Pocket Guide to Chemical and Environmental Safety in Schools and Colleges

VOLUME 1
BASIC PRINCIPLES

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Chemical and Environmental Safety and Health in Schools and Colleges Series

Compact School and College Administrator's Guide for Compliance with Federal and State Right-To-Know Regulations

Written Hazard Communication Program for Schools and Colleges

Concise Manuals of Chemical and Environmental Safety in Schools and Colleges

Volume 1 Basic Principles
Volume 2 Hazardous Chemical Classes
Volume 3 Chemical Interactions
Volume 4 Safe Chemical Storage
Volume 5 Safe Chemical Disposal

Pocket Guides to Chemical and Environmental Safety in Schools and Colleges
(Five condensed, portable versions of the Concise *Manuals,* with the same volume numbers and titles as above)

Handbook of Chemical and Environmental Safety in Schools and Colleges

Compendium of Hazardous Chemicals in Schools and Colleges

List of Lists of Hazardous Chemicals and Environmental Pollutants

Cross-Reference Index of Hazardous Chemicals, Synonyms, and CAS Registry Numbers

Index of Hazardous Contents of Commercial Products in Schools and Colleges

Pocket Guide to Chemical and Environmental Safety in Schools and Colleges

VOLUME 1

Basic Principles

The Forum For Scientific Excellence, Inc.

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Foreword to the Series

The Forum For Scientific Excellence, Inc. (FSE) has spent many years developing an integrated hazardous chemical management program for schools and colleges. This program is the result of careful consideration of all existing regulatory requirements at federal and state levels, practical experience and awareness of actual needs within the educational environment, and the best ideas from employee committees and management teams. As our on-the-job experience in schools and colleges has revealed new informational needs, we have expanded the available resources.

This comprehensive school and college series has been designed to benefit administrators and employees alike. In order to effectively modify poor employee work habits, often established over the course of many years, employees must be provided with hazardous chemical information in a variety of continuous, complementary ways that will remind them that their health and safety on the job depend on personal knowledge and work practices. Simultaneously, management needs to become more aware that safety and health on the job raises productivity and morale. Administrators should implement not only "bare minimum" procedures, but also a responsible hazardous chemical management program that fulfils all three of the following objectives:

1. Public Responsibility: What must be done to properly protect employees, students, or contractors who work in an educational facility, and maintain public confidence.
2. Tort Liability: What can be done to minimize the potential for lawsuits.
3. Regulatory Compliance: What the laws require.

We have found that educational institutions often have neither enough time nor money to do the job right the first time, but always have enough time and money to do it over-after there has been an accident, lawsuit, or fine. Similarly, employees often "know a better way," even if it is not safer, until there is an accident on the job. Then they often retort: "You should have made me listen!"

Two books in this series have been designed specifically to increase the knowledge and awareness of school and college administrators:

Compact School and College Administrator's Guide for Compliance with Federal and State Right-To-Know Regulations

Written Hazard Communication Program for Schools and Colleges

Ten employee training manuals have been designed to progressively increase employees' knowledge and awareness of hazardous chemicals:

Concise Manuals of Chemical and Environmental Safety in Schools and Colleges

Volume 1 Basic Principles
Volume 2 Hazardous Chemical Classes
Volume 3 Chemical Interactions
Volume 4 Safe Chemical Storage
Volume 5 Safe Chemical Disposal

Pocket Guides to Chemical and Environmental Safety in Schools and Colleges (condensed editions of the five volumes listed above)

Five reference books have been developed to give both administrators and employees in schools and colleges access to identification, properties, and hazard information for chemicals and products:

Handbook of Chemical and Environmental Safety in Schools and Colleges (consolidates all the information in the Concise Manuals into one major reference)

Compendium of Hazardous Chemicals in Schools and Colleges

List of Lists of Hazardous Chemicals and Environmental Pollutants

Cross-Reference Index of Hazardous Chemicals, Synonyms, and CAS Registry Numbers

Index of Hazardous Contents of Commercial Products in Schools and Colleges

Although we have applied considerable experience and expertise in the development and integration of this hazardous chemical management system, customized adjustments within your school or college should probably be considered to cover any special local needs or conditions. Specific state or institutional regulations or priorities also may warrant some modifications in this system, but we have tried to accommodate as many contingencies as we could envision.

The breadth and depth of the Series will certainly leave considerable opportunity for improving areas in each book. We invite comments and suggestions that will improve these publications for all potential users.

Dr. George R. Thompson, CEO
The Forum For Scientific Excellence, Inc.

Contents

Pocket Guide to Chemical and Environmental Safety in Schools and Colleges

VOLUME 1
BASIC PRINCIPLES

Introduction

All conditions and circumstances affecting our surroundings are considered part of our environment, and protecting that environment is everyone’s job. Since the best way to do this is to prevent problems from occurring, prevention is the primary goal of this academic hazard communication and training program.

Your administration recognizes the importance of your role in maintaining the highest standards of personal and environmental protection. Throughout this manual, you will be shown the necessity for:

1. Carefully following label directions,
2. Using proper safety precautions in the operation of equipment, and
3. Using protective apparatus and devices provided for your personal protection.

This book will provide you with the knowledge you need to recognize a potential problem before it occurs and threatens your safety. It will also teach you how to take corrective actions to prevent hazardous situations from developing.

Your own personal health and safety as well as that of your students is of major concern to your administration. Enhancing your personal awareness of chemical hazards and improving your ability to prevent accidents are our main objectives. Your administration wants you to learn the information in this manual and to conscientiously implement all recommended health and safety practices. Please report any potential hazards that you observe to your administrator.

CHAPTER 1

The OSHA Hazard Communication Standard and Individual State Right-To-Know Laws

APPLICABILITY AND SCOPE OF REGULATORY REQUIREMENTS

Development of a standard on hazardous materials labeling by the United States Occupational Safety and Health Administration (OSHA) began in 1974. The initial Standard was promulgated on November 25, 1983, but affected only chemical manufacturers, distributors, and importers in industries defined by Standard Industrial Classification (SIC) Codes 20-39. Employers in those industries were required to inform their employees of hazards within their work areas by supplying container labels, providing accessibility to Material Safety Data Sheets (MSDSs) or comparable written information, developing written plans for implementing the hazard communication program, and training employees to protect themselves from specific chemical hazards.

A revised OSHA Standard was promulgated August 24, 1987, and went into effect June 24, 1988, following various court actions that delayed implementation of requirements for various industries. This revised OSHA Hazard Communication

Standard requires chemical manufacturers, distributors, and importers to ensure that MSDSs are provided with the next shipment of hazardous chemicals to nonmanufacturing employers or distributors. The original application of this Standard has now been expanded to encompass all private employees and employers throughout the United States. Chemical manufacturers are required to prepare the technical hazard information for MSDSs and labels accompanying hazardous chemicals. A comprehensive hazard communication program involving individualized training must be offered to all employees potentially exposed to hazardous chemicals.

Both state and local laws competing with the OSHA Standard have been preempted for all private employers. Public educational institutions in the 18 states with individual “right-to-know” laws, however, are not affected by this OSHA Standard, but must comply with their state right-to-know law. Public educational institutions in the 9 states and the District of Columbia with no right-to-know laws also are not required to comply with the OSHA Standard, but using this Standard as a “guideline” would be prudent. Public educational institutions in 23 states and 2 territories with OSHA-approved state plans and all private educational institutions must follow the OSHA Standard.

The scope of responsibilities essential to either the OSHA Standard or the individual state right-to-know laws encompasses eight specific areas. Some unique requirements are added for a few states.

Of the 18 state and 1 federal set of regulations, 17 require a hazardous substance list. Audits, surveys, or inventories are required by 18 of the 19 agencies. Specific content and reporting requirements, however, vary. Chemical or product research to assure that employees recognize and understand chemical or product ingredients is required by 18 of the 19 agencies, thus fulfilling the hazard communication for the employees’ “right to know.”

All 19 agencies demand that hazardous chemical data sheets be supplied. Material Safety Data Sheets from the manufacturers are relied upon by 17 of the 19 agencies. The states of New Jersey and New York provide their own chemical data sheets, but also require that product data sheets be obtained from manufacturers and made available to employees. Some form of chemical or product labeling is required by 11 of the 19 agencies, but 8 of those 11 do not specify labeling requirements. Written and/or oral employee education and training is required by 17 of the 19 agencies. OSHA, Maine, North Dakota, and Oklahoma require a written Hazard Communication Program.

Responsibilities and rights of the various parties named in the OSHA Standard and individual state right-to-know laws vary. Some legislative bodies have taken a very general approach, whereas others have defined their laws in great detail.

In order to fully understand compliance requirements applicable to your educational institution, we suggest you contact your regional OSHA office and/or responsible state agency. States with individual right-to-know laws have individuals assigned to answer your questions and help clarify your program.

PURPOSE OF THE REGULATIONS

The OSHA Hazard Communication Standard and most state right-to-know laws cover situations in which employees "may be exposed" to hazardous chemicals. Such exposure is defined to include "potential," as well as actual, exposure. This is to ensure that employees receive information about all chemical hazards in their work areas, and that they are prepared to deal with any unexpected releases or emergency situations, as well as exposures during the normal course of employment.

Developing a Written Hazard Communication Program

Each educational facility that must comply with the OSHA Standard or the Maine, North Dakota, or Oklahoma right-to-know laws must establish a comprehensive written hazard communication program that includes provisions for hazard assessments, Material Safety Data Sheets, container labeling, and an employee training program. The program must also contain a list of the hazardous chemicals in each work area, the means by which the employer will inform employees of the hazards of nonroutine tasks (e.g., cleaning boilers), hazards associated with chemicals in unlabeled containers, and the way the educational institution will inform contractors in its facilities of the hazards to which contractor employees may be exposed.

The written program need not be lengthy or complicated, but should include the following elements:

- Written hazard assessment procedures
- Material Safety Data Sheets
- Labels and other forms of warning
- Employee training

Hazard Assessments

Schools and colleges are not required to evaluate chemical or product hazards by the OSHA Standard or by any individual state right-to-know laws, since they are allowed by these laws to rely upon the required assessments performed by the chemical manufacturer or importer. The frequent and gross inadequacies of many manufacturer and importer assessments, however, coupled with potentially significant tort liability risks for schools and colleges that accept erroneous manufacturer or importer assessments, warrant careful consideration of this matter by prudent school and college administrators.

Regardless of who performs the hazard assessments, health evaluations for chemicals must consider all animal and human studies "designed and conducted according to established scientific principles, and which report statistically significant conclusions." Health hazards include carcinogenic, corrosive, highly toxic, toxic, irritant, sensitization, and target organ effects. Physical hazard assessments for a chemical must consider all "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,"

Health and physical hazard assessments must also be performed for all mixtures. Untested mixtures with health hazard components that comprise 1% or greater of the mixture, or carcinogenic components that equal or exceed 0.1% of the mixture, are presumed to present the same health or carcinogenic hazards as the components. Physical hazard assessments for mixtures must be based upon "whatever scientifically valid data are available. "

Material Safety Data Sheets

Chemical manufacturers and importers must obtain or develop a Material Safety Data Sheet (MSDS) for each hazardous chemical they produce or import. Employers must have an MSDS for each hazardous chemical and product containing a hazardous chemical they use.

Each MSDS should be in English and should contain very specific information as required by the OSHA Hazard Communication Standard. If no relevent information is available, the MSDS must be marked to indicate that no applicable information was found.

