resulting from other routes of exposure common to the laboratory use of chemicals (i.e., inhalation and skin absorption) may be negligible. On the other hand, laboratories and shops

should consider, at a minimum, the following chemicals known to cause reproductive effects when inhaled:

carbon disulfide
dinitrobenzene
ethylene glycol monoethyl ether
ethylene glycol monomethyl ether
lead and lead compounds
mercury and mercury compounds
toluene
ethylene oxide

Appendix 14

Safety Training Check List

Appendix 14

Safety Training Check List

Introduction

It is the responsibility of Division management and line supervisors to train employees in the safety rules of the laboratory and to foster in them an attitude that day-to-day safety is an integral part of all experimental work. The purpose of this checklist is to provide guidance to supervisors for on-the-job safety orientation and training for new and current employees and participating guests. Employee and supervisor signatures at the end provide a record of hazard review.

It is important to:

- Review general laboratory safety rules and specific hazards with the new employee using the attached summary.
- Make arrangements for new employees to attend necessary training, listed in the Course Information bulletin. Call x5514 or x5251 for information.
- Make sure that the employee knows about the Material Safety Data Sheets and other safety references, their purpose and their locations.
- Make sure the employee knows that in the event of an emergency, help should be sought at LBL by dialing x7911.

Instructions:

All new, or transferred employees are to review this checklist with their immediate supervisor in the first week of work. The employee and the supervisor will sign the checklist and a copy shall be retained in the employee's file for as long as he/she works in that lab. Upon termination or transfer, a copy shall be sent to personnel for permanent retention in the employee's file.

Table of Contents:

A. General Safety Information

Yes	No	
		I understand safety responsibilities and authorities at LBL:
___	___	- personal
___	___	- my supervisor
___	___	- EH&S
___	___	I know what PUB-3000 is.
___	___	I know where PUB-3000 is.
___	___	I know what the Chemical Hygiene & Safety Plan (CHSP) is.
___	___	I have been designated as a Radiation Worker.
		I participate in the following radiation exposure monitoring programs:
		- Radiation Dosimeter:
___	___	gamma only
___	___	gamma/neutron
___	___	- Bioassay
___	___	I know that there is no eating and drinking in labs/shops.
___	___	I know that no smoking is allowed in labs.
___	___	I know my responsibilities regarding Hazards Communication.
___	___	I am responsible for safety training for others.
___	___	I know where to find MSDS for chemicals/materials.
___	___	I know what an Operational Safety Procedure (OSP) is, what a Specific Safety Procedure (SSP) is, and when each is required.
___	___	I know who the Division Safety Coordinator is.
___	___	I know my assembly area in an emergency.
___	___	I know where to find the Laboratory Emergency Plan.
___	___	I know about the LBL Bioassay Program.

Yes	No	
___	___	I know where emergency numbers are posted.
___	___	I know where hazard signs are posted - proper label used.
___	___	I know Workers' Compensation Procedures, and will report any illness or injury to my supervisor and Health Services.

B. Hazard Training

I have been instructed in the handling/use of the following hazardous materials and physical hazards.

No	N/A		Yes	If Yes, Was Training By: Supervisor	EH&S	Other (Specify)
___	___	Biohazards	___	_____	_____	_____
		list: _____				
___	___	Human blood & blood products	___	_____	_____	_____
___	___	Carcinogens	___	_____	_____	_____
		list: _____				
___	___	Corrosives:	___	_____	_____	_____
		Acids	___	_____	_____	_____
		Caustics	___	_____	_____	_____
___	___	Cryogenic Materials	___	_____	_____	_____
___	___	Electrical Hazards	___	_____	_____	_____
		list: _____				
___	___	Explosive Materials	___	_____	_____	_____
___	___	Flammables	___	_____	_____	_____
___	___	Gases:	___	_____	_____	_____
		Compressed	___	_____	_____	_____
		Flammable	___	_____	_____	_____

