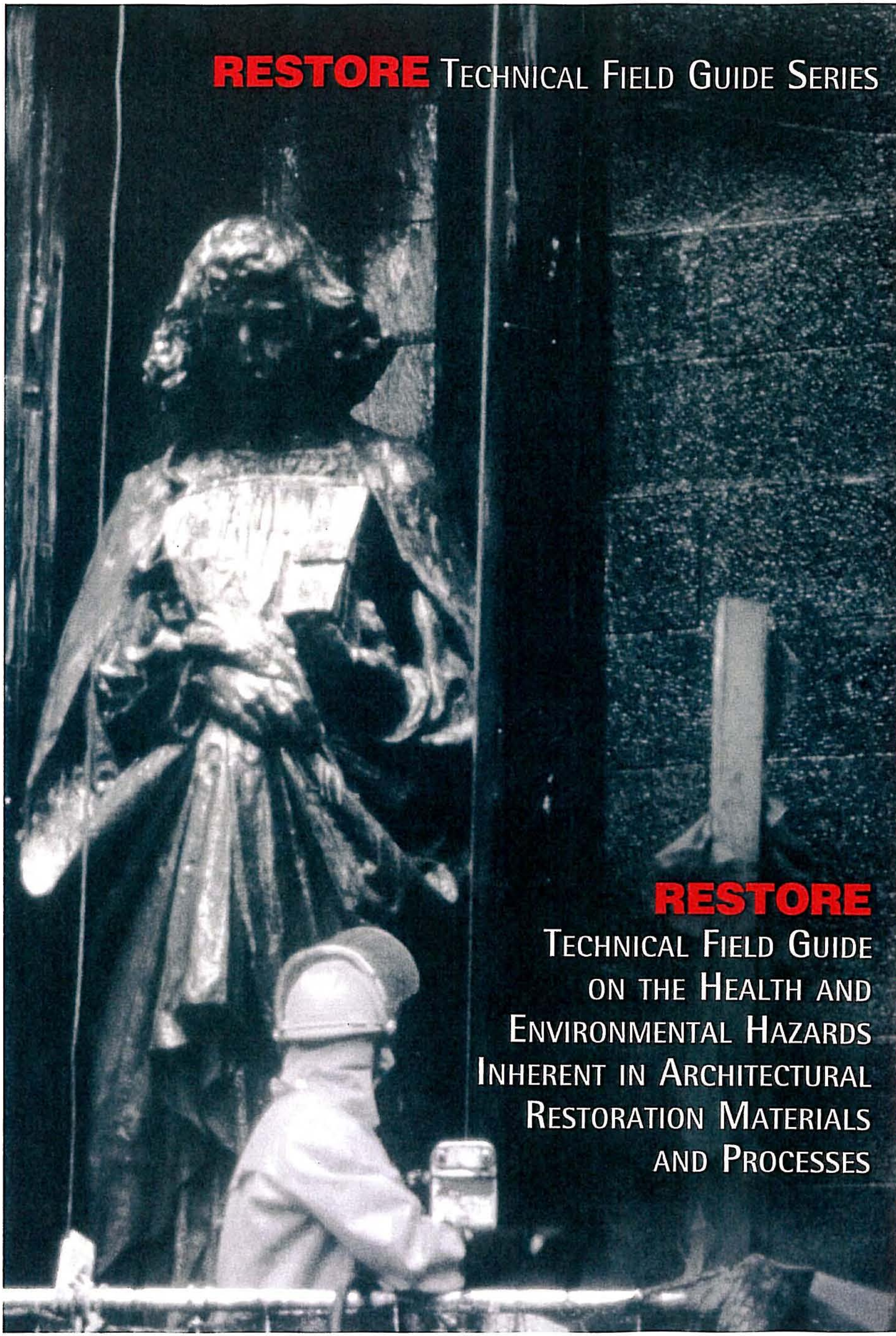

RESTORE TECHNICAL FIELD GUIDE SERIES

RESTORE

TECHNICAL FIELD GUIDE ON THE HEALTH AND ENVIRONMENTAL HAZARDS INHERENT IN ARCHITECTURAL RESTORATION MATERIALS AND PROCESSES

RESTORE

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RESTORE Technical Field Guide on the Health and Environmental Hazards Inherent in Architectural Restoration Materials and Processes

RESTORE has made every effort to provide accurate and up-to-date information in this Technical Field Guide. However, please be aware that as research on health and environmental hazards of materials is conducted, laws, regulations and procedures for using specific materials constantly change. Readers are advised to investigate further specific materials and their uses. Simply providing workers with a copy of this Field Guide does not satisfy Right-to-Know training requirements. A qualified person with knowledge of the worksite should be present to discuss the material and answer questions. This Field Guide does not attempt to render legal or medical advice. Readers are advised to consult legal and medical professionals for further guidance on legal and medical issues.

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RESTORE Technical Field Guide on the Health and Environmental Hazards Inherent in Architectural Restoration Materials and Processes

Monona Rossol, M.S., M.F.A., Industrial Hygienist

Part 1
Environmental Health and Safety For Building Restoration and Renovation

Introduction

Today's technology is evolving so rapidly that keeping abreast of new information is often difficult for design professionals, craftworkers, architectural conservators, archaeologists and cultural resource managers. As a by-product of changing technology, new health and environmental hazards inherent in conservation processes are being identified and strictly regulated. Building restoration work is increasingly affected by laws that apply to almost every aspect of the building industry, including worker health and safety, environmental protection, waste disposal, and asbestos and lead paint removal.

A host of hazards and environmental issues affect the way we work, how we design, specify, use, store and dispose of materials. Often, irreversible or inappropriate work is done because architects, engineers and preservation craftworkers have relied solely upon product manufacturers' literature or are forced to try various solutions on a trial-and-error basis. RESTORE's goal is to bring preservation professionals up to speed with the safe use of materials and processes that technological advances have made available. State-of-the-art conservation technology will be viable only if design professionals and craftworkers understand and can respond to the potential hazards of the materials and processes they specify and use every day, *e.g.*, cleaning chemicals, solvents, epoxies, adhesives, coatings and consolidants. Failure to understand and comply with regulations not only threatens the health and safety of employees and contaminates the environment but can endanger a company's financial well-being with costly accidents, fines, stop-work orders and lawsuits.

This Technical Field Guide will address some of the most important aspects of environmental, health and safety regulations, presenting practical information concerning the critical architectural preservation problems related to the hazards and environmental impact of the technology we specify and use today. Special emphasis will be placed on the Hazard Communication Standard, or "Right-to-Know" laws, which require that employers formally train workers about the chemical hazards of the materials they use.