Labeling

In the workplace, each container must be labeled, tagged, or marked with the identity of hazardous chemicals it contains. The label must show hazard warnings appropriate for employee protection. The hazard warning can be any combination of message, words, pictures, or symbols that convey the hazards of the chemical(s) in the container. Labels must be legible, in English (plus other languages, if desired), and prominently displayed. The name and address of the chemical manufacturer, importer, or other responsible party must be shown.

The employer, and employees, should not remove or deface existing labels on incoming containers of hazardous materials. New warning labels need not be applied if existing labels already convey the required information, but employees must usually be trained how to use each labeling system. All the stated requirements apply to employees through each work shift within the workplace.

Some labeling systems used in the workplace communicate the degree of severity of the hazard by a numerical rating system. While these would not be appropriate for labels on containers leaving the workplace (since they do not convey full hazard information), they can be used in the workplace where labels are supplemented by MSDSs and training. Written alternatives to workplace labels are often permitted as long as the labels are supplemented with more specific information.

Trade Secrets

Employees must be informed about companies that withhold specific chemical identification or claim the chemical is a trade secret. The claim that the information withheld is a trade secret must be indicated on the MSDS. The specific trade secret chemical identity must be made available to health professionals and designated representatives if an emergency does occur.

Employee Information and Training

Information and training requirements are performance oriented and are designed so that each employer will adequately address the hazards posed by chemicals in the workplace. Training may be done specifically on each chemical within the workplace or by categories of hazards (e.g., flammable, carcinogen, etc.). Retraining must take place both when a new chemical is introduced into the workplace and when the hazard changes.

List of Hazardous Chemicals

A current on-site hazardous chemical inventory must be accessible to employees; data sheets for each product or chemical on this list must also be made available.

Hazards of Nonroutine Tasks

Methods to be used to inform employees of the hazards of nonroutine tasks and the hazards of chemicals in unlabeled containers must be written and presented to affected employees. Documentation of employee training given for procedures used for nonroutine tasks is usually required.

On-site Contractors

Methods to inform on-site contractors of hazards their employees may be exposed to while performing their work must also be developed and implemented by the employer. Documentation of contractor awareness of potential hazards would be prudent.

State Plan Applicability

The 25 states and territories with their own OSHA-approved occupational safety and health plans must adopt a comparable standard within six months of the publication date of the final standard. The revised or expanded OSHA Standard went into effect on June 24, 1988, for most nonmanufacturing employers, although some states delayed implementation slightly longer. Private, and many public, educational institutions in states with OSHA-approved state plans must comply with all the OSHA Standard requirements and responsibilities.

CHAPTER 2

Understanding "Hazards"

Before we look at other specific terms and definitions, let us first consider the term hazard. What does it mean? As you will see, a hazard can be many things, in many different settings, at many different times. The dictionary defines the word hazard as "an exposure to danger or harm; a thing which includes a risk or peril." A hazardous substance is risky or potentially dangerous.

We are surrounded by many hazards in our daily lives, and some of these risks or perils we accept matter-of-factly. For example, we do not ordinarily think of gasoline as a hazardous material-it is routinely pumped at service stations, and many people carry large amounts in their cars. Not many of us stop to think about gasoline's potentially flammable and toxic nature. When stored, pumped, and transported correctly, this fuel is safe for its intended use. Because it evaporates easily, however, gasoline exposes us to risk. We have all been taught not to expose gasoline to heat or flame. In fact, every service station is required by law to post warning signs about not smoking near gasoline pumps and shutting off the car engine when filling your tank. These warnings reduce the potential risk associated with gasoline so that it can be used safely. Hazardous materials represent only potential for risks or perils, but when correctly handled, potentially hazardous materials can be used safely.

USEFUL DEFINITIONS

In order to better understand your role in the hazard communication or right-to-know program, you must be familiar with the terms and definitions that follow. They will help you understand many written and oral communications as well as interactions you will have during your employment. These communications include written labels, Material Safety Data Sheets (MSDSs), or Hazardous Substance Fact Sheets (HSFSs), written materials such as this training manual, and oral communications from classroom training instructors.

As you review these terms, keep in mind that definitions in this manual not only apply to the federal OSHA provisions and many state right-to-know laws, but also represent accepted scientific standards.

General Terms

Chemical: Any element, chemical compound, or mixture of elements and/or compounds. (To most scientists, the term chemical does not include mixtures or chemical compounds. The federal OSHA Standard and the various state laws include both chemical compounds and mixtures in their legal definitions of chemicals. Consequently, this definition of chemical will be used throughout this book.)

Chemical Abstracts Service (CAS): A systematic, computerized chemical information source established by a division of the American Chemical Society. CAS is a repository of all significant chemical research information reported in international literature.

Chemical Abstracts Service (CAS) Registry Number: An identification number, assigned by the American Chemical Society's Chemical Abstracts Service, that uniquely designates a specific chemical compound. This entry conclusively identifies a substance regardless of the name, or naming system, used.

Chemical Name: The scientific designation of a chemical in accordance with the naming system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS). The chemical is clearly identified by this designation for the purpose of conducting a hazard evaluation. Some states, however, have chosen to specify chemical names for their listed hazardous substances, and those designated names do not always conform to either of the two designated source criteria (i.e., IUPAC or CAS).

Chemical Waste: A residual material that has been selected for waste disposal for such reasons as loss of potency or color or texture change, or that has lost its usefulness. Chemical waste often contains toxic or polluting materials that can harm the environment if improperly disposed of. Nor all chemical waste is hazardous. (See Hazardous Waste, below.)

Hazard Terms

Hazardous Substance: Substances or materials, in quantity or alone, for which there are sufficient data to indicate a reasonable risk to physical and/or environmental health. Such substances are classified as poisonous or toxic, corrosive, flammable, explosive, radioactive, or materials that build up heat through storage. OSHA has published a 'list of some hazardous substances in 29 Code of Federal Regulations (CFR), Part 1910, Subpart Z. Some states have adopted this OSHA list, whereas others have defined specific substances and have developed their own list.

Hazardous Warning: Any words, pictures, or symbols, alone or in combination, appearing on a label. Other approved forms of warning may also convey the hazards of the chemical(s) in the container(s).

Hazardous Waste: Any waste, or combination of wastes, that poses a present or potential threat to human health, living organisms, or the general environment. A hazardous waste must be discarded in an approved manner prescribed by law. No employee is ever permitted to change or alter the manner in which a hazardous waste is disposed of. Under federal law, a hazardous waste is fully regulated from the time of its creation to the time it is properly discarded. A hazardous chemical or product becomes a hazardous waste when the educational institution classifies the material as “waste.”

Health Hazards

Health Hazard: A chemical for which there is statistically significant evidence, based on at least one study conducted in accordance with established scientific principles, that acute (short-term) health effects or chronic (long-term, or possibly delayed) health effects may occur in exposed employees.

Toxic: Any substance that causes damage to living tissue, impairment to the central nervous system, severe illness, or, in extreme cases, death. The amounts required to harm the body vary widely with the nature of the substance and the exposure time. Acute toxicity refers to exposure of short duration (one brief exposure); chronic toxicity refers to exposure of long duration (repeated or prolonged exposures).

Carcinogen: A substance that can promote or initiate malignant or benign neoplasia (cancer). A chemical evaluated by the International Agency for Research on Cancer (IARC) and found to be a carcinogen, or a potential carcinogen, or one that is listed by the National Toxicology Program (NTP) in its latest edition of the Annual Report on Carcinogens, is known as a carcinogen. OSHA must regulate a chemical that is found to be carcinogenic.

Mutagen: A chemical or physical agent that disturbs the hereditary mechanisms in cells or organisms so that subsequent cellular divisions produce cells that are altered in function, appearance, or survivability. Such chemicals are said to be mutugenic.

Teratogen: Any substance that causes physical or functional defects in the developing embryo during pregnancy. These effects manifest themselves as birth defects in the newborn, or compromise survivability. Such chemicals are teratogenic.

Exposure: Subjection to a chemical through any route of entry, such as inhalation, ingestion, or skin contact. Potential exposure (i.e., accidental or possible) is included in this definition by most hazardous substance regulations. Inhalation and skin contact are the two most common routes of exposure in educational institutions.

Corrosive: A chemical that causes visible destruction of, or *irreversible* alterations in, living tissue by chemical action at the site of contact.

Irritant: Any chemical that, although not corrosive, causes a *reversible* inflammation of living tissue by chemical action at the site of contact.

Sensitizer: A chemical that causes a substantial proportion of exposed people to develop an allergic reaction in normal tissue after repeated exposure.

Allergic Reaction: An exaggerated response (typically including itching, stinging, redness, and/or blistering) to a substance, situation, or physical state that has no comparable effect on unsensitized individuals.

Threshold Limit Values (TLVs): Recommendations issued by the American Conference of Governmental Industrial Hygienists (ACGIH) indicating the safe average permissible exposure limits of airborne substances to which nearly all workers may be repeatedly exposed for a continuous eight-hour work day and a forty-hour work week without adverse effects. TLVs are reviewed and/or revised annually.

Physical Hazards

Physical Hazard: A chemical for which there is scientifically valid evidence that it is a combustible liquid, a flammable liquid or solid, a compressed gas, or an explosive. Other physical hazards are classified as oxidizers, pyrophorics (spontaneously combustible), water-reactives, radioactives, organic peroxides, and unstable/reactive chemicals.

Combustible Liquid: "Any liquid having a flash point at or above 100^o F (37.8^{o}C) and below 200^o F (93.3^o C), except any mixture having components with flash points of 200^o F (93.3^o C) or higher, the total volume of which make up 99% or more of the total volume of the mixture."

Compressed Gas: A gas, or mixture of gases, in a container having an absolute pressure exceeding *40 pounds per square inch* (psi) at 70^{o} F (21.1^{o} C); or a gas or mixture of gases in a container, with an absolute pressure above 104 psi at 130^{o} F (54.4^{o} C), regardless of the pressure at 70^{o} F (21.1^{o} C). Compressed gas also includes flammable liquids having a vapor pressure beyond 40 psi at 100^{o} F (37.8^{o} C).

Explosive: A chemical that causes a sudden, almost instantaneous release of energy, pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. (An explosion can often be viewed as a very quick fire.)

Flammable Liquid: Any liquid having a flash point below 100^{o} F (37.8^{o} C) and a vapor pressure of not greater than 40 psi at 100^{o} F. This also includes any mixture having one or more components with flash points of 100^{o} F (37.8^{o} C) or lower that make up more than 1% of the total volume of the mixture.

Flammable Solid: A solid, other than an explosive, that can cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing. A flammable solid can be ignited readily and will burn vigorously and persistently, causing a serious hazard. A chemical is considered to be a flammable solid if, when tested by a federally approved method, the solid ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flash Point: The minimum temperature at which a liquid or volatile solid gives off a vapor in sufficient concentration to ignite. Tests to indicate flash point are: *Tagliabue Closed Cup* (TCC) for liquids that do not contain suspended solids and do not have a tendency to form a surface film under test; *Pensky-Martens Closed Tester* for liquids that contain suspended solids or that have a tendency to form a surface film under test; or *SetaFlash Closed Tester.* Excluded from any of the flash point testing methods are organic peroxides that undergo autoaccelerating thermal decomposition. Many Material Safety Data Sheets include flash point data listed as *Tagliabue open Cup* (TOC), which is unacceptable for federal, and most state, regulatory requirements.