No	N/A		Yes	If Yes, Was Training By: Supervisor	EH&S	Other (Specify)
___	___	Hazardous Equipment	___	_____	_____	_____
___	___	Heavy Metals	___	_____	_____	_____
___	___	High Pressure	___	_____	_____	_____
___	___	High Temp.	___	_____	_____	_____
___	___	Infectious agents	___	_____	_____	_____
		list: _____				
___	___	Irritants/ Sensitizers	___	_____	_____	_____
___	___	Lasers	___	_____	_____	_____
___	___	Lifting	___	_____	_____	_____
___	___	Magnetic Hazards	___	_____	_____	_____
___	___	Microtomes	___	_____	_____	_____
___	___	Noise	___	_____	_____	_____
___	___	Organic Solvents	___	_____	_____	_____
___	___	Oxidizers	___	_____	_____	_____
___	___	Radiation/ Accelerator	___	_____	_____	_____
___	___	Reproductive Toxins	___	_____	_____	_____
		list: _____				
___	___	Solvents	___	_____	_____	_____
___	___	Toxic Materials (not already listed)	___	_____	_____	_____
		list: _____				

No	N/A		Yes	If Yes, Was Training By: Supervisor	EH&S	Other (Specify)
		WASTE:				
___	___	Medical/ Biohazardous	___	_____	_____	_____
___	___	Chemical	___	_____	_____	_____
___	___	Radioactive	___	_____	_____	_____
___	___	Sharps	___	_____	_____	_____

Others:

_____

_____

_____

C. Work Practices and Procedures

I have been instructed in the following work practices and procedures.

No	N/A		Yes	If Yes, Was Training By: Supervisor	EH&S	Other (Specify)
___	___	Assembly area in an emergency	___	_____	_____	_____
___	___	CPR	___	_____	_____	_____
___	___	Earthquake preparedness procedures	___	_____	_____	_____
___	___	Emergency exits	___	_____	_____	_____
___	___	Emergency procedures	___	_____	_____	_____
___	___	Emergency showers, eyewashes	___	_____	_____	_____

No	N/A		Yes	If Yes, Was Training By: Supervisor	EH&S	Other (Specify)
___	___	Fire extinguishers (location and use)	___	_____	_____	_____
___	___	Laboratory Emergency Plan	___	_____	_____	_____
___	___	Lockout-Tagout	___	_____	_____	_____
___	___	Spill kits - location and use	___	_____	_____	_____
___	___	Standard First Aid	___	_____	_____	_____
___	___	Ignition sources around flammable materials	___	_____	_____	_____
___	___	Appropriate chemical storage	___	_____	_____	_____
___	___	Transporting chemicals safely	___	_____	_____	_____
___	___	Confined Space Entry	___	_____	_____	_____
___	___	Not working alone (Always let someone know where you are and how long you'll be working)	___	_____	_____	_____
___	___	Fume hoods - correct use and performance checks	___	_____	_____	_____
___	___	Labelling of chemical containers	___	_____	_____	_____
___	___	Pipetting - mechanical (never by mouth)	___	_____	_____	_____
___	___	Waste Minimization	___	_____	_____	_____

D. Equipment/Machinery

I have been trained in the use of the following equipment.

No	N/A		Yes	If Yes, Was Training By: Supervisor	EH&S	Other (Specify)
___	___	Centrifuges	___	_____	_____	_____
___	___	Compressed gas cylinders	___	_____	_____	_____
___	___	Ergonomic use of VDTs	___	_____	_____	_____
___	___	Equipment operated at extreme temperatures or pressures	___	_____	_____	_____
		list: _____				
___	___	Lifting equipment	___	_____	_____	_____
___	___	Machine/ equipment guards	___	_____	_____	_____
___	___	Sterilization equipment	___	_____	_____	_____
___	___	Radiation monitoring equipment	___	_____	_____	_____
___	___	UV lights	___	_____	_____	_____
___	___	Vacuum systems	___	_____	_____	_____
___	___	X-ray sources	___	_____	_____	_____
___	___	Machine Tools	___	_____	_____	_____
___	___	Soldering, welding, cutting	___	_____	_____	_____
___	___	Syringes & needles	___	_____	_____	_____

No	N/A		Yes	If Yes, Was Training By: Supervisor	EH&S	Other (Specify)
___	___	Use of power tools and/or shop/industrial machinery *list:*	___	_____	_____	_____
___	___	Shop/industrial machinery (other, not already listed) *list:*	___	_____	_____	_____

Others:

_____

_____

_____

E. Electrical Safety

I am aware of the following regulations:

Yes	No	N/A	
___	___	___	All boxes, raceways, fittings, etc., must have protective covers.
___	___	___	Cable trays are to be properly grounded; not overfilled.
___	___	___	Disconnect devices (switches, breaks, etc.) are to be identified as to use.
___	___	___	Electrical cords/wires are to be protected from damage.
___	___	___	Electrical equipment is to be grounded or provided with barriers/shields.
___	___	___	Electrical equipment that is provided should be suitable for workplace environment (i.e., proper electrical classification for wet or explosive areas, etc.).
___	___	___	Exposed terminals are to be guarded adequately.
___	___	___	Ground fault interrupters (GFI) are installed in wet areas and in receptacles within 6 feet of sinks, including fume hood sinks.

Yes	No	N/A	
___	___	___	Grounding points are to be clearly identified inside enclosures.
___	___	___	Hand-held power tools are to be provided with double insulation or electrical grounds.
___	___	___	High voltage control panels and doors are to be closed and interlocked. Power cabinets are to be properly labeled.
___	___	___	High voltage equipment grounding hooks are available and fully visible.
___	___	___	High voltage warning signs are to be posted at enclosure doors and removable panels as required (voltage greater that 600 volts).
___	___	___	Lock out tags should be on circuit breaks, unused circuit breakers should be locked out and tagged.
___	___	___	No broken or removed grounding pins are to be present on 3-wire cord plugs.
___	___	___	No metal ladders are to be near electrical equipment, or to be used for electrical work.
___	___	___	Office wiring should be sufficient to meet electrical needs.
___	___	___	Oil-filled transformers are to be provided with a secondary containment.
___	___	___	Permanently located machinery is to be hard wired.
___	___	___	Plugs, cords (no frayed cords) and receptacles are to be properly installed and in good condition. They must have cover plates on receptacles.
___	___	___	There is unobstructed access to control switches, circuit breakers, electrical panels (3 foot clear zone).
			Proper use of power extension cords:
___	___	___	1. Not using them in place of permanent wiring
___	___	___	2. Not running through walls, ceilings, doors, etc.
___	___	___	3. Use of proper cord plugs
___	___	___	4. Use of three conductor cables
___	___	___	5. No use of damaged or taped cords
___	___	___	6. Not daisy-chaining them together

F. Housekeeping

I am aware of the following general needs/requirements.

Yes	No	N/A	
___	___	___	Aisles, passageways have 3 ft. of clearance.
___	___	___	Floors are clean and dry.
___	___	___	Furniture is in good repair.
___	___	___	Storage areas are orderly.
___	___	___	Storage shelves have lips to prevent objects from falling.
___	___	___	Houseplants are properly secured.
___	___	___	Locker, file cabinets, furniture, and equipment over 5 feet high are secured against tipping and falling during an earthquake. Seismic tiedown has been completed.
___	___	___	No heavy objects are stored above 5 feet unless secured.
___	___	___	No cardboard boxes, piles of papers, or computer output are stored under tables.
___	___	___	No food or beverages are in chemical use/storage areas.
___	___	___	No sharp, protruding objects are left unprotected.
___	___	___	No trip hazards exist.
___	___	___	There is an orderly and clean appearance to the work area.
___	___	___	Raised areas (platforms) which are used for storage are identified as to load limit. Loads are within limits.
___	___	___	Refrigerators are properly labeled when used for food or beverage storage.
___	___	___	Separate storage and disposal containers are available for rags, glass, paper, and hazardous materials.
___	___	___	There is sufficient illumination of work areas.

Yes	No	N/A	
___	___	___	Unused equipment is maintained in a safe, orderly manner or is sent to storage/salvage.
___	___	___	When materials are stored, they are securely stacked to prevent tipping.

I understand that my supervisor will keep me trained as new hazards are introduced into the workplace, and that I can ask my supervisor or EH&S for further health and safety information as the need arises.

Any comments:

_____

_____

_____

_____

_____

_____

_____

Employee's signature: _____

Date: _____

Supervisor's signature: _____

Date: _____

Appendix 15

Chemical Information
(MSDSs, Ethernet, and TOMES)

Appendix 15

Using the Material Safety Data Sheet (MSDS)

I. INTRODUCTION

The purpose of the MSDS is to provide vital information on health and physical hazards. This part of the program 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 Terms (Appendix Thirteen) 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 information, some are adequate, and others are poor. Other sources of data on toxic and health effects should be consulted for more complete information.