Part I of this Technical Field Guide concentrates on information about occupational laws and workers' health. The concepts covered in Part II include U.S. and Canadian Right-to-Know training rules, which require workers to understand the technical concepts needed to interpret data regarding chemicals found on product labels and on Material Safety Data Sheets.

For all of us entrusted with the preservation of our cultural and architectural heritage, there is a fundamental need for further education and technical information about the processes and materials used in architectural conservation work and their inherent hazards. A thorough understanding of the health risks posed by many restoration materials and processes is essential to the safe and effective treatment of conservation problems. RESTORE's objective is to equip design professionals and craftworkers with the knowledge to design and produce safe, cost-effective and viable projects.

This is a cutting-edge issue. Clearly, design professionals and craftworkers who are trained and are knowledgeable about preservation materials and processes are able to avoid hazardous situations that are costly for their projects and could cause irreversible damage to our cultural heritage, to the health of craftworkers and the public and to the environment. The end result of knowledge and proper training is that people will benefit, the environment will benefit and our cultural and architectural heritage will benefit.

Environmental Regulations

Today, disposal of chemicals is strictly regulated in the U.S. and Canada. The amounts and types of chemicals that may be disposed of into sewage systems are regulated. Similar controls apply to chemicals that are flushed from worksites into storm sewers, such as residual surface treatments from exterior building facades. Different rules apply to disposal of renovation refuse, paint containers, lead paint chips and other hazardous waste. Businesses located in areas where septic systems are used or where ground water may be contaminated will have yet another set of rules.

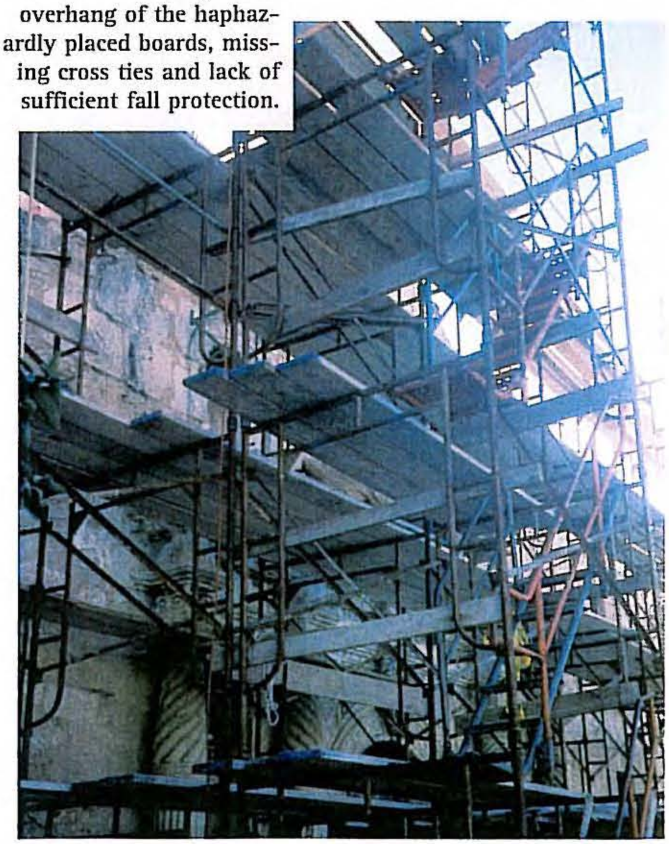
Failure to comply with many of these regulations can result in exceedingly large fines. Accidental spills or releases of chemicals into sewers or the environment must be reported to authorities and cleaned up at the company's expense. Even worse, permanent environmental damage may result.

The disposal laws may be federal, but local rules vary widely. In the U.S., for example, the Clean Water Act (CWA) regulates pollutants discharged into water sources such as rivers and lakes. This law defines which chemicals are environmentally hazardous and the levels at which these chemicals must be limited in discharge water. The CWA's limitations are imposed on local sewerage authorities who, in turn, set limits on local facilities to insure that CWA's discharge limits are not exceeded.

This means that the only way to find out what an individual restoration project may lawfully discharge is to consult a local authority. For example, if a particular local water-treatment plant has a federal discharge permit for zinc of 5 parts per million (ppm), they may impose a more severe limit on a contractor or worksite to assure the plant meets its 5 ppm limit. In addition, even stricter limits may be used in some treatment facilities that differ in their method or treatment capacity.

Since all these rules vary from location to location in both the U.S. and Canada, it is necessary to spend some time researching them before starting any project. Contact local sewerage and water facilities and the local departments of environmental protection for information. Check disposal information on Material Safety Data Sheets and from manufacturers' technical representatives before purchasing products. Professional waste collection or carting services usually make their rules clear in their contracts. If not, one must ask. Mistakes in waste dis-

A restoration worksite with unsafe scaffolding. Note overhang of the haphazardly placed boards, missing cross ties and lack of sufficient fall protection.



posal can put an historic institution and the restoration contractor out of business.

Occupational Safety Regulations

Both the United States and Canada have very complex regulations governing the relationship between employer and employee. However, whether the regulations are called the Occupational Safety and Health Act (OSHAct in the United States) or Occupational Health and Safety Act (OHSAct in Canada), their main purpose is very simple – to protect workers.

The OSHAct general duty clause reads in part that the "employer shall furnish... employment and a place of employment which are free from recognized hazards." The Canadian OHSAct requires employers and supervisors to "take every precaution reasonable in the circumstances for the protection of a worker."

These brief general statements serve as the foundation for complex regulatory structures. The acts include rules about chemical exposures, noise, ladder safety, machinery guarding, and a host of other subjects. If you are not versed in these regulations, call your nearest Department of Labor and obtain a copy. For rules applicable in the U.S., ask for copies of the Construction Standards, 29 Code of Federal Regulations (CFR) 1926 and the General Industry Standards, 29 CFR 1900-1910. In Canada, contact your Provincial Department of Labour and ask for applicable rules. Each province's rules may differ.

Restoration and repair work done on historic restoration sites in the U.S. falls under the Construction Industry Standards (29 CFR 1926). OSHA's definition of construction work is broad and includes any "alterations or repair, including painting and decorating."

Once the site is open to the public or occupied, all work such as general maintenance, office work, tour guiding, and other activities are regulated under the General Industry Standards (29 CFR 1900-1910). Work on historic buildings, then, is regulated by both the construction and general industry standards.