Oxidizer: A chemical, other than a blasting agent or explosive, that initiates or promotes combustion in other materials, causing fire either of itself or through the release of oxygen or other flammable gases.

Pyrophoric: Any liquid or solid that will ignite *spontaneously* in air below 130° F (54.4° C). Pyrophoric materials must be stored in an atmosphere of inert gas or under kerosene. One example found in educational institutions is white phosphorous.

Water-Reactive: A chemical that reacts with water to release a gas that is either flammable or presents a health hazard. An example found in educational institutions is sodium metal.

Government Agencies

Four federal agencies are associated directly or indirectly with the Hazard Communication Standard:

Occupational Safety and Health Administration (OSHA): Responsible for establishing and enforcing standards regarding exposure of workers to harmful materials in industrial work sites, and other matters affecting the health and well-being of industrial personnel. OSHA developed the initial Hazard Communication Standard and the current revision (1988).

Environmental Protection Agency (EPA): Established in 1970 to oversee products or materials that would adversely affect the health and safety of the environment. Under the Toxic Substances Control Act of 1976, and amendments passed in 1986, EPA is required to ensure the safe manufacture, use, and transportation of hazardous chemicals and the availability of community right-to-know information for highly hazardous chemicals. Other concerns covered by EPA are pesticides, fungicides, and water and air pollution, as well as hazardous waste disposal.

Department of Labor (DOL): The federal agency under which OSHA is organized. The Secretary of Labor may make an agreement with a state under which the state will be permitted to enforce one or more federal occupational health and safety standards in that state. That agreement is in effect until final action is taken by the Secretary with respect to a plan submitted by the state under a specific federal requirement.

Department of Transportation (DOT): Regulates interstate shipping of hazardous materials by air, highway, rail, or water. DOT requires a warning label on any container of hazardous material to be shipped. These labels indicate whether a material is corrosive, dangerous when wet, explosive, flammable gas, flammable liquid, flammable solid, irritant, nonflammable gas, organic peroxide, oxidizer, poison, or radioactive. DOT also uses a four-digit *United Nations* (UN) or *North America* (NA) *identification number.* For shipments overseas, an *International Maritime Organization* (IMO) *identification number* must also be used.

Enforcement of state right-to-know laws is the responsibility of one or more agencies as designated in each specific law. Commonly, however, this responsibility has been assigned to departments of environmental protection, health, labor, and industry or even Workmen's Compensation Bureaus. Every educational institution, and each employee, should become familiar with the appropriate agency in their state.

EXAMPLES OF PHYSICAL AND HEALTH HAZARDS

Flammable Substances

These substances are easily set on fire and burn readily. Combustion occurs when three elements are in place at the same time: (1) a fuel, (2) oxygen, and (3) a source of ignition. Vaporization of liquids and solids occurs at various temperatures, depending upon the material. A potentially quick-spreading fire will occur when a source of ignition (a lighted cigarette, or a spark from a nearby motor, for example) comes in contact with the vapor cloud. Flammable substances should be stored in fireproof *metal* cabinets that are vented from the bottom to the outside of the building.

The relative fire hazard associated with flammable substances has been quantitated by a four-class system. Class 4 represents the greatest fire hazard, and Class 1, the least.

Corrosive Materials

A corrosive material is a liquid or a solid that causes visible destruction or irreversible alterations in the skin at the site of contact. Corrosives can destroy metal containers and thereby escape into the atmosphere of the storage area. Corrosive materials should be kept cool, but well above freezing. Ventilation in corrosive storage areas should be sufficient to prevent accumulation of fumes. Containers of corrosive materials should be carefully handled, kept closed, and clearly labeled as "corrosive." Corrosive materials should be stored in *wooden* cabinets, preferably painted with corrosive-resistant paint, and storage areas should be vented to the outside.

Poisons

A poison can be defined as any agent capable of producing a harmful response in a biological system. Virtually every known chemical has the potential to produce injury or death if present in a sufficient amount. *The dose makes the poison!* Exposure signs and symptoms vary widely from substance to substance. Consequently, each poison must be individually considered.

Oxidizers

One of the most common types of chemicals found in hazardous situations in educational institutions, oxidizers promote combustion in other materials. The term includes such chemical classes as peroxides, chlorates, perchlorates, nitrates, and permanganates. Storage areas for these materials should be kept well-ventilated and as cool as possible. It is unsafe to store oxidizers near flammable substances, corrosives, cloth, or paper products since reactions with these materials can cause spontaneous fires. When oxidation proceeds so rapidly in air that ignition occurs spontaneously, the reaction is known as *pyrophoric.*

Reactives/Explosives

Reactive or explosive chemicals give off a sudden release of energy, pressure, gas, or heat. This occurs when they come in contact with an incompatible chemical or a source of heat, or when they are severely jarred or shocked. Reactive or explosive chemicals should be stored in the smallest quantities possible in locked explosion-proof cabinets. Access should be limited to individuals familiar with these chemicals.

Water-reactive chemicals will react with water, water vapor, high humidity, steam, or water solutions to evolve heat and flammable or explosive gases. Careful consideration should be given to the storage of these chemicals so that they cannot come in contact with water, even under fire conditions (e.g., they should not be stored under a sink!).

Carcinogens

Carcinogens cause *cancer,* a nontechnical term for a diverse class of diseases marked by abnormal cell growth. Tumors result from aberrant cell development and uncontrollable growth. *Benign tumors* grow in one site and generally do not invade other tissues. *Malignant tumors* continue to proliferate and may invade nearby tissues or distant parts of the body where sites of uncontrolled growth begin.

In general, individuals are not exposed to any one suspected carcinogen, but to very low levels of a broad spectrum of environmental carcinogens. As the population ages due to improved nutrition and better medical practices, the probability of developing cancer from “natural” causes increases. The body, however, is equipped with various methods to detoxify and repair itself. These methods can generally cope with exposure to limited amounts of toxic materials, including carcinogens. Avoiding or minimizing exposure to toxic substances aids the natural defense mechanism of the body in protecting it against cancer.

Mutagens

Mutagens produce changes in the genetic material of individual cells, which may lead to birth defects in future offspring. There is a strong correlation between the mutagenicity of a chemical and its carcinogenicity. Chemicals that produce genetic changes also often produce cancer in one or more species.

Teratogens

Teratogens cause birth defects through direct action on the developing fetus, including misformation of cells, tissues, and organs. Teratogenicity and mutagenicity may produce somewhat similar biological effects.

CHAPTER 3

Chemical Handling Mechanisms Within the Body

THE SKIN

The skin is one of the main defensive organs that separates man from toxic substances. The outer, horny layer of the skin is known as the epidermis and is composed of dead cells. This layer of skin represents the most effective barrier to many hazardous chemicals. The lower skin layer is called the dermis and contains hair follicles, blood vessels, oil ducts, and connective tissue. Once a chemical enters the dermis, absorption will occur.

CHEMICAL ABSORPTION, DISTRIBUTION, AND EXCRETION

For most toxic agents, the higher the concentration of the toxicant absorbed by the body, the greater the harm.

Except for irritants and corrosives, which act topically, toxicants are usually absorbed and enter the blood before they produce undesirable effects. For academic institution employees, the major routes of entry of toxicants are the lungs, gastrointestinal tract, and skin. Once inside the bloodstream, chemicals are transported to body organs, where they produce damage. Affected parts of the body are known as the target *organs.*

Toxicants may also act directly on cells and other vital substances circulating in the bloodstream. The circulatory system will transport a toxicant to other organs, where it may produce its toxic effects. A hazardous agent must reach a certain organ in order to affect that specific organ. The organ in which the toxicant is most highly concentrated, however, is not necessarily the one where most of the tissue harm occurs. Chemicals usually affect very specific cells in selected organs.

The harmful chemical is eliminated from the blood by excretion, accumulation at various storage sites, and transformation to less harmful chemicals within the system, usually by the liver. Elimination of most toxicants from the body is handled by the kidneys. Two other organs important in excretion are the lungs and the liver. Lungs eliminate volatile chemicals (gases and liquids that evaporate easily) in the expired air; the liver secretes chemicals into bile in the gall bladder and the gastrointestinal tract.

A toxic agent may pass through a multitude of barriers before reaching a sufficient concentration at the organ where the characteristic damage is produced. These barriers include membranes of many cells. The skin has thick cell layers, whereas the layers of the lungs and the gastrointestinal tract are thin. Other cells through which chemicals must pass include those lining blood vessels throughout the body, the cells of organs where the chemical produces its harmful effects, and the cells that eliminate the toxicant from the body.

Most toxicants cross body membranes by simple diffusion. The body transports those toxicants that are unable to pass body membranes by simple diffusion through more specialized means. The act that allows a harmful substance to pass the body membranes and enter the bloodstream is known as absorption. People do not have a special system exclusively for absorbing toxicants. The toxicant appears to penetrate the body membranes and enter the bloodstream to be absorbed in the same manner as oxygen, food, and other nutrients.

A toxicant is distributed throughout the body following absorption. Distribution usually occurs quickly. The rate of distribution to the tissues of each organ is determined by blood flow through the organ itself, and the ease by which the chemical passes the capillaries and pierces the cells of individual organ tissues.

Some toxicants have restricted distribution and do not readily pass cell membranes. Others pass through cell membranes easily and are distributed throughout the body. Accumulation of some toxicants occurs in various parts of the body. In many instances, the site of an accumulated toxicant may not be its site of major damage. When the hazardous chemical has gathered at an area other than the site at which it produces its toxic action, the accumulation may serve as a protective mechanism by distributing part of the toxicant into a storage area, which could keep the concentration level lower in the target organ.

CHEMICAL BREAKDOWN AND METABOLISM

The most damaging chemical changes occur in vital living cells that produce energy for essential body processes and good health. *Metabolism* is the process by which these particular substances are broken down in the body. There are a few important factors that affect the rates of metabolism for foreign substances. One is the concentration of enzymes involved in the particular changes of the chemical in question. *Enzymes* are proteins that are generated by living cells and bring about certain chemical reactions at body temperatures, including the breakdown of harmful, as well as nutritious, chemicals. The chemical concentration in the tissues that produce these enzymes is dependent upon the rate of chemical absorption, breakdown, and excretion. Target organ damage is minimized when the excretion of a toxic substance is rapid. Various body factors that control the rate of metabolism of substances are age, sex, race, nutritional status, and the timing of daily body rhythms (e.g., metabolism is slower at night).

Generally, a human fetus metabolizes foreign substances at a rate lower than that seen in adults. Also, there is often a marked difference in the response of females as compared to males in the metabolism of chemical substances. Sex-dependent differences in metabolism and physiological response to harmful substances are important considerations.

Each person has a number of enzymes and enzyme systems that alter metabolic reactions relating to hazardous substances. These enzymes possess the ability to break down and change substances of widely varied structure and represent a vital protective mechanism following exposure to hazardous substances. The effectiveness of enzyme metabolism of chemicals, and other body defensive mechanisms, enables people to be exposed to low levels of hazardous chemicals without adverse body effects. Higher exposure levels saturate enzyme systems so that they cannot break down and eliminate the toxicant fast enough to avoid harmful effects. Consequently, the *dose* makes the *poison.* Prevention, or minimization, of exposure is the best protection!

CHAPTER 4

Employee Health and Safety

MATERIAL SAFETY DATA SHEETS (MSDSs)

A Material Safety Data Sheet is a document that provides important information on and a profile of a particular hazardous substance or mixture. Although it is called a “sheet,” an MSDS may be several pages in length. The formerly approved OSHA Form 20 is no longer acceptable to OSHA and many state agencies since the old standardized form contained insufficient data. A copy of each acceptable MSDS must be available in a Central File of your facility.