II. PRODUCT IDENTITIY

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 Number(s): 24-hour number(s) that the manufacturer provides, so that emergency information can be obtained (e.g., medical emergencies).

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

Formula: The chemical formula may be given for single elements and compounds [e.g., sulfur dioxide (SO2), formaldehyde (HCHO)]. This is not the formulation for mixtures.

Using the Material Safety Data Sheet (MSDS), cont.

III. HAZARDOUS INGREDIENTS

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.

IV. 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 Fahrenheit (°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 25oC (77oF). 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.

Using the Material Safety Data Sheet (MSDS), cont.

% Volatiles by Volume: How much of the material evaporates at room temperature. A substance that is 100% volatile, will evaporate completely, leaving no residues.

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

V. FIRE & EXPLOSION HAZARD DATA

This section should clearly indicate whether the material is flammable. If it is flammable, make sure there are no ignition source nearby and that 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 gives off enough vapor to ignite; this will help determine storage and handling procedures. The method used to obtain this information should be stated (e.g., closed cup).

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.

Using the Material Safety Data Sheet (MSDS), cont.

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.

VI. 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. This is important to determining what other chemicals the material cab be stored/used with.

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 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.

VII. 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 "target organ" 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.

Using the Material Safety Data Sheet (MSDS), cont.

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.

VIII. PRECAUTIONS FOR HANDLING

This information will help you prepare for emergencies by having the proper materials and equipment on hand. This 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.

IX. 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.

Canadian Centre for
Occupational Health and Safety

BUTYLAMINE

CHEMICAL INFOGRAM 36

CAS 109-73-9
FORMULA: CH_3-CH_2-CH_2-CH_2-NH_2

DESCRIPTION
Colourless liquid.
Fishy or ammonia-like odour.

Used as:
- catalyst
- corrosion inhibitor
- food flavouring

Used in the manufacture of:
- rubber
- other chemicals

SHORT-TERM EXPOSURE EFFECTS


Toxic


Corrosive

Inhalation:
Vapour or mist can irritate nose, throat and lungs.
High concentrations may cause fatal fluid build-up in lungs.
Symptoms such as shortness of breath may appear several hours after exposure.

Eye Contact:
Liquid, vapour or mist can severely irritate eyes causing redness and pain.
Severe exposure may burn eyes.
Other amines can cause temporary visual disturbances, such as blurred vision.

Skin Contact:
Liquid or mist can irritate skin.
Severe exposure can cause corrosive skin burns.
Prolonged contact may produce toxic effects such as:
- headache
- faintness
- nausea
- anxiety

Ingestion:
Liquid may burn:
- mouth
- throat
- digestive tract

Symptoms same as prolonged skin contact.

LONG-TERM EXPOSURE EFFECTS
Some forms of amines cause respiratory sensitization.
At very low levels, sensitized people experience asthma-like symptoms such as:
- wheezing
- difficult breathing

Repeated or prolonged skin contact with some amines, and possibly butylamine, can cause allergic skin sensitization with itching and rash.

FIRE AND EXPLOSION


Flammable Liquid

Can be ignited under almost all normal temperature conditions.
Vapour can form explosive mixtures with air.
Extinguish fires with:
- dry chemical
- halons
- alcohol foam
- polymer foam
- carbon dioxide
- large amounts of water

CHEMICAL REACTIVITY


Corrosive

Normally stable.
May react violently with oxidizing agents and cause fire and explosion.
May react violently with:
- acids
- alcohols
- glycol ethers
- monomers

Corrosive to certain metals.

PERSONAL PROTECTION
Inhalation:
Wear suitable breathing apparatus if vapour or mist concentration is unknown or exceeds exposure limits.

Skin:
Wear, as needed:
- gloves
- coveralls
- boots

A suitable material is Teflon.
Have a safety shower/eyewash fountain available in the immediate area.

Eyes:
Wear chemical safety goggles.
A face shield may be needed.

STORAGE AND HANDLING
Follow rules for storing and handling flammable materials.
Store butylamine:
- in suitable, labelled containers
- in a clean, well-ventilated area
- away from work areas and incompatible materials
- out of direct sunlight
- away from heat and ignition sources

Ground drums and bond transfer containers.
Keep containers closed when not in use.
Avoid releasing mist or vapour.