For example, while construction is ongoing, U.S. workers must be protected from falls of 6 feet or more by guarding floor openings (1926.500(b)(1) & (7)) and open-sided floors or platforms (1926.500(d)(1)). Once the work is finished, the General Industry Standards require that workers be protected from falls of 4 feet or more by guarding all open sided floors, platforms, and runways (1910.23(c)(1)).

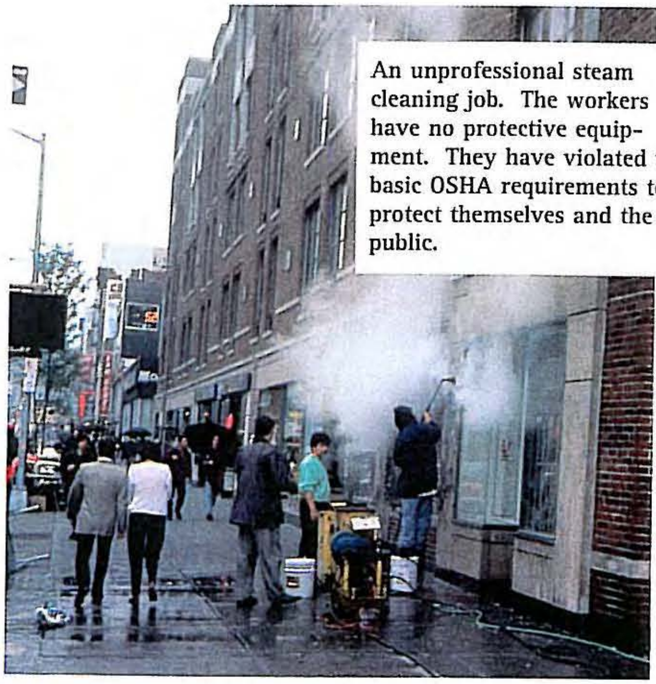
This Field Guide will make recommendations regarding both standards when appropriate in the accepted format as: 29 CFR 1926 and 29 CFR 1900-1910. Readers should refer to copies of the standards.

U.S. OSHA Rules Applicable to Restoration Work

OSHA regulations apply to almost all work activities on restoration sites. Some applicable regulations include:

- Hazard Communication (1926.59, 1910.1200)
- Respiratory Protection (1926.103, 1910.134)
- Personal Protective Equipment (1926.28, 1910.132)
- Fall Protection (1926.500-503)
- Confined Space (1910.146)
- Hazardous Waste Operations and Emergency Response (1910.120)
- Occupational Noise Exposure (1910.95 or 1926.52)
- Lead in Construction (1926.62)
- Asbestos in Construction (1926.1011)
- Emergency Plans and Fire Prevention (1910.38, 1926,150)
- Electrical Safety (1926.401-.405, 1910.331-333)
- Medical Services and First Aid (1910.151, 1926.50)

Included in the many provisions in each of these regulations are requirements for formal worker training. In the case of the lead paint and asbestos regulations, both training and certification of workers are required.



An unprofessional steam cleaning job. The workers have no protective equipment. They have violated the basic OSHA requirements to protect themselves and the public.

Compliance With Training Programs

Many employers simply do not take the time to train their workers. They rely on the odds that they will finish the job without being inspected by OSHA. This is one reason why there are more serious accidents in construction work than any other industry. Once a fatality or serious accident brings OSHA to the site, it is common for heavy fines to be levied. Employers would be wise to protect both their workers and their business by properly training their employees. Moreover, training is required by law.

One of the first training programs employers should institute is the one required in the Hazard Communication Standard (1910.1200, 1926.59). Once workers are properly trained in hazard communication, it is easy to train them in other standards that require knowledge of chemical hazards such as Respiratory Protection and Personal Protective Equipment, Medical Service and First Aid, Confined Spaces, Spill and Leak Procedures and the Hazards of Welding.

The importance U.S. OSHA places on the hazard communication standards is evident in the fact that Hazard Communication (HAZCOM) violations are among the most frequently cited OSHA standards.

Hazard Communication: The Workers Right-to-Know

The history of the U.S. Hazard Communication Standard begins with the so-called "Right-to-Know" laws passed by a number of states in the 1980s. All of these laws were basically similar, but different enough to make compliance very difficult for employers with jobs in more than one state. In 1987, a federal Hazard Communication Standard was instituted. There is a similar history in Canada with the resulting passage and adoption by the provinces of the federal Workplace Hazardous Materials Information System (WHMIS).

Who Is Covered?

Essentially, all employees in the United States are covered by state, or federal hazard communication laws. Even federal workers, long exempt from OSHA regulations, come under this rule. All employees in Canada are covered by the Workplace Hazardous Materials Information System. All employers in both countries, therefore, are required to develop programs and to train their employees when hazardous materials are present.

Self-employed people are not covered, but may be affected by the laws. For example, if you work as an independent contractor at a site where other workers are present, all the products and materials you bring onto the premises must conform to the employer's Hazard Communications or Workplace Hazardous Materials Information System program labeling requirements. Your use of these products also must conform.

U.S. teachers in high schools, trade schools or universities instructing students in the building trades have a unique Hazard Communications obligation arising from the fact that they can be held liable for any harm classroom activities cause their students. To protect their liability, teachers should formally transmit to their students Hazard Communications training about the dangers of classroom materials and processes. They also must enforce the safety rules and serve as good examples by demonstrating proper precautions.

Complying With Right-to-Know Laws

1. To comply, first find out what law applies to you. Call your local Department of Labor and ask them to tell you whether you must comply with a state/provincial or federal Right-to-Know.

2. Ask for a copy of the law that applies to you. In the U.S., construction companies should ask for 29 CFR 1926.59 (or the state OSHA equivalent). General industry businesses and schools should ask for 29 CFR 1910.1200 (or the state equivalent). In Canada, WHMIS is implemented by a combination of federal and provincial legislation. Ask your local Department of Labour for a copy of the law that applies to you. Ask for explanatory materials. Some of the government agencies have prepared well-written guidelines to take you through compliance step by step (see the Bibliography).

3. A written program detailing procedures and identifying individuals responsible for various activities is required in some instances. An example of a written program for the U.S. Hazard Communication Standard can be obtained from OSHA (see the Bibliography).