Recent federal and state legislation requires the MSDS to be made available to employers and employees whenever there is a likelihood that a hazardous substance or mixture will be introduced into the workplace. Developing an MSDS is the responsibility of the manufacturer or formulator of the hazardous substance or mixture. Obtaining and maintaining a current copy of an MSDS for each chemical and product is the responsibility of every employer. Some states, like New Jersey, require an MSDS for *products* in the Central File to verify nonhazardous product components, as well as hazardous constituents, even though they use a Hazardous Substance Fact Sheet as the preferred *chemical* information document.

Reading an MSDS

MSDSs contain a number of sections, but because the headings of the sections and their sequence may differ slightly from supplier to supplier, every specific heading cannot possibly be summarized. Information associated with the following general headings, however, appears in some form on all MSDSs:

- Product information
- Hazardous ingredients (composition data)
- Physical and chemical data
- Fire and explosion hazard data
- Health hazard data (physiological effects)
- Reactivity data
- Spill or leakage procedures (environmental data)
- Special protection information
- Special precautions

LABELS

Two types of labels must be present on chemical containers: manufacturing and warning. Both types have the same common rules: (1) read all labels; (2) never remove a label or cover it; and (3) pay attention to what the label says.

Manufacturing labels are used by manufacturers to record such specific facts as lot numbers, date of production, storage data, and department or plant number. *Warning labels are* used to protect individuals and the environment by informing the user of potential hazards associated with the chemical in the container as well as providing handling instructions.

The warning labels on chemical containers tell us such things as how to stack the containers, whether the containers should not be stored near a source of ignition, and whether the containers must be protected from water. In order to understand these instructions, you must read the label and *think. You* must implement *appropriate* safety practices. When you read "flammable" on a label, you must think: *Do not expose to heat.* When you read "water-reactive," you must think: *Do not store under a sink.*

To make chemical identification consistent on warning labels, a standard *coding system* is available throughout the United States. This coding system includes a unique CAS Registry Number to identify each chemical. Every known hazardous and nonhazardous chemical is assigned an identification number by the Chemical Abstracts Service (CAS). This CAS Registry Number can be located easily in a number of guidebooks and is used to identify appropriate information for safe handling, or emergency response procedures. The CAS Registry Number is required on warning labels by some states.

You have probably seen the diamond-shaped signs mounted on many containers, vehicles, train cars, and building walls required by DOT to indicate flammable, corrosive, etc. These signs are one type of *warning* system. They use a combination of symbols, colors, and numbers to give immediate information.

When cartons are packaged in one large container, both the container and *each carton* must be labeled if they contain a hazardous component that is listed on your state Hazardous Substance List (if you comply with a state right-to-know law) or that is determined by your employer to be hazardous (if you comply with the OSHA Standard).

Chemical containers may include as many as five hazardous protective equipment symbols, as illustrated in Appendix A, to increase safety awareness for both faculty and students. Appropriate equipment and apparatus necessary for the safe handling of the specific material or product are indicated on the label shown in the Appendix by obliterating nonapplicable symbols. *All safety equipment indicated on this label should be considered in light of the specific use.* For example, a nurse using isopropyl alcohol on a cotton ball would not need to use the protective equipment, but a custodian cleaning the gymnasium floor with a product containing a high concentration of isopropyl alcohol should use all recommended equipment because the duration of use is extended and the potential quantity of exposure is greater in this case. A container should not be opened until all protective equipment and apparatus are properly in place.

PROTECTIVE EQUIPMENT

Safety Procedures

Grounding

Grounding involves connecting circuits or equipment to the earth or a common ground plane through a continuous path that will obstruct electrical movement. Do not rely on grounding to mask a defective circuit or attempt to correct a fault by inserting another fuse, possibly one of greater capacity. Grounding is especially critical when pouring flammable liquids or dusts into metal containers since a static electrical spark could cause a fire. (This is why gasoline nozzles at service stations have a grounding wire from the metal nozzle through the hose to the tank and ground.)

Mechanical Ventilation

Mechanical ventilation consists of three categories: (1) hoods or enclosures at point sources of air contamination (e.g., chemistry laboratories, artroom kilns, printing presses, etc.); (2) air-moving equipment (e.g., fans) that can dilute toxic or serious air pollutants; and (3) air-cleaning equipment that can remove contaminants from the atmosphere in a specific work area.

These types of equipment can be used in a variety of areas in the educational facility. The specific type of ventilation is determined by the work area requirements and the quantity of chemical to be removed or diluted.

A fume hood is a special exhaust duct designed to enclose experiments or procedures involving toxic chemicals or unpleasant odors. The hood, however, is not designed to capture contaminants that become airborne in remote parts of the work area. A hood is also not intended to contain explosions.

Air-moving equipment involves fans or natural fresh air. Factors to consider with air-moving systems are the temperature and air pressure within the workplace. Air-moving systems function best when the temperature and air pressure within the workplace are constant and comfortably low. Sudden increases of either factor may distribute or intensify airborne particles to other parts of the work site, causing unnecessary contamination.

Air-cleaning equipment should be considered when property damage, neighborhood pollution, or reentry of polluted air into the workplace should be prevented. For example, academic institutions that use completely recirculated air in a facility to achieve energy conservation must incorporate air-cleaning equipment in the system to assure that toxic chemicals or particulates are not transmitted from one work area to other work areas (e.g., print shop vapors distributed to an office area, or duplicating vapors distributed to a classroom).

Safety Equipment

The proper use of personal protective equipment prevents exposure by protecting you against chemical contact. An employer is libel for citation by OSHA or state agencies if personal protective equipment is not used by an employee when handling specially regulated hazardous chemicals. Protection of students by the use of appropriate personal protective equipment is also a prudent and effective safety precaution. Consequently, proper use and understanding of protective equipment protects employees and students, fulfills regulatory requirements, and reduces the prospects for liability lawsuit.

Skin and Eye Protection

Skin is the second most common route of chemical exposure in academic institutions. Since skin exposure can vary from localized to whole-body contamination, the type of protective equipment used should be appropriate for either the most likely risk, or the worst-case possibility, depending upon the hazardous product being handled and the work site circumstances. For example, if a concentrated acid is being used in a partially closed hood of a science laboratory, eye protection may not be needed, but the same material handled over an open bench warrants goggles and an apron with sleeves-all impervious to the corrosive risk. Protective equipment for skin exposure should anticipate accidental exposure rather than protect only against expected exposure.

Wash Facilities

Eye *washes* are devices that provide a *continuous flow* of drinkable water that will wash both eyes simultaneously with copious quantities of water. The unit allows the user to have both hands free to hold both eyes open for maximum washing effectiveness.

The *body shower* provides a massive, sudden flow of water to handle chemicals splashed on the body or clothing. A full body drench with fresh water can be supplied through a special emergency shower. The main considerations with a body drench are: (1) a large volume of water, (2) constant water pressure, (3) fixed water temperature, and (4) efficient drainage.

Protective Gloves

Not all gloves are designed for the same purpose. Some are for protection from physical injury (i.e., abrasion, heat, and cold), whereas others provide protection from hazardous chemical exposure. Obviously, no glove is effective in all circumstances. Although more than one type of glove may provide “excellent” resistance for a specific chemical, none provides “universally” excellent resistance. The gauge or thickness of material in the glove also affects the chemical resistance, but heavier-gauged gloves also reduce flexibility and finger dexterity, which can increase the likelihood of a chemical accident. Of course, care should be taken to consider all factors before selecting a glove for your specific needs.

Protective Aprons

Aprons should protect the full body trunk area down to the knees. Protective sleeves should also be used in conjunction with an apron when serious skin exposures may occur. There are various grades of plastic designed for a number of uses. In fact, protection and wearability of protective aprons have increased due to changes in fabric design. Many are treated with a coating that adds to their durability. Generally, a *plastic* apron protects against oils, acids, solvents, salts, and minor abrasions. Chemically resistant *vinyl plastic* usually is adequate for students, particularly if only dilute solutions are handled. *Rub-*

ber aprons have significant durability. They are designed to protect the body from acids, solvents, abrasions, alkalies, oils, and caustics.

Lead aprons protect against radiation exposure. Heavy lead, rubber aprons have been replaced by lighter, more flexible lead materials. For added strength, lead vinyl is supported by fiberglass in one type of apron.

Safety Eyewear

Most state and federal laws require the use of eye protection whenever a possibility of eye danger exists within the workplace. Your administration cannot protect you from eye injury simply by making eye protective equipment available. You and your students must *wear* the equipment to avoid injury and prevent accidents. Protective eyewear consists of three types:

Safety glasses are eyeglasses with specially treated lenses and side shields. The lenses resist breakage upon impact, but do not provide adequate protection from splashed chemicals and may be damaged by hot particles (e.g., welding sparks). The side shields protect against any flying particles not in the direct line of vision.

Goggles are designed to protect the entire eye area-above, beneath, and around the eye. They are usually tinted to prevent glare and may or may not be vented on the sides for comfort. Vented goggles are used for areas involving dusts and particles; *unvented goggles must be used with hazardous liquid chemicals.*

A *full face shield* should be worn for protection in situations involving woodworking, metal machining, spot welding, handling of hot or corrosive metals, buffing, wire brushing, grinding, and explosions. The design of the face shield should also give added protection to the neck area.

A special note is required for *contact lens wearers.* Faculty, staff, students, and visitors should indicate whether they wear contact lenses before entering a laboratory or other chemical handling area. When possible, contact lenses should be replaced by safety glasses. Otherwise, unvented goggles should be used to cover the contact lenses and eyes. A record should be kept in an accessible file within the work area of employee and student contact lens wearers, and procedures should be implemented to assure that they are adequately protected.

Contact lenses can trap chemicals, hold them next to the eye, and prevent the cornea from being adequately irrigated during emergency flushing. Immediately after chemical exposure and before eye washing, therefore, the lenses must be removed. In several cases of chemical eye burns, individuals received more serious burns when contact lenses were left in the eyes during irrigation. Contact lens wearers must understand the importance of adequate eye protection and take special precautions.

Respiratory Protection

Respiratory protection may be important in every work area because there are numerous sources of hazardous vapors and airborne particles in academic institutions, inhalation being the primary route of chemical exposure. Equipment for respiratory protection varies from dust masks (for painting and nuisance dust) to cartridge respirators and self-contained breathing apparatuses (for pesticide or chemical spraying).

Dust masks are lightweight, inexpensive, and sometimes disposable. An adjustable nose bridge provides a safe fit for every face size. Dust masks are primarily designed to remove only large particles that affect the nose, throat, and upper respiratory system, but do not remove smaller particles that can enter the lungs. More sophisticated respiratory protection equipment is required to prevent exposure to these smaller particles and hazardous chemical vapors. The effectiveness of a dust mask is significantly diminished by facial hair, especially a beard. Dust masks may provide protection for educational employees assigned to selected industrial art, custodial, and maintenance responsibilities.

Cartridge respirators are designed for use in low concentrations of materials and can be equipped with cartridge filters for protection against dusts, mists, gases, or vapors. Many chemical cartridges are treated with a specially activated carbon, which has a high capacity to absorb. Since their absorption capacity is limited, chemical cartridges become less efficient with extended use, or in high concentration exposure situations. Contaminant concentration and breathing rate of the wearer are factors affecting cartridge efficiency.