CLEAN-UP AND DISPOSAL
Only trained personnel should clean up.
Ensure appropriate ventilation is provided.
Use appropriate protective clothing and respirators.
Remove or extinguish all ignition sources.
Follow manufacturer's recommendations for clean-up and decontamination.
Comply with environmental regulations.

FIRST AID
Inhalation:
Ensure own safety first.
Use "buddy" system.
Control source of butylamine or move victim to fresh air.
Trained person may administer oxygen if physician advises.

Eye Contact:
Flush affected eye(s) with lukewarm, gently flowing water for 20 minutes, holding the eyelid(s) open.

Skin Contact:
Remove contaminated clothing under running water.
Immediately wash affected area with lukewarm, gently running water for at least 20 minutes.

Ingestion:
Never give anything by mouth if victim is:
- losing consciousness
- unconscious
- convulsing

Rinse mouth thoroughly with water.
Have victim drink about 250 mL (8 oz.) of water.
DO NOT INDUCE VOMITING.

Note: Obtain medical attention IMMEDIATELY for all serious exposures. Consult a physician or the nearest Poison Control Centre.

NEED MORE INFORMATION?
See CHEMINFO record no. 454E, available from CCOHS.

250 Main Street East Hamilton Ontario Canada L8N 1H6
Telephone (416) 572-2981 Fax: (416) 572-2206

ISSN 0835-8176
August 1992

TOMES Plus™

Toxicology, Occupational Medicine & Environmental Series

MICROMEDEX, INC.®

TOXICOLOGY, OCCUPATIONAL MEDICINE & ENVIRONMENTAL SERIES

The TOMES Plus™ Information System is a user-friendly, industrial chemical database which is continually updated and republished every 90 days in its entirety. It provides rapid, easy access to medical and hazard information needed for safe management of chemicals in the workplace, for evaluating exposures, for right-to-know issues for SARA Title III regulatory compliance and for quick response to emergency situations and environmental incidents. On-going enhancements make the TOMES Plus Information System the ultimate tool for occupational and environmental toxicity information. The components of the TOMES Plus database are as follows:

MEDITEXT™ - Medical Managements

Information for health care professionals involved in the evaluation and treatment of individuals acutely exposed to industrial chemicals. It also contains information necessary for reporting potential adverse health effects and treatment of chemical release exposures as required under Title III (Emergency Planning and Community Right to Know) of the Superfund Amendment and Reauthorization Act (SARA). MEDITEXT includes:

- Overview
- Chemical synonyms and potential use data
- Clinical effects of exposure (indexed by organ system)
- Laboratory evaluation of exposed individuals
- Treatment of exposed individuals (organized by route of exposure)
- Range of toxicity
- Available forms and sources
- Kinetics
- Toxicology mechanisms
- Standards
- Physicochemical parameters
- References

HAZARDTEXT™ - Hazard Managements

Information needed for the initial response to incidents involving hazardous materials such as spills, leaks and fires. It may be useful for medical and Hazmat first responders. HAZARDTEXT includes:

- Chemical names and synonyms
- Clinical effects
- Treatment
- Range of toxicity/standards
- Hazard data and management
- Physicochemical parameters
- References

TOMES plus™

1st Medical Response Protocols

Information for developing training programs or establishing protocols for first aid or initial response to accidents or illnesses occurring in the workplace. It may be useful for occupational medicine and safety personnel. Examples are amputations, burns, heat illness and seizures. 1st Medical Response Protocols include:

- Presentation
- Stabilization
- Base contact
- Special concerns
- References

RTECS from NIOSH

Registry of Toxic Effects of Chemical Substances Database from the National Institute for Occupational Safety and Health

An annual compendium of toxicity data extracted from the scientific literature. Over 95,000 documents containing data on mutagenicity, carcinogenicity, reproductive hazards and acute and chronic toxicity of hazardous substances. RTECS documents include:

- Substance identification
- Synonym/trade name
- Health hazard data
- Acute toxicity
- Irritation
- Reproductive effects
- Genetic effects
- Standards and regulations
- Status in the United States
- Reviews