General Requirements For HCS and WHMIS

There are small differences between the United States and Canadian laws. For example, the definition of "hazardous" varies, and the Canadian law requires information in French. However, the two laws require employers to take similar steps toward compliance:

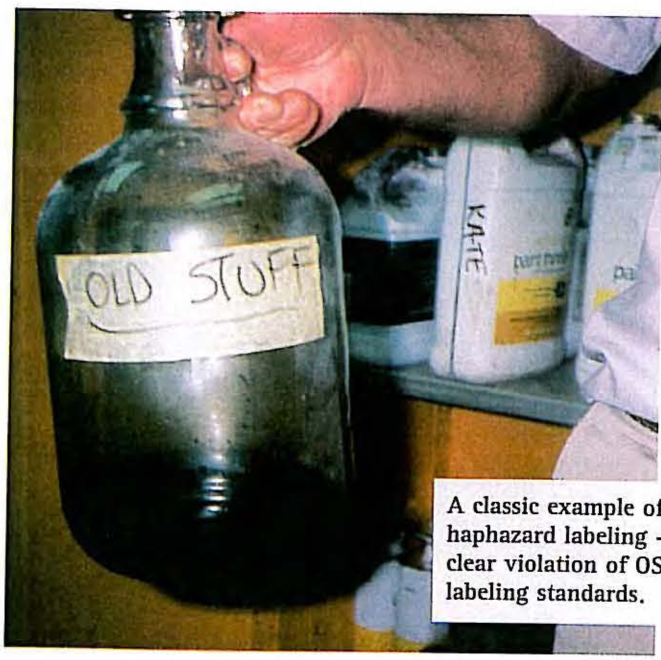
1. INVENTORY ALL WORKPLACE CHEMICALS. List everything, including consumer products that are potentially hazardous. This is an excellent time to cut down paperwork by trimming your inventory. Dispose of old, unneeded or seldom-used products. Try to purchase chemicals only in amounts that can be used up in a few months time. Products found on an inventory for which documentation cannot be obtained (see 3 and 4 below) must be eliminated. The list should be updated as chemicals are added and removed from stock and the inventory must be checked for accuracy each year.

2. IDENTIFY HAZARDOUS PRODUCTS IN YOUR INVENTORY. Apply the definition of "hazardous" in the Right-to-Know law that applies to you.

3. ASSEMBLE MATERIAL SAFETY DATA SHEETS (MSDS) ON ALL HAZARDOUS PRODUCTS. MSDSs are prepared by manufacturers or importers of products. Write to manufacturers, distributors, and importers of all products on hand for MSDSs. Require MSDSs as a condition of purchase for all new materials. Assure that the collection of MSDSs is complete, regularly updated and readily available to the users of all potentially hazardous products. Three-year-old MSDSs are automatically invalid in Canada, and, while not required, U.S. users should ask for regularly updated MSDSs. (Products whose MSDSs do not list ingredients because they are trade secrets should not be purchased for use on historic or landmark sites for ethical and professional reasons.)

4. ASSURE THAT ALL PRODUCTS IN THE WORKPLACE ARE PROPERLY LABELED. Check all product labels to

be sure they comply with the law's labeling requirements. In most cases this means that each is labeled with 1) the identity of the material, 2) appropriate hazard warnings, and 3) name and address of manufacturer or other responsible party. Other data may be required by some state OSHA laws. Products that do not comply must be eliminated or relabeled. Prepare and apply proper labels to all containers into which chemicals have been transferred. (Chemicals in unlabeled containers that are used up within one shift need not be labeled.) Use of unlabeled color-coded containers can not be considered a substitute for proper labeling.



A classic example of haphazard labeling – a clear violation of OSHA labeling standards.

5. PROVIDE EMPLOYEES ACCESS TO RIGHT-TO-KNOW MATERIALS. Make all lists of hazardous materials, Material Safety Data Sheets, and other required written materials readily available to employees. In the construction industry, this means that MSDSs and other vital information should be on-site.

6. CHECK TO SEE IF YOU ARE RESPONSIBLE FOR ADDITIONAL STATE AND PROVINCIAL REQUIREMENTS. In the United States, the Supreme Court upheld (July 3, 1989) the right of states to enforce certain amendments to the federal Right-to-Know (HAZ-COM) law.

7. IMPLEMENT A TRAINING PROGRAM (see below).

Training Requirements

All covered employees in both the United States and Canada must receive formal Right-to-Know training. Employees need to be trained before they begin work with chemicals and they must be retrained each time new chemicals or procedures are initiated. Many state laws require annual retraining as well. Canadian WHMIS requires annual review of the instruction program.

OSHA's rules apply only to full- and part-time employees. However, any business or institution that also uses volunteers, students or interns should train these people as well. Employers have liability for these workers and all health and safety measures should be extended to them.

The amount of time the training should take usually is not specified. This is because the law intends the training to be performance oriented – that is, the employees must be educated enough to be able to read MSDSs, to understand the hazards of their specific jobs and to know how to work safely. Often short quizzes are used to verify that the employees have understood.

All workers must be trained in a language they comprehend. The U.S. OSHA has made it clear that illiterate workers require even more training.

Employers must remember the following points when instituting a comprehensive training program for the worksite.

1. The training program must include an explanation of the employer's hazard communication program, including a description of the labeling system, the

Material Safety Data Sheets and how employees can obtain and use hazard information.

2. Employees must have knowledge of the physical dangers and health hazards of the chemicals in the work area. Workers must not only be aware of hazards such as fire and explosions, but must also understand how chemicals enter the body and the effects of exposure over time.

3. Employees must know how they can protect themselves. The training program must include information on safe work practices, emergency procedures, use of personal protective equipment that the employer provides and an explanation of any ventilation systems or other engineering controls used to reduce exposure.

4. The employer and employees must know how to detect the presence of hazardous chemicals in the work area. Workers should be equipped with training about environmental and medical monitoring conducted by the employer, the use of monitoring devices, the visual appearance and odor of chemicals and any other detection or warning methods.

This Field Guide addresses points 2 through 4 above, and can be used as training material. However, simply providing workers with a copy of this monograph does not satisfy the requirements. A qualified person with knowledge of the worksite must be present to discuss the material and answer questions.

Health Concepts For Worker Training

Hazard communication laws require restoration workers to understand how chemicals and their materials affect them. Studying the hazards of renovation and restoration materials is difficult because they contain so many different toxic chemicals. For example, there are toxic mineral dusts in cement and stone; acids in masonry cleaners; solvents in paints and graffiti removers; plastic monomers in adhesives and resins; and toxic metals in paint pigments, welding fumes and brazing metals. Each of these types of chemicals affects the body in its own unique way. The study of these effects is called toxicology.