Self-contained breathing apparatuses are used when there are very high concentrations of gases or vapors, when the surrounding atmosphere is oxygen-deficient, or when very fine, highly hazardous particulates contaminate the atmosphere. There are two basic types of self-contained breathing apparatus, but both include more specialized units. The two basic types handle exhaled air by different mechanisms:

Open Circuit Breathing Apparatus: Expels the user's air directly to the outside atmosphere. A chemical cartridge is used on the respirator to purify the incoming air. The duration of usage for open circuit units is dependent upon the rate at which the cartridge becomes saturated with the hazardous contaminant.

Closed Circuit Respirators: Use a regenerator unit that removes carbon dioxide and adds oxygen supplied from an external tank. A pressure regulator maintains positive pressure in the mask during inhalation, preventing entry of the hazardous contaminant. Closed circuit units have a limited oxygen supply and, therefore, the duration of use is equivalent to the availability of this external supply (15 to 60 minutes, depending on the rate of respiration).

Miscellaneous Protective Equipment

Full protective suits are usually worn by employees who engage in transportation or use of highly hazardous chemicals that can cause serious skin effects, or are absorbed easily through the skin and, therefore, require fully body protection. The suit provides complete protection against any form of skin contact with a hazardous substance. When inhalation of harmful fumes is a problem-during large-scale waste removal, equipment failure, or equipment maintenance, for example-a self-contained breathing apparatus should also be worn.

Bottle carriers reduce the potential danger of carrying hazardous chemical bottles. There are various types of carriers, depending on the contents of the bottle and the number of bottles carried. The most common bottle carrier is made of rubber, which catches any spill and cushions the bottle against bumps and collisions while in transit. A two-part polyethylene carrier can also be used to completely envelope the bottle, cushioning it from any impact. This type of carrier has a tight-fitting strap that secures the top and bottom sections, enclosing the bottle. Six small- to medium-size bottles can be carried in one durable polyethylene carrier. Its rigid design resists impact and eliminates bottle bumping, chipping, or cracking.

Adequate understanding and proper use of protective equipment assures your personal health and safety, as well as the safety of your students and colleagues, and protects your environment from potential hazards. Remember: *Only you can prevent accidents.'*

OCCUPATIONAL MEDICINE

Your health can be compromised by chemicals in the food you eat, in the air you breathe, in your water, and in your work environment *if you are exposed to a sufficiently high concentration.* If, however, exposure or consumption levels are maintained below some “safe” level, these same chemicals will *not* make you ill. They may actually be essential for good health at these safe levels. Vitamin A, for example, must be consumed in small amounts, or night blindness and increased susceptibility to infections will occur. Excessive intake of Vitamin A, however, causes irritability, headache, dry and cracking skin, bone pain, retarded growth, and many other serious symptoms. Similarly, our lungs and red blood cells maintain a “safe” level of carbon dioxide (CO_2) necessary for survival, but working in a room filled with CO_2 would very quickly become lethal. Remember: *The dose makes the poison.*

Occupational medicine is a special field concerned with identifying safe levels of chemicals in the workplace and treating individuals who have been exposed to concentrations beyond these safe levels. Your medical department and/or nurse are the resident members of your occupational health team and may be able to answer many of your questions regarding chemical exposure.

The medical orientation of a hazard communication program focuses upon three priorities: (1) prevention of hazard exposures; (2) identification of safe working conditions; and (3) minimizing effects from any accidental exposures through quick, appropriate treatment. You can use several methods to recognize potential health and safety hazards in your area, or elsewhere in your building, before they become accidents or exposures: (1) visual observations: (2) unusual odors; (3) information regarding the presence and severity of chemical hazards; and (4) container labels.

Visual observation of mists, fumes, or dusts in your classroom and other work areas may indicate a potentially hazardous situation. Similarly, you should evaluate unusual or strong odors to identify any hazardous conditions. Although all odors are not necessarily a sign of hazardous situations, you should *always report* unusual *odors* to your supervisor so that proper evaluations may be performed. Sometimes a small amount of a chemical in the air can cause an odor throughout a very large area and still be within safe levels. At other times, however, an odor indicates that the concentration of a chemical already exceeds the safe level.

Your personal use of and familiarity with information about potentially hazardous chemicals (e.g., Material Safety Data Sheets, Fact Sheets, warning labels, etc.) will also provide a valuable basis for recognizing possible hazards. Container warning labels represent a special source of specific hazard information. Labels applied by the manufacturer, as well as those supplied by your institution, may provide valuable hazard information and identify appropriate protective equipment or procedures. *Recognition of potential hazards is the first step towards preventing accidents.*

Many techniques can be used to prevent and control employee exposure to hazardous substances:

- Substitution
- Isolation
- Enclosure
- Local exhaust ventilation (hoods)
- Dilution ventilation (fans, air conditioning)
- Absorption/neutralization
- Good housekeeping
- Personal hygiene
- Personal protective equipment

Substitution of less hazardous products will be most frequently applicable to chemicals used by maintenance personnel, but may be useful in some classroom situations as well. *Isolation* and *enclosure* obviously apply to storage conditions for substances that are flammable, corrosive, pyrophoric (spontaneously ignite), etc. Chemicals must be properly stored to reduce their hazards. Different classes of hazardous chemicals should not be stored together (e.g., corrosives stored with flammables or poisons can produce more hazardous circumstances than either class might produce by itself). (For additional details on safe chemical storage, see Volume 4 of this series.) *Local exhaust ventilation* (e.g., hood in a science laboratory or over a kiln in an artroom) is most useful to remove point sources of hazardous chemicals and to minimize potential student and personnel exposure as previously discussed. *Dilution ventilation* provided by fans, air conditioning, etc., is most useful for dissipating relatively harmless vapors, mists, and dusts. All hoods and ventilation ducts should be tested annually to assure that they are functioning properly and have not become contaminated with toxic dusts, molds, etc.

Absorption/neutralization are especially useful for spills. Neutralization is used primarily for acids and bases-corrosives and caustics. Care must be taken to assure neutralization with the appropriate reactant for a potentially hazardous material. Otherwise, highly hazardous chemical interactions may create serious consequences.

Good housekeeping seems too obvious to mention, but poorly maintained storage and work areas greatly increase the potential hazards of many materials. Chemical containers must also be inspected and maintained on a regular basis. Containers with hazardous chemicals around their caps, or spilled on the outside, are sources of exposure as well as potentially serious chemical interactions.

All employees *must* practice good *personal hygiene,* regardless of the area in which they work! Chemical hazards can result from inhalation, skin exposure, or ingestion. Hands should always be washed before handling food and drinks. Remember, you want to ingest only your food and not any materials that may be on your hands and face. You should also wash your hands *before* using the toilet as well as afterwards. Washing is every employee's responsibility and must be taken seriously. If a hazardous material is splashed onto your clothes, you should *immediately* change and clean your soiled clothes before you wear them again. Exposure of the skin to certain chemicals can cause local irritation or burns, or possibly lead to absorption through the skin. Proper precautions and procedures can eliminate any risks.

Personal protective equipment must be available as appropriate for each specific circumstance. Eye wash fountains and emergency showers should always be maintained in proper working condition. Your application and use of these various techniques will *help you help your institution prevent and control employee exposures.*

A number of procedures commonly available to measure and evaluate employee exposures are: (1) air monitoring (use of personal and area sampling techniques where excessive exposure levels are suspected); (2) monitoring equipment such as pumps, filters, and calibration; (3) interpretation of sampling and analytical results; and (4) biological monitoring methods. These techniques are not routinely available in many academic institutions, but can be used for specific circumstances if warranted.

Every raw material and product has either "safe" levels or "safe" working procedures defined. However, if you ever suspect that you are exhibiting symptoms possibly indicative of exposure to materials in your area, immediately report your symptoms to your medical personnel *and* your supervisor. Your assistance in reporting suspicious circumstances or symptoms is absolutely essential for assuring a safe educational environment. You are also a vital member of the occupational health team in your institution!

CHAPTER 5

Environmental Safety

CHEMICAL STORAGE

Use of appropriate storage cabinets for each type of hazardous chemical can significantly reduce risks, whereas inappropriate cabinets mask, and therefore increase, the danger. Wooden storage cabinets for acids, for example, are safer and more durable than metal cabinets, unless a metal cabinet is specially treated with a corrosion-resistant coating. Likewise, specially designed fireproof metal cabinets are preferable for storage of flammable materials since they can maintain flammable liquids below vaporization temperatures, even in a fire. Steel cabinets, common in most schools and colleges, are highly inappropriate for the storage of flammables since they allow heat from a fire to be quickly transferred to the cabinet shelves. This results in rapid vaporization of the flammable liquids, bottle breakage, and accelerated fire spreading.

Potent poisons should be stored separately and securely in locked cabinets, deterring any type of vandalism. Several cases of student suicides have followed the unauthorized removal of highly hazardous poisons from educational institutions. Double-locking the cabinet is added protection for highly hazardous poisons. A *quantitative* inventory list of these special poisons should be permanently attached on the inside of the door, and a "Poison" placard should be placed securely on the outside of the door.

The safe storage of hazardous chemicals requires careful consideration and adjustments for specific academic work sites. For example, the pure chemicals in a science classroom should be stored by individual, worst-case hazard classes for each chemical; industrial art and custodial products, often composed of several hazardous chemicals, on the other hand, must be sorted according to the composite hazard for the mixture.

Many basic rules for hazardous chemical storage, however, should be considered in all academic departments:

- Storing chemicals on the floor should be avoided, even temporaril y .
- Chemicals, products, and equipment should not be stored above eye level so that storage circumstances can always be easily evaluated (e.g., corroded containers, deteriorating contents, etc.).
- Any shelving within the storage area should be firmly secured to the floor and wall.
- Island shelf assemblies should be avoided unless they are secured to the ceiling.
- Unsecured shelves can easily tip over and injure an employee or student, or cause serious chemical interactions.
- Lips on storage shelves are recommended to prevent bottles from rolling off.
- Wooden shelves are best suited for general chemical storage since they are less effective heat conductors, but metal shelves should be used for flammables to reduce fire hazards.
- Chemical storage under, over, or near a sink should be avoided since many chemicals are affected by moisture and can become highly hazardous.
- Chemical storage should be away from heavily travelled areas, such as classroom entrances.
- All storage cabinets or closets should be locked when not in use.
- Stored chemicals should be cool and dry, and have caps and lids tightly closed; none of the chemical should be on the outside of the container.

- Each chemical storage area should be properly vented.
- Stored chemicals should be arranged in compatible families rather than in alphabetical order.
- Particularly hazardous chemicals should be purchased in small quantities so that they are used within one year.

Two unsafe practices common in schools and colleges should be carefully avoided. First, a conventional refrigerator is an inappropriate storage area for volatile materials such as ether or other flammable liquids. An explosion in a standard refrigerator could be caused by a spark from the motor, thermostat, or light switches, igniting the volatile fumes. Explosion-proof refrigerators can be purchased for the storage of volatile materials.

Second, storing chemicals in a hood is dangerous for several reasons. For example, a corrosive environment underneath the hood may lead to highly hazardous chemical interactions or, at least, damage warning labels sufficiently to prevent proper handling. A hood fire could be complicated by the presence of stored hazardous chemicals in the hood. Work space within the hood is reduced by chemical storage, thereby increasing the likelihood of container breakage and chemical interactions. Elimination of inappropriately stored hazardous chemicals from conventional refrigerators and laboratory hoods can substantially improve chemical safety for individuals and the educational facility.