HSDB from NLM

Hazardous Substances Data Bank from the National Library of Medicine

Extensive reviews of the toxicity and hazards of over 4,000 chemicals. HSDB documents include:

- Administrative information
- Substance identification
- Manufacture/use information
- Chemical & physical properties
- Safety & handling
- Toxicity/biomedical effects
- Pharmacology
- Environmental fate/exposure potential
- Exposure standards & regulations
- Monitoring & analysis methods
- Additional references
- Express data

OHM/TADS from EPA

Oil and Hazardous Materials/Technical Assistance Data System from the Environmental Protection Agency

Environmental effects of over 1,200 petroleum products and hazardous materials. OHM/TADS documents include:

- Substances
- Transport/storage/handling
- Laboratory
- Physicochemical parameters
- Fire/explosion/corrosion hazards
- Environmental hazards
- Range of toxicity
- Human health hazards
- Cleanup procedures
- Data adequacy evaluation

CHRIS from Coast Guard

Chemical Hazard Response Information System developed by the U.S. Coast Guard

Release, fire and health hazards of over 1,000 chemicals. CHRIS documents include:

- Overview
- Response to discharge
- Label
- Chemical designations
- Observable characteristics
- Health hazards
- Fire hazards
- Chemical reactivity
- Water pollution
- Shipping information
- Hazard classifications
- Physical & chemical properties

DOT Emergency Response Guides

Department of Transportation Emergency Response Guides

Initial response to fires, explosions and releases involving hazardous chemicals. Documents include:

- Potential hazards
- Emergency action
- Reference

IRIS from EPA

Integrated Risk Information System from the Environmental Protection Agency

Information on how 375 chemicals affect human health. It is a primary source of risk assessment data on chemicals of environmental concern. IRIS documents include:

- Introduction
- Chronic health hazard assessment for non-carcinogenic effects
- Carcinogenicity assessment for lifetime
- Health hazard assessments for varied exposure durations
- U.S. EPA regulatory actions
- Supplementary data
- Bibliography
- Revision history

SEARCHING THE SYSTEM:

Chemicals can be retrieved by chemical name or synonym and CAS, NIOSH/RTECS, STCC, UN/NA (DOT), ENT or USAF numbers. After the first entry, searching is accomplished by single keystroke choices from a series of menus. "Backtracking" through the search is also done by single keystrokes. As every screen displays all needed navigation instructions, formal training is not needed and a cumbersome user's manual does not need to be mastered. Several features make searching quick and simple:

HELP SCREENS - Explain instructions for using the system
USING THE SYSTEM - Identifies where specific topics can be found
HOW THE DOCUMENT IS ORGANIZED - Displays subject categories and their subheadings
INTEGRATED INDEX - Offers search capability on specific chemicals in several databases

THE EDITORIAL BOARD:

The primary responsibility for maintaining quality rests with the TOMES Plus™ Editorial Board and Editorial Staff, which is comprised of leading professionals in environmental, industrial and reproductive toxicology, occupational medicine and industrial hygiene and safety. The number of member editors continues to rise as the system expands to cover new topics and becomes more comprehensive. Publication of this system has been through the efforts and contributions of the Editorial Board and the following Editorial Staff:

DELIVERY METHODS

The TOMES Plus Information System is offered via the following delivery methods:
Compact disc for use with personal computers
Computer tapes for IBM and DEC VAX
Other configurations under development.

WHO IS MICROMEDEX?

In 1974, Micromedex introduced its first product by publishing information on microfiche for Poison Centers in the United States. By 1989, more than 35 countries were relying on the Micromedex databases. In addition to toxicology information, Micromedex now provides drug information, emergency medicine information and other programs. In 1987, the TOMES database was originally derived from the Micromedex POISINDEX® System. In April 1989, the TOMES Plus database was introduced, an enhancement of the original product offering several additional chemical databases. The Micromedex state-of-the-art databases are available on various configurations including compact disc (CD-ROM) and mainframe tapes. A wholly owned subsidiary of Mead Data Central since 1985, Micromedex expects to continue its growth by providing current and comprehensive reference sources.

Appendix 16

Subject Index

Appendix 16

Subject Index

A

B

C

D

E

F

G

H

I

J-L

M-N

O

P

Q-R

S

T

U-V

W,X,Y,Z

END

DATE FILMED

2/5/93