An example of a proper restoration worksite. Note the barriers to protect the public from runoff and falling debris.

Basic Concepts Of Toxicology

DOSE. Chemical toxicity is dependent on the dose – that is, the amount of the chemical that enters the body. Each chemical produces harm at a different dose. Highly toxic chemicals in very small amounts can cause serious damage. Moderately and slightly toxic substances are toxic at relatively higher doses. Even substances considered nontoxic can be harmful if the exposure is great enough.

TIME. Chemical toxicity is also dependent on the length of time over which exposures occur. The effects of short and long periods of exposure differ.

SHORT-TERM OR ACUTE EFFECTS. Acute illnesses are caused by large doses of toxic substances delivered in a short period of time. The symptoms usually occur during or shortly after exposure and last a short time. Depending on the dose, the outcome can vary from complete recovery, to recovery with some level of disability, to death. Acute illnesses are the easiest to diagnose because their cause and effect are easily linked. For example, exposure to solvents while painting with oil-based enamels can cause effects ranging from light-headedness to more severe effects such as headache, nausea and loss of coordination. At even higher doses, unconsciousness and death can result.

LONG-TERM OR CHRONIC EFFECTS. These effects are caused by repeated low-dose exposures over many months or years. They are the most difficult to diagnose. Usually the symptoms are hardly noticeable until permanent damage has occurred. Symptoms appear gradually and may vary from person to person. In addition, the symptoms may mimic other illnesses. For instance, chronic exposure to solvents during a lifetime of painting may produce dermatitis in some individuals, chronic liver or kidney effects in others and nervous system damage in still others.

EFFECTS BETWEEN ACUTE AND CHRONIC. There are also other effects between acute and chronic such as "sub-acute" effects produced over weeks or months at doses below those that produce acute effects. Such effects also are difficult to diagnose.

CUMULATIVE AND NONCUMULATIVE TOXINS. Every chemical is eliminated from the body at a different rate. Cumulative toxins, such as lead, are substances that are eliminated slowly. Repeated exposure will cause them to accumulate in the body.

Noncumulative toxins, like alcohol and other solvents, leave the body very quickly. Medical tests can detect their presence only for a short time after exposure. Although they leave the body, the damage they cause may be permanent and accumulate over time.

THE TOTAL BODY BURDEN. This refers to the total amount of a chemical present in the body from all sources. For example, we all have body burdens of lead from air, water and food contamination. Working with lead-containing materials can add to this body burden.

MULTIPLE EXPOSURES. We carry body burdens of many chemicals and are often exposed to more than one chemical at a time. Sometimes these chemicals interact in the body.

Lack of OSHA Training Linked to Professor's Death

New York *Times,* August 9, 1997 ▪ *Chem. & Eng. News,* August 25, 1997, pp. 9-10 ▪ *Chemical & Engineering News,* May 12, p. 7, June 16, pp. 6 & 12 ▪ *Concord Monitor,* 6/10/97, pp. B-1 & 8 ▪ *Union Leader,* Manchester, NH, 6/10/97, obit.

Karen E. Wetterhahn, a brilliant and beloved professor of Chemistry at Dartmouth College, died at age 48 from mercury poisoning. One day last August she spilled between one and a few drops of dimethylmercury on her latex gloves. Unknown to her, it permeated the gloves and absorbed through her skin. She began experiencing increasing difficulty with balance, speech, vision and hearing. She was diagnosed with mercury poisoning in January. Doctors managed to reduce her mercury levels, but her neurological functions could not be restored. She died June 8, 1997.

OSHA proposed a $135,000 fine for Dartmouth's failure to train workers about protective equipment, e.g., glove permeability. Dartmouth's laboratory workers were routinely using disposable latex or vinyl medical examination gloves when handling organic chemicals and solvents. Many chemicals will penetrate these and even thicker rubber and plastic gloves. OSHA requires the employers of all workers who wear chemical resistant gloves to be formally trained about the limits of the protection they provide.

ADDITIVE EXPOSURES. Exposure to two chemicals is considered additive when one chemical contributes to or adds to the toxic effects of the other. This can occur when both chemicals affect the body in similar ways. Working with paint thinner and drinking alcohol is an example.

SYNERGISTIC EXPOSURES. These effects occur when two chemicals produce an effect greater than the total effects of each alone. Alcohol and barbiturates or smoking and asbestos are common examples.

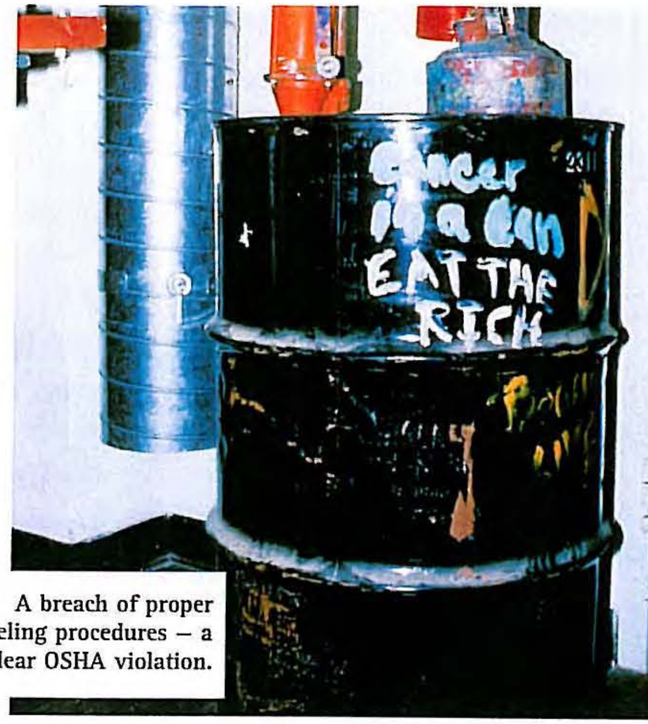
ANTAGONISTIC EXPOSURES. Some chemicals act to reduce or mitigate each other's effects. For example, severe overexposure to wood alcohol (methanol) is sometimes treated with intravenous administration of grain alcohol (ethanol), which delays and mitigates liver and optic nerve damage.

CANCER. Occupational cancers are a special type of chronic illness. Chemicals that cause cancer are called carcinogens. Examples include asbestos and benzidine dyes and pigments. Unlike ordinary toxic substances, the effects of carcinogens are not strictly dependent on dose. No level of exposure is considered safe. However, the lower the dose, the lower the risk of developing cancer. For this reason, exposure to carcinogens should be avoided altogether or kept as low as possible.