Inappropriate storage of chemical combinations can create “hidden,” insidious hazards when the wrong chemicals interact. Inappropriate, highly hazardous chemical interactions can occur accidentally through the spread of vapors or fumes, through chemical spills, or through contact due to contamination of the outside of containers. For example, nitric acid should be stored in an acid cabinet, but it must be isolated from the other acids within that cabinet. Hydrochloric acid must be stored away from formaldehyde to avoid the production of a carcinogenic vapor from the interaction of these two chemicals. (If flammables and corrosives are stored separately, as they should be, these two chemicals will be separated. Unfortunately, they are often found in close proximity.) Extra protection should be given to mercury and the bottle in which it is stored, preventing mercury spill. Mercury creates dangerous vapors and requires special cleanup procedures. The heavy liquid metal is easily absorbed through the skin or, in the case of a spill, can vaporize and be inhaled.

Several prerequisites will help you safely organize a chemical storage area:

- Check school purchasing procedures.
- Make a complete quantitative inventory of chemicals found on your premises.
- Identify and estimate the minimum amounts of each chemical you will need for the next year.
- Assign someone within your institution, or a consultant, the responsibility of inspecting all chemical storage areas at least once annually and of reporting the findings to the administration.
- Confirm that chemical storage meets local fire codes.
- Do not store chemicals in alphabetical sequence since this can place two chemicals side by side that produce highly hazardous chemical interactions (e.g., acetaldehyde and acetic acid).

Storing Compressed Gases

Compressed gas cylinders should be stored separately by hazard class (a) in a fire-resistant area, (b) in a well-ventilated area, (c) in a location away from sources of ignition, excessive heat, or moisture, and (d) always attached to a permanent anchor (i.e., laboratory bench, wall, counter, etc.).

Indoor storage areas for gas cylinders must not be located near steam or hot water pipes, boilers, or any sources of ignition. Outdoor storage areas should have proper drainage and be protected from any serious weather conditions.

Make sure cylinders are securely chained in an upright position to avoid tipping or falling. Certain gases require a segregated storage facility, away from a common area or enclosure. A few examples are oxygen, chlorine, propane, and vinyl chloride. Large quantities of some compressed gases, such as acetylene, should be stored in “explosion-proof” rooms with a breakaway wall or ceiling to minimize damage if an accident should occur.

Only those cylinders in use should be confined and stored within the work area. Full and empty cylinders should not be stored together. In all cases, compressed gas storage areas should comply with federal, state, and local requirements.

Cylinders of compressed gas should always be transported with an appropriate cylinder hand truck or on a pallet for larger quantities. Securing devices should always be in place before the cylinder is moved. Standard hand trucks for moving boxes should not be used for gas cylinders, and gas cylinders should never be rolled, since damage to the valves can produce serious hazards for employees, students, and the facilities.

FIRES

A fire alarm system must be installed in each building and tested periodically. Fire alarm drills should involve all employees and students. Each classroom and adjacent areas should have an evacuation procedure clearly on display near the exit. Which exits to use for each work area under various circumstances, and where to reassemble on the grounds, should be defined in advance. You should know the nearest exit to your classroom or work area and learn to recognize the sound of the alarm.

Fire extmguishers found in key locations throughout the building are intended for emergency use only on fires that fall in the range of the extinguisher size and capabilities. Extinguishers must be inspected regularly and serviced annually. Their labels must not be removed or altered. Read directions and familiarize yourself with the location of all fire extinguishers.

Remember, *not all fires can be controlled with the same type of fire extinguisher* (for example, water-reactive chemicals become more hazardous when sprayed with water), and *not all extinguishers are the same.* Fire extinguishers contain different materials for use on different types of fires. There are four different types of fires, depending upon the fuel involved:

Class A Fires: Include combustible materials such as wood, paper, cloth, and rubber.

Class B *Fires:* Involve flammable liquids, solvents, grease, paint, butane, fats, and gasoline.

Class C *Fires:* Involve electrical equipment.

Class D Fires: Result from burning metals such as sodium, potassium, or calcium.

Different extinguishers are effective for different types of fires:

Water: Effective on Class A fires.

Dry Chemical Powders: Effective against Class A, B, and C fires. A tri-class, ABC extinguisher is available as a single, combined unit effective for fire Classes A through C.

Carbon Dioxide (CO_2): Effective against Class B and C fires.

Halon: Effective against A, B, and C fires. (Placement of halon extinguishers in educational institutions, however, should be undertaken with great caution because of the potentially violent reactions of halon with some chemicals, e.g., acetaldehyde and rare earth metals.)

Alcohol Foam: Effective against water-soluble or polar flammable liquids, except for those that are only "very slightly" soluble.

Special Powders: A commercial powder formulation, powdered graphite, or trimethoxyboroxine will extinguish a Class D fire (metals). These powders are applied to the fire with a scoop rather than an air-pressurized system.

Extinguishers should be located within 25 feet of any area where employees or students work. Each location should have the appropriate fire extinguisher for that particular area. For this reason, do not exchange extinguishers from area to area without permission.

Asbestos fire blankets have been outlawed under a recent federal ruling. A fire blanket made of polymeric fabric (which could possibly melt and press into the flesh) has been replaced by a fire retardant treated *woolen fire blanket.*

EXPLOSIONS

Many materials, combinations of substances, mixtures, or compounds can become explosive under the right circumstances. Commercial products with which schools and colleges are concerned fall into three categories:

Class A Explosives: Detonating or "high" explosives, for example nitroglycerine, dry picric acid, and lead azide. Other substances in this category, although not normally found in academic facilities, include dynamite, black powder, mercury fulminate, blasting caps, and detonating primer.

Class B Explosives: Include photographic flash powders, propellant explosives, and special fireworks.

Class C Explosives: Manufactured combinations of Class A and B explosives in restricted concentrations and quantities.

Forbidden explosives are those materials not acceptable for regulated transportation by the U.S. Department of Transportation (DOT). A partial list includes:

- Dynamite (except gelatin dynamite) containing more than 60% of liquid explosive ingredient
- Liquid nitroglycerin
- Dry and noncompressed nitrocellulose in a quantity greater than 10 pounds total weight per package
- Explosives containing an ammonium salt and a chlorate (ammonium perchlorate)
- Explosive conditions that undergo marked decomposition or that ignite spontaneously making the products and their use more hazardous
- Dry mercury fulminate and fulminates of all other metals in any condition except as a component of manufactured articles not now forbidden
- Explosives not packed or marked in accordance with the requirements of DOT
- New explosives not yet approved by DOT (a permit may be granted for transportation and possession for laboratory examination of such explosives when under development by a reputable research organization)

SPILLS AND LEAKS

Spills and leaks can be hazards to the soil, the air, and water as well as to the interior of an educational facility. Efficient detection, however, can minimize the risk, and regular monitoring of the volume of material in a container and properly evaluating valve operation, storage locations, and the condition of containers can prevent unnecessary spills or leaks.

Three control procedures should be established for unforeseeable spills and leaks for hazardous chemicals: (1) Evacuate students and faculty from the immediate vicinity; (2) contain the spill; (3) stop the leak.

Employees should not treat spills and possibly create a new hazard or become unnecessarily exposed unless they have been properly trained. If done incorrectly, a toxic vapor may be generated by the spill treatment, thus creating an additional hazardous situation. If the spill is the result of an incorrectly opened or closed valve, set the valve to the correct position. If a leak occurs in a container, when *possible,* contain the discharge in another, often larger, container. In all cases, *report all spills or leaks to your administrator.*

HAZARDOUS WASTE DISPOSAL

Flammable liquids, toxic and corrosive materials, and other substances that may create environmental problems are defined as hazardous wastes. An important safety aspect of academic worksite operations involves proper disposal of waste chemicals. State and local standards place limits on who does the disposal, where the materials are disposed, and how disposal can be done. Consequently, every educational institution should establish proper procedures for chemical disposal.

Chemicals are designated for disposal for various reasons: (1) chemicals are aged and useless; (2) an experiment has been abandoned or a safer substitute has been found; (3) the container is not labeled, resulting in unknown contents; (4) the container is damaged or deteriorated; and (5) there are excessive quantities of highly hazardous materials.

When extraordinary conditions arise, companies specializing in controlling or cleaning up hazard situations should be employed. Any questions about the proper removal of waste materials from *your* area must be addressed to your administrator so that special waste control measures can be properly used to assure that proper disposal is achieved. *Protect yourself and your work environment by following proper waste disposal procedures.*

There are a number of options for disposing of chemical wastes. A specialized company will use these methods after categorizing the wastes to be removed. All chemicals cannot be disposed of by the same procedure. The following guidelines apply for chemical waste disposal:

Evaporation: Evaporate *small* quantities of solvents that have flash points above room temperatures (68-70” F) and are noncombustible by trained, experienced personnel. Vapors must not create a health, fire, or environmental interaction risk, and proper procedures must be followed to assure that air pollution liabilities are not created.

Neutralization and Dilution: Acid and alkaline materials can be carefully neutralized by knowledgeable experts, and soluble materials can be cautiously diluted into a sewer system. Care must be taken that the concentration of the materials will not damage the plumbing or harm anything within the path of the disposal system. Some chemicals may react with the pipe material, causing corrosion or toxic vapors. Because a local water system is recyclable, caution must be used to ensure that no pollutants enter or remain in the water.

Burial: Poisonous wastes are disposed by special, licensed companies using the burial method. Care must be taken to (1) assure that quantities of chemical waste will not reach surface or ground waters, (2) prevent uptake of toxic substances by crops grown over the burial site, (3) prevent scavengers from reaching the waste material by providing enough earth cover, and (4) record the burial site so that subsequent grading or construction does not unintentionally uncover the buried waste.

Burning: Large quantities of hazardous waste are burned in special, controlled, high-temperature incinerators. Under supervised conditions, *small* quantities of flammable chemicals can be burned on the ground or in a shallow metal container but, again, proper procedures must be followed to assure that air pollution liabilities are not created.

Two categories of chemicals that must be handled separately from the above-stated disposal procedures are radioactive materials and reactive chemicals. A specialized company should be employed to take care of these two types of highly hazardous chemical waste. *Radioactive materials* should always be segregated and handled in accordance with specific federal requirements. *Reactive chemicals* should be treated individually according to the nature of the material (a violent reaction may occur if they come in contact with any type of moisture, air, or an incompatible chemical).

Improper disposal of hazardous waste can cause problems for the entire community. Garbage trucks have burned and sewers have exploded because people carelessly discarded flammable or reactive wastes. Acids poured down the sink often cause corrosion in plumbing systems and can potentially release poisonous gases if the trap of the sink contains reactive material. Also, not all wastewater treatment plants are designed to handle certain types of hazardous chemical wastes. Modern sanitary landfills must be specially designed to accept toxic wastes. Groundwater, surface water, and air can be polluted by improper disposal in a landfill.

Simple safeguards should also be used when disposing of common hazardous household chemicals that might be used at work: (1) read the label and make sure its intended use is what you want; (2) buy only what you need; (3) read and follow directions on how to use the product; and (4) follow recommended disposal procedures.

If you have any questions regarding chemical disposal, contact your local health department, your state departments of health or environmental protection, or the U.S. Environmental Protection Agency.