Occupational cancers typically occur ten to forty years after exposure. This period of time, during which there are no symptoms, is referred to as a latency period. Latency makes determination of the cause of occupational cancers difficult.

MUTAGENICITY. Mutations (and cancer) can be caused by chemicals that alter the genetic blueprint (DNA) of cells. Once altered, such cells usually die. Those few that survive will replicate themselves in a new form.

Any body cell (muscle, skin, *etc.*) can mutate. However, when the cell affected is the human egg or sperm cell,



A breach of proper labeling procedures – a clear OSHA violation.

mutagenicity can affect future generations. Most pregnancies resulting from mutated sperm and eggs will result in spontaneous termination of the pregnancy (*e.g.*, reabsorption, miscarriage, *etc.*). In other cases, inherited abnormalities may result in the offspring.

Only a handful of chemicals, pesticides, and drugs have been studied sufficiently to prove they are human mutagens. Such proof requires that thousands of exposed individuals be studied for many decades. Because this is not practical, chemicals are considered "suspect human mutagens" if they cause mutation in bacteria or animals. Some chemicals found to be suspect mutagens include a number of pigments, solvents and plastics chemicals. Both men and women should avoid exposure to suspect mutagens.

TERATOGENICITY. Chemicals that affect fetal organ development – that is, cause birth defects–are called teratogens. They are hazardous primarily during the first trimester. Two proven human teratogens are the drug Thalidomide and grain alcohol. Chemicals that are known to cause birth defects in animals are considered "suspect teratogens." Among these are many solvents, lead and other metals.

FETAL TOXICITY. Toxic chemicals can affect the development of the fetus at any stage.

SENSITIVITY OR ALLERGENICITY. Allergies are adverse reactions of the body's immune system. Common symptoms may include dermatitis, hay fever-like effects and asthma. Although a particular person can be allergic to almost anything, certain chemicals produce allergic responses in large numbers of people. Such chemicals are called "sensitizers." Some strong sensitizers include epoxy adhesives, chrome compounds found in trace amounts in many cements, and wood dusts

The longer people work with a sensitizing chemical, the greater the probability they will become allergic to it. Once developed, allergies tend to last a lifetime and symptoms may increase in severity with continued exposure. A few people even become highly sensitized — that is, develop life-threatening reactions to exceedingly small doses. This effect is caused by bee venom in some people, but industrial chemicals have also produced similar effects — including death.

How Chemicals Enter The Body: Routes Of Entry

In order to cause damage, toxic materials must enter the body. Entry can occur in the following ways:

SKIN CONTACT. The skin's barrier of waxes, oil and dead cells can be destroyed by chemicals such as acids, caustics, solvents and the like. Once the skin's defenses are breached, some of these chemicals can damage the skin and the tissues beneath the skin. Chemicals can then enter the bloodstream, where the circulatory system transports them throughout the body, causing damage to other organs.

Cuts, abrasions, burns, rashes and other violations of the skin's barrier can allow chemicals to penetrate into the blood. There are also many chemicals that can — without your knowing it — enter the blood through undamaged skin. Among these are benzene in gasoline and glycol ethers in many graffiti removers.

INHALATION. Inhaled substances are capable of damaging the respiratory system acutely or chronically at any location — from the nose and sinuses, to the lungs. Examples of substances that can cause chronic and acute respiratory damage include acid vapors and fumes from heating or burning plastics.

Some toxic substances are absorbed by the lungs and are transported via the blood to other organs. For example, lead in solder fumes may be carried via the blood to damage the brain and kidneys.

INGESTION. You can accidentally ingest toxic materials by eating, smoking or drinking while working, licking soiled fingers to turn pages, biting your nails and similar habits. The lungs' mucous also traps dusts and removes them by transporting them to your esophagus where they are swallowed.

Accidental ingestion can occur when people pour chemicals into paper cups or glasses and later mistake them for beverages. Some of these accidents have even killed children who were allowed near workplace chemicals.

Toxic chemicals and food should never be stored together.

Who Is at Risk?

Everyone is susceptible to occupational exposures. How they are affected will depend on the nature of the chemical, its route of entry, the degree of exposure and, in some cases, the susceptibility of the exposed person. For example, most people's lungs will be affected equally by exposure to similar concentrations of strong acid vapors. However, someone who already has bronchitis or emphysema may be even more seriously harmed.

HIGH-RISK INDIVIDUALS. Certain segments of the population – particularly the disabled, the chronically ill (especially those with pre-existing damage of organs such as the liver or lungs), pregnant women and the fetus, children and elderly – are at especially high risk from certain art activities. For example, the hearing-impaired may risk further damage to their already defective hearing if they engage in activities that employ noisy machinery. The retarded should not be exposed to chemicals that are known to adversely affect mental acuity and behavior, such as lead and chemical solvents.

People taking certain medications are sometimes at higher risk. For example, medications (and recreational drugs) that are narcotic may potentiate the effects of solvents and metals that also are narcotic, *i.e.*, affect the brain.

Occupational Illnesses

Any organ in the body can be affected by an occupational illness. Occupational illnesses include the following:

SKIN DISEASES. Two types of dermatitis are among the most common occupational skin diseases.

1. Primary Irritant Contact Dermatitis. This is a nonallergic skin reaction from exposure to irritating substances. Exposure to irritants accounts for 80% of the cases of occupational contact dermatitis. There are two major types of irritants:
   - mild irritants require repeated and/or prolonged exposure to cause damage. Included in this category are soaps, detergents and many solvents. This damage is usually reversible if exposure is discontinued.
   - strong irritants or corrosives require only short exposures to cause damage. Substances included in this category are strong acids, alkalis and peroxides. Prolonged exposure to corrosive chemicals can produce irreversible damage to the skin.

2. Allergic Contact Dermatitis or Hypersensitivity Dermatitis. This is a delayed allergic skin reaction that occurs when sensitized individuals are exposed to allergens. Common allergens include epoxy adhesives, chrome and nickel compounds and many woods.

Other occupational skin diseases include infections and skin cancer. Working with cuts, abrasions or other kinds of skin damage may lead to infections. Some paint pigments and ultraviolet radiation are associated with skin cancer.

EYE DISEASES. Irritating, caustic and acid chemicals can damage the eye severely. Infrared (from glowing hot kilns) or ultraviolet light (*e.g.*, from welding) can cause eye damage. A few chemicals, such as methanol and hexane, also can damage the eyesight when they enter the body by routes such as inhalation.

RESPIRATORY SYSTEM DISEASES. Any irritating airborne chemical can be potentially hazardous to the respiratory system. Damage can range from minor irritation to life-threatening chemical pneumonia, depending on how irritating the substance and how much is inhaled. Exposures to smaller amounts of irritants over years can cause chronic respiratory damage such as chronic bronchitis or emphysema. Often the first symptom of respiratory irritation is an increased susceptibility to colds and respiratory infections.

Another factor affecting respiratory damage is the irritant's solubility in liquid and mucous. Highly soluble irritants, such as hydrochloric acid gas, produce immediate symptoms in the upper respiratory tract. These warning symptoms usually cause people to take action to avoid further exposure. Poorly soluble irritants such as ozone or nitric acid cause delayed damage to the lower respiratory tract. In cases of heavy exposure, pulmonary edema may occur as much as twelve hours after exposure.

Hydrofluoric Acid Kills Sanitation Worker

New York *Times*, November 17, 1996

On November 12, 1996, a Brooklyn sanitation worker died and his partner was injured when they were splashed by hydrofluoric acid after a discarded container burst under the compacting blades of their sanitation truck. Two days later sanitation workers in the Bronx found more illegally discarded bottles of hydrofluoric acid. A building cleaning was in progress on the Bronx street.

If the police investigations can show a link between the building cleaners and the hydrofluoric acid incidences, it is likely that both criminal charges and hazardous waste violations will be filed against the company.

Some types of soluble chemicals, including lead and solvents, are absorbed by the lungs, passed into the bloodstream and transported to other organs in the body. Insoluble particles, on the other hand, may remain in the lungs for life if they are deposited deeply in the air sacs (alveoli). Some of these insoluble particles such as asbestos and silica can cause lung-scarring diseases (fibroses) such as asbestosis and silicosis, and/or lung cancer.

Allergic diseases such as asthma, alveolitis and hypersensitivity pneumonia may result from exposure to sensitizing chemicals.

Smokers are at greater risk from lung cancer and almost all other diseases of lungs. Smoking inhibits the lungs' natural clearing mechanisms. As a result, toxic particles remain in the lungs longer, which allows them to do more damage.

HEART AND BLOOD DISEASES. Many solvents at high doses can alter the heart's rhythm (arrhythmia) and even cause a heart attack. Deaths related to this phenomenon have been noted among both industrial workers and glue-sniffers whose level of exposure to solvents were very high. Benzene, still found in gasoline, can cause aplastic anemia (*e.g.*, decreased bone marrow production of all blood cells) and leukemia.

NERVOUS SYSTEM DISEASES. Metals like lead and mercury are known to cause nervous system damage. The early symptoms of exposure often are psychological disturbances and depression.

Almost all solvents can affect the nervous system. Symptoms can vary from mild narcosis (light-headedness, headache, dizziness) to coma and death at high doses. Over a period of years, people exposed to small amounts of solvent daily often exhibit the symptoms of chronic nervous system damage such as short-term memory loss, mental confusion, sleep disturbances, hand-eye coordination difficulties and depression.

Some chemicals such as n-hexane (found in rubber cements, some aerosol sprays, *etc.*) are particularly damaging to the nervous system and chronic exposure can result in a disease similar to multiple sclerosis.

LIVER DISEASES. Hepatitis can be caused by chemicals as well as by disease organisms. Some toxic metals and nearly all solvents, including grain alcohol, can damage the liver if the dose is high enough. Liver cancer is caused by chemicals such as carbon tetrachloride.

KIDNEY DISEASES. Kidney damage is also caused by many metals and solvents. Lead and chlorinated hydrocarbon solvents such as trichloroethylene are particularly damaging. Heat stress and accidents are also causes of kidney damage. Damaged blood and muscle cell debris block kidney tubules.

BLADDER DISEASES. Benzidine-derived pigments and dyes are documented causes of bladder cancer.

REPRODUCTIVE EFFECTS. Chemicals can affect any stage of reproduction: sexual performance, the menstrual cycle, sperm generation, all stages in organ formation and fetal growth, the health of the woman during pregnancy and the newborn infant through chemicals secreted in breast milk. More is being learned each day regarding such effects. Prudence dictates that both men and women planning families exercise care when working with restoration and renovation materials containing toxic chemicals. (See also the section above on mutagenicity and teratogenicity.)

PART II
UNDERSTANDING THE HAZARDS OF RESTORATION PRODUCTS

The U.S. Hazard Communication Standard (29 CFR 1910.1200) and the Canadian Workplace Hazardous Materials Information System (WHMIS) require that all workers using toxic chemicals be trained by their employers to understand the hazards of their materials and how to use them safely. A crucial part of the training is teaching workers to interpret Material Safety Data Sheets (MSDSs).

Employers in the construction and restoration fields often find reading MSDSs difficult or confusing. They wonder how they can be expected to train their workers to read these documents. However, the regulation is clear. Workers must understand the hazards of their materials and be able to carry out precautions effectively and consistently or the employer cannot responsibly allow them to work with toxic materials.

Fortunately, experience in the U.S. and Canada has shown that employers and workers alike can be trained to comprehend MSDSs. Some of the health terminology used on MSDSs are found in Part I of this Field Guide. Technical concepts on toxicology and chemical properties will be covered in Part II.

Parts I and II taken together can be used as required training materials. Providing workers with a copy of this Field Guide does not satisfy training requirements. A qualified person is also needed to present the material and answer questions. With some preparation, workers with science backgrounds can often be taught to provide this training in-house. Otherwise, a professional trainer or industrial hygienist can be brought in to conduct sessions. Trainers also may want to use audiovisual training materials. Safety catalogs usually offer such training aids.

Employers must also provide trainees with information on their rights and obligations under the specific law applicable to them, with MSDSs and other technical material related to actual products they use, and with information about on-site conditions at specific worksites.

Documentation that training has been done and was effective is useful and is required by some state regulations.

TECHNICAL CONCEPTS RELATED TO AIR QUALITY

Health-damaging chemicals can enter our body by inhalation, skin contact and ingestion. Exposure by skin contact can usually be prevented by wearing gloves and using tools to handle materials. Ingestion can be prevented by good work habits and by not eating, smoking or drinking in the workplace. Precautions against inhalation are more complex.