CHAPTER 6

Overlooked Hazards in Educational Institutions

MISCONCEPTIONS AND OVERSIGHTS

Many administrators, teachers, and students incorrectly assume that the only hazardous chemicals in schools and colleges reside in science laboratories. This misconception underscores a broad unawareness of hazardous chemicals in general and of specific hazardous chemicals, products, and by-products that reside, or are produced, in numerous nonscience areas throughout educational institutions. This unawareness also emphasizes the need for implementing effective chemical hazard communication programs in each department (not just in science laboratories) that will both inform and protect employees, students, and physical facilities.

The spectrum of chemical hazards in nonscience areas is far more diverse than most employees expect. Flammable materials are broadly distributed in art, industrial art, home economics, health, office, custodial and maintenance, athletic, and many other instructional work areas. Corrosive chemicals and products are common in photography, printing, art, cafeteria, custodial, and maintenance work sites. Poisons of various potency are present in nearly all nonscience academic locations. Chemicals that can produce cancer or birth defects in women of childbearing age are common in art materials (i.e., glazes, paints, etc.), office supplies (i.e., rubber cement, White Out/ Liquid Paper, etc.), industrial art products, as well as custodial and maintenance products. Inhalation is the primary route of exposure to many of these hazardous materials, but some of these chemicals and products can be absorbed through the skin if proper precautions are not followed.

Most employees in educational institutions are also unaware of their potential occupational exposure to “natural” sources of hazardous chemicals. For example, exposure to the radioactive radon gas generated by the natural decay of substances in rocks and soils beneath educational facilities may increase risks for lung cancer in thousands of institutions nationwide. Improper location of air intake vents has resulted in the internal redistribution of noxious building exhausts picked up from nearby exhaust vents, automobile/bus exhausts from nearby parking lots, groundskeeping pesticide sprays applied near intake vents, or industrial wastes from nearby chemical plants. Few employers and employees are aware that all photocopy machines produce toxic levels of a “natural gas” if not housed in a well-ventilated room. Even the “natural” process of installing carpets in classrooms, or tarring a roof, has produced “crises of the first order” in many educational institutions due to the release of hazardous and/or noxious solvents and odors. These “natural” sources of hazardous chemicals usually become apparent when employees and/or students have suffered ill effects.

Many educational institutions have inappropriately focused their chemical hazard communication programs on science departments, thinking that science teachers will know how to deal properly with hazardous chemicals. Unfortunately, few science teachers, including college chemistry professors who train science teachers, have any formal training related to chemical hazards, proper precautions, appropriate personal protective equipment, emergency procedures, and proper chemical disposal. Hazard communication programs in nonscience areas are often minimal to nonexistent because the responsible science personnel are unfamiliar with hazardous chemicals and products in nonscience areas and have little time and minimal incentive to become familiar with the diversity of potentially hazardous circumstances in the nonscience areas. Some academic institutions, including large school districts and universities, have found that an effective chemical hazard communication program requires implementation either by an external consultant organization or by consultants working with institutional personnel to achieve an integrated, balanced program in both science and nonscience areas.

Because most hazardous chemical management crises in academic institutions develop in nonscience areas, subsequent sections in this chapter will focus upon specific nonscience areas.

ART MATERIALS IN SCHOOLS AND COLLEGES

Art and craft materials present specific chemical hazards for teachers, students, artists, and hobbyists who may be exposed to a myriad of art and craft supplies. Most people think art materials are not harmful, but a careful review of product labels reveals a broad spectrum of potential health and physical hazards. Because children are frequent users of art and craft materials, their exposure to these hazardous substances is especially critical.

Children of all ages are considered high risks for hazardous chemical exposures, with very young children being the most susceptible, due to several factors: (I) incompletely developed body systems that break down and excrete hazardous chemicals, (2) small lung passages that are more sensitive to inflammation and spasms, (3) rapidly growing tissues that are much more easily damaged by poisons or the lack of oxygen or nutrients, and (4) low body weight (or smaller body masses) for chemical dilution. In addition, children are often unable to comprehend potential dangers (consider their tendency to put things in their mouths). A combination of any of these factors makes children more susceptible to smaller amounts of toxic materials than might harm an adult.

Art and craft materials that may be harmful to adults and children include the following:

- Paints and solvents
- Drawing inks
- Dyes
- Pottery clay (silica)
- Sculpture and molding
- Resins, dusts, and paints
- Printing solvents, washes, and inks
- Silk screen solvents and pigments
- Wood preservatives
- Aerosol sprays
- Glues and adhesives
- Permanent markers

These materials can produce a wide variety of acute (short-term) and chronic (long-term) health effects that range from lightheadedness, coughing, and skin irritation through possible birth defects and cancer. Potential hazards associated with art chemicals are real, and the absence of awareness on the part of art educators and their students increases the likelihood of accidental and unnecessary employee or student exposures.

INDUSTRIAL ARTS-SPECIAL HAZARDS

The diversity of hazards in woodworking, autobody repair, printing, cosmetology, and electronics shops in schools and colleges is too broad and too specialized in each area for detailed discussion in this book. The classes of hazardous chemicals in each of these areas, however, are similar and include:

- Flammables
- Corrosives
- Poisons
- Carcinogens
- Mutagens
- Teratogens

In addition, primary risks in essentially all industrial art areas arise from inhalation exposure (e.g., paints and solvents in woodworking; welding and exhaust fumes in autobody shops; ink and wash solvents in printing; nail polish remover and hair spray solvents in cosmetology; spray solvents and solder fumes in electronics shops). All of these areas also involve secondary risks from skin exposure. These similarities in classes of hazardous chemicals and routes of exposure enable proper safety management to be somewhat standardized despite the breadth and specialized hazards in each area.

Employee and student protection in each industrial art work site, for instance, should focus upon three priorities: (1) fire prevention; (2) avoiding exposure to vapors and fumes; and (3) prevention of skin exposures.

Fire prevention requires storage of flammable materials in metal, fireproof cabinets, use of safe procedures and effective student training, and availability of appropriate fire extinguisher systems (i.e., fire extinguishers, sand, automatic sprinklers, fire alarms close at hand, etc.). *Inhalation exposure* to vapors and fumes can be reduced by appropriate work site ventilation, including local spot vents, generalized room ventilation (exhausted directly to the outside, *not* recirculated!), air dilution techniques (i.e., standing fans, open doors and windows, etc.), and personal protection equipment (e.g., cartridge respirators, “backpack” respirators). *Skin exposures* can be minimized by the use of appropriate personal protective equipment (i.e., gloves, aprons, safety glasses, goggles, faceshields, and full body clothing) and effective personal hygiene, including the availability of nearby hand- and face-washing facilities, an eyewash fountain (portable eyewash bottles are ineffective when both eyes are involved in an accident), and a full body shower with appropriate drainage. Employees and students working with hazardous chemicals in industrial art areas should wash their hands before and after using the bathroom. Administrators and industrial art instructors must plan and prepare properly if fire, inhalation, and skin hazards are to be prevented.

SPECIAL HAZARDS IN PHOTOGRAPHY FACILITIES

Many schools and most colleges have at least one darkroom, and many academic institutions have several photography areas to support various departments. Many potentially hazardous chemicals used to develop film are not effectively labeled for employee and student protection; furthermore, employees and students often handle these hazardous chemicals carelessly, usually due to unawareness of the risks.

Photographic chemicals include corrosives, poisons, and some carcinogens and flammables. Most darkrooms are inadequately ventilated and typically reek with pungent chemical odors, but users of these facilities seldom question the potential impact of exposure to these chemicals. Similarly, personal protective equipment is often inadequate, and available gloves, goggles, tongs, etc., are not always used.

Development of a proper safety protocol for photographic facilities should be a priority. These procedures should include the proper storage of hazardous chemicals and products, and the availability of adequate ventilation and of eyewash fountains and other appropriate safety equipment.

OVERLOOKED HAZARDS IN OFFICE AREAS

School and college administrators and office employees alike generally consider office areas to be free of hazardous chemicals. Certainly there are considerably fewer chemicals than in science, art, industrial art, custodial, and maintenance areas, but flammable, poisonous, carcinogenic, and teratogenic chemical products are used routinely in office areas. Although office employees often recognize odors from rubber cement and other adhesives, duplicating machines, laminating machines, permanent markers, and rubbing alcohol, most do not understand that these products contain hazardous chemicals.

Fire danger from flammable products and inhalation exposure represent the two primary concerns in office areas. Fire injuries and damage can occur from inappropriate or careless use of any office products that contain flammable solvents (e.g., duplicating fluid, rubbing alcohol, rubber cement, fingernail polish remover, etc.). Inhalation exposures usually result from inadequate ventilation. Some inhalation risks are the result of disturbance or inadequate sealing of building materials (e.g., asbestos, fiberglass, etc.).

Air pollutants common to office areas include:

- Asbestos
- Fiberglass
- Flormadehyde
- Photocopy toner
- Ozone
- Radon
- Tobacco smoke
- Duplicator solvents

HAZARDOUS CHEMICALS IN CUSTODIAL AND MAINTENANCE AREAS

Many chemical products used by custodial and maintenance personnel in schools and colleges are flammable or corrosive. Essentially every flammable product also represents an inhalation exposure health hazard, and every corrosive product represents a skin and eye exposure health hazard. Most custodial and maintenance employees, however, regularly endure exposures to these hazardous chemicals and products but remain unaware of the potential injury, even when they experience symptoms such as coughing, tearing eyes, headache, dizziness, itching skin, or hand rashes. Too often these employees do not use protective gloves, respirators, or dust masks, even when available. Old habits are hard to break!

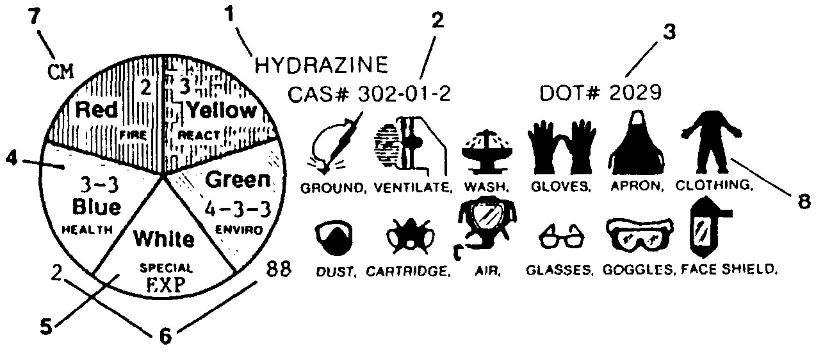
Inappropriate mixing of various custodial and maintenance products results in hundreds of serious hazardous chemical exposures each year. For example, the relatively common practice of mixing ammonia and bleach to produce a “super floor cleaning solution” sent two custodians and four rescuers to the hospital in Utah as a result of exposure to the resultant corrosive gas. In another case, a $200,000 lawsuit was filed against one institution when a visitor was hospitalized after being overcome by a toxic gas in a restroom. The gas was produced because a contract plumber left toilet bowl cleaner in a repaired toilet and an unwary custodian subsequently added ammonia to the same toilet. Chemical interaction hazards are very serious and warrant specialized training for all custodial and maintenance personnel.

Inappropriate storage of custodial and maintenance chemicals can result in accidental hazardous chemical interactions. For example, leaking or spilled ammonia and bleach will produce the same corrosive gas mentioned above. Chlorine oxidizers used in powdered cleansers and swimming pool additives can interact with combustible materials (i.e., paper, cloth, etc.) or flammable products to produce spontaneous fires. Storage of hazardous custodial and maintenance chemicals near, or above, food products can result in food contamination from spilled or leaking containers. Hazardous custodial and maintenance chemicals and products should be stored by hazard class, away from foods, in appropriate, well-ventilated cabinets or rooms.

Custodial and maintenance personnel must also be aware of hazards associated with chemicals and products in other departments so they are not inadvertently exposed to unfamiliar hazardous products or circumstances. For example, a group of custodians was asked to remove chemicals from a science laboratory prior to remodeling and unwittingly mixed hazardous chemical containers in storage drums. An explosion and spontaneous fire would have occurred as a result of accidental chemical interactions during replacement if consulting hazardous chemical experts had not discovered the problem during the interim. At other times, custodial or maintenance personnel may be working in artrooms while a kiln is firing and the exhaust fan is off. Plumbers may need to work near water-reactive chemicals, electricians in rooms filled with flammable vapors. Effective hazard communication and employee education and training are especially important in custodial and maintenance areas.

APPENDIX A

Saf-T-Label with Hazard Assessments and Protective Equipment



1. Chemical Name
2. CAS Number
3. DOT Number
4. Hazard Ratings (0-minimum, 4-maximum)

Fire
Reactivity
Health (Acute-Chronic)
Environmental (Air-Water-Soil)

5. Special Hazard Indicator

OXY-Oxidizer EXP-Explosive
RAD-Radioactive W-Water Reactive

6. Application Date
7. Special Health Hazard Indication

C-Carcinogen T-Teratogen
M-Mutagen N-Neurotoxin

8. Recommended Protective Equipment

Health (Blue Section) Numeric values in this section range from 0 to 4. A 0 value indicates no health hazard, whereas a 4 value indicates a maximum health risk. The first number represents acute, or short-term, health risks; the second number summarizes chronic, or long-term, health risks.

Fire (Red Section) This numeric value also ranges from 0 to 4, with a 0 again indicating no flammability risk and a 4, an extreme fire hazard.

Chemical Reactivity/Explosive (Yellow Section) Numeric values in this section cover the same 0 to 4 range, with 0 indicating no hazard and 4 indicating maximal risk.

Environment (Green Section) Numeric values again range from 0 to 4, with 0 indicating no hazard and 4, maximal hazard. The first number indicates the hazard in air, while the second and third numbers show water and soil risks, respectively.

Special Risks (White Section) Values in this section include: unusual reactivity with water (W); oxidizing chemical (OXY); and radiation hazard (RAD).

Protective Equipment Symbols (Black) Pictorial protective equipment symbols include: first row (left to right) grounding, proper mechanical ventilation, wash facilities (eye, hand, and/or body shower), gloves, protective apron, full protective suit; *second* row (left to right) dust mask, chemical cartridge respirator, self-contained air supply, safety glasses, safety goggles, full face shield.

APPENDIX B

Employee Safety Procedure Checklist

An employee safety procedure checklist has been included as a review of the topics covered in this basic chemical manual. You may want to use this checklist to evaluate chemical safety procedures in your workplace.

IS:

______ A dangerous solution left in a drinking glass or beverage bottle?

______ Washing hands before and after each laboratory experiment a general practice?

______ A complete chemical inventory available and current?

______ A fume hood used routinely when transferring corrosive liquids?

______ Adequate protective equipment used according to the chemical procedure implemented?

______ Appropriate chemical disposal practiced in all departments and facilities?

______ Pipetting in science laboratories done with rubber bulbs or similar equipment, never by mouth?

______ A specially designed, explosion proof refrigerator used to store chemicals requiring extra cool temperatures?

______ A fire extinguisher accessible and is maintenance checked at regular intervals?

______ A smoke detector installed within chemical work and storage areas?

ARE:

______ Faulty equipment and potential dangers identified, and the problems communicated in writing to appropriate administrative staff?

______ Unlabeled reagent bottles separated for identification prior to disposal?

______ Supplies and materials for cleaning and controlling spills kept in a consistent location in each work area?

______ Bottle carriers used when transporting glass containers of corrosive liquids?

______ You working alone in a laboratory area?

______ Small spills wiped up immediately?

______ Container labels legible and securely attached to the container?

______ Acids and flammables stored in separate OSHA-approved cabinets?

______ Extremely hazardous and carcinogenic chemicals identified and removed from the classroom area?

______ Cylinders of compressed gas that have loose screw caps moved?

______ Only small quantities of chemicals maintained in the classroom?

________ Special disposable gloves worn when handling radioactive materials? Are the gloves in storage frequently checked for prior contamination?

________ Employees and students that wear contact lenses identified?

________ Emergency phone numbers posted in conspicuous places within each work area?

________ Special laboratory rules properly communicated and posted?

________ Storage container corrosion and leakage checked on a regular basis?

________ Unused equipment, glassware, and material not involved in the immediate operation being kept away from the worksite?

________ Smoking, eating, and drinking restricted from laboratory or chemical storage areas?

________ The safety instructions and supervision that teachers give students appropriate for the students and environment being studied?

________ Loose clothing, untied shoelaces, dangling jewelry, and long hair contained or removed, as appropriate?

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SERIES DESCRIPTION

CHEMICAL AND ENVIRONMENTAL SAFETY AND HEALTH IN SCHOOLS AND COLLEGES

Comprehensive Hazard Communication and Right-To-Know Compliance Publications

Now being compiled and written by The Forum For Scientific Excellence, Inc., this series is designed to facilitate school and college compliance with federal and state hazardous chemical regulations and to provide required employee training and understanding. The information contained in the series is the result of the author's extensive and ongoing consulting experience in this field.

These publications cover essentially every aspect of the OSHA Standard and individual state Right-To-Know laws, and encompass the following:

1. Policies, procedures, and administration
2. Employee training and communication
3. Hazardous chemical and product information

Policies, Procedures, and Administrative References

Compact School and College Administrator's Guide for Compliance with Federal and State Right-To-Know Regulations

Translates the "legalese" and technical language of current hazardous chemical standards and regulations into meaningful, easily understood terminology. Provides a simplified, step-by-step program to assure that an institution or system fulfills all compliance requirements. Valuable introduction for all concerned with developing a workable, effective program.

Written Hazard Communication Program for Schools and Colleges

Identifies and describes the objectives an educational institution must achieve to assure that its hazardous chemical compliance program is appropriate and adequate. Includes specific examples of the written program requirements, including the MSDS format and hazard assessment criteria, as well as communication vehicles and formats. Essential for the administrator assigned responsibility for the compliance program. Practical ring binding allows individualized inclusions of additional local information specific to the site.

Employee Training and Communication Manuals-Five-Year Program

The following texts are designed for quantity distribution and use in fulfilling the ongoing training requirement in the OSHA Standard and various state regulations. They are useful for formal in-house training programs and seminars and also are effective individual self-study tools. As a five-year program the order of presentation suggested may be changed to fit local needs, although initial use of Volume 1: Basic Principles is strongly recommended. Additionally, since the workforce rarely is static, concurrent use of different texts with employee subgroups is a natural outcome. All five texts fulfill federal and state ongoing training requirements. Special discounts are available on quantity orders.

Concise Manuals of Chemical and Environmental Safety In Schools and Colleges

Volume 1: Basic Principles

A comprehensive primer that provides individual employees the basic definitions, concepts, and methods for dealing with hazardous materials safely. Reviews federal and state standards and regulations and discusses MSDSs, various definitions, labeling, occupational medicine and industrial hygiene, protective equipment, and proper work practices and procedures.

Volume 2: Hazardous Chemical Classes

A second-year training and communication resource for individual employees. Expands hazardous chemical information into classes of chemical hazards, including routes of absorption, flammables, corrosives, poisons, oxidizers and reactives/explosives, radioactive materials, carcinogens, mutagens, and teratogens, as well as general human and environmental safety. Gives emergency treatment procedures for groups of hazardous chemicals within each class.

Volume 3: Chemical Interactions

Third-year training and communication text module. Describes serious, "hidden" hazards and incidents that can arise when two or more chemicals interact inappropriately. Outlines mechanisms for prevention of such unnecessary hazards.

Volume 4: Safe Chemical Storage

An essential, ready reference that identifies procedures for safely storing chemicals and products in a variety of educational areas, including laboratories, art and graphics areas, industrial and vocational shops, and custodial and storage areas. Describes severe dangers created by storing chemicals in alphabetical order. Lists chemicals that should not be present and those that become more hazardous with age.

Volume 5: Safe Chemical Disposal

A detailed description of proper procedures for safely disposing of various classes of hazardous chemicals and products in educational institutions. Identifies safe interim storage procedures and potentially hazardous chemical interactions that must be avoided. Describes mechanisms to minimize costs and assure proper regulatory compliance. Fulfills OSHA, EPA, and many state requirements.

Pocket Guides to Chemical and Environmental Safety in Schools and Colleges

Five condensed, portable "field" guides with the same volume numbers and titles as the *Concise Manuals* above. Each includes essential information and checklists found in the *Concise Manuals* but in abbreviated form with less theory and examples. Designed for quantity distribution and use; handy pocket size; quantity discounts also are available.

Hazardous Chemical and Product Information

Handbook of Chemical and Environmental Safety in Schools and Colleges
A comprehensive master reference containing all of the information presented in the five *Concise Manuals* and *Pocket Guides* described above, as well as additional regulatory data and checklists. Includes basic chemical safety and health principles, hazardous chemical classes, hazardous interactions, and safe storage and disposal procedures. A "total" sourcebook for anyone wanting substantial treatment of principles, techniques, and legal requirements.

Compendium of Hazardous Chemicals in Schools and Colleges
Encyclopedic coverage of more than 700 hazardous chemicals commonly found in schools and colleges. Includes all data necessary for properly identifying and defining the acute and chronic health hazards of each chemical, as well as fire, explosion, environmental, and special risks such as radiation or oxidation for each of the substances. Also includes actual hazard assessments derived from published hazard assessment criteria, as well as labeling data. The information fulfills all aspects of federal and state data requirements and also includes additional nonrequired information that has been found useful in managing effective programs. Provides a basis for evaluating the accuracy of supplier MSDS data, regulations, and employee concerns.

index of Hazardous Contents of Commercial Products in Schools and Colleges

Lists hazardous components found in nearly 10,000 commercial products used in educational facilities, and includes specific component chemical identities and, whenever possible, the percentage of the total content. When used in conjunction with the *Compendium* above and the *Cross-Reference Index of Hazardous Chemicals, Synonyms, and CAS Registry Numbers,* this work provides the data needed for safe practices and compliance with the OSHA Standard and state Right-To-Know laws.

List of Lists of Worldwide Hazardous Chemicals and Environmental Pollutants

The most extensive compilation of regulated hazardous chemicals and environmental pollutants available. Includes separate lists of substances regulated by more than 25 state, federal, and international agencies, along with many of their selection criteria. Also includes a master list in both alphabetical and Chemical Abstracts Service (CAS) Registry Number sequence. The first place to look to see if a substance is regulated in any major area or country.

Cross-Reference Index of Hazardous Chemicals, Synonyms, and CAS Registry Numbers

An extensive cross-reference listing of more than 40,000 synonyms for the hazardous chemicals and environmental pollutants identified in the worldwide *List of Lists* above. Represents the most comprehensive source available for properly identifying common names, chemical names, and trade names associated with those regulated chemicals. Provides a ready reference for identifying the CAS numbers for common or product names that “hide” their true chemical identity.

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