Airborne Chemicals

To prevent inhalation of chemicals, it is first necessary to understand the nature of airborne contaminants such as gases, vapors, mists, fumes and dust.

GASES. Scientists define gas as "a formless fluid" that can "expand to fill the space that contains it." We can picture this formless fluid as many molecules moving rapidly and randomly in space.

Air, for example, is a mixture of different gases that is, different kinds of molecules. Even though each different gas has a different molecular weight, the heavier gases will never settle out because the rapid molecular movement will cause them to remain mixed. In other words, once gases are mixed, they tend to stay mixed.

In almost all cases, gases created during the use of restoration products are mixed with air as they are released. This means they also will not settle, but instead will "expand into the space that contains them." Thus, in time, the gas will diffuse evenly throughout the room.

When the gas escapes from the room or is exhausted from the room by ventilation, expansion of the gas continues theoretically forever. It is this expansion, for example, that causes Freon refrigerants to reach the stratospheric ozone layer.

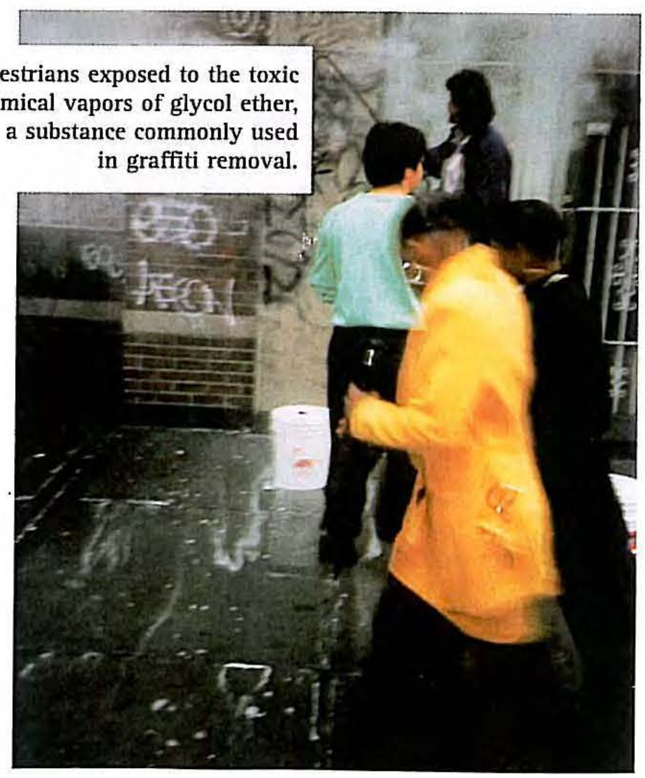
Under certain conditions, gases will not freely mix with air. For example, carbon dioxide gas from dry ice will form a foggy layer at ground level because the cold gas is denser and heavier than air (the molecules are closer together). In another instance, gases that are heavier than air may layer out or take a long time to mix with air in locations where there is little air movement – such as in storage areas.

Gases may be toxic in various ways. They can be irritating, acidic, caustic, poisonous and so on. Some gases also have dangerous physical properties such as flammability or reactivity. Toxic gases that may be encountered in restoration work include: hydrochloric acid gas and hydrofluoric acid gas from acid cleaning; and ozone and nitrogen oxides from welding.

Some gases are not toxic. An inert gas such as argon used in inert gas welding is an example. Such gases are dangerous only when present in such large quantities that they reduce the amount of oxygen in the air to levels insufficient to support life. These gases are called simple asphyxiants.

VAPORS. Vapors are the gaseous forms of liquids. For example, water vapor is created when water evaporates – that is, releases water vapor molecules into the air. Once released into the air, vapors behave like gases and expand into space. However, at high concentrations they will recondense into liquids. This is what happens when it rains.

There is a common misconception that substances do not vaporize until they reach their "vaporization point" –



Pedestrians exposed to the toxic chemical vapors of glycol ether, a substance commonly used in graffiti removal.

that is, their boiling point. Although greater amounts of vapor are produced at higher temperatures, most materials begin to vaporize as soon as they are liquid. Even some solids convert to a vapor form at room temperature. Solids that do this are said to "sublime." Mothballs are an example of a chemical solid that sublimes.

Vapors, like gases, may vary greatly in toxicity, flammability and reactivity. Common toxic vapors include those from solvents such as turpentine, mineral spirits and lacquer thinners.

MISTS. Mists are tiny liquid droplets in the air. Any liquid, water, oil or solvent can be misted or aerosolized. The finer the size of the droplet, the more deeply the mist can be inhaled. A mist of a substance is more toxic than the vapor of the same substance at the same concentration. This results from the fact that when inhaled, the droplets deliver the mist in little concentrated spots to the respiratory system's tissues. Vapors, on the other hand, are more evenly distributed in the respiratory tract.

Some mists, such as paint spray mists or wet abrasive blasting mists, also may contain hazardous solid material. These mists can float on air currents for a time. Then the liquid portion of the droplet will vaporize — convert to a vapor — and the solid part will settle as a dust.

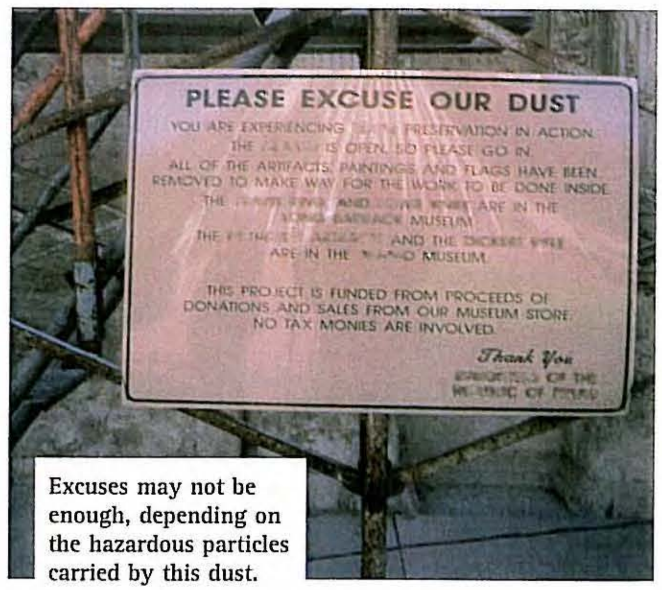
FUMES. Laymen commonly use this term to mean any kind of emission from chemical processes. In this Field Guide, however, only the scientific definition will be used.

Technically, fumes are very tiny particles usually created in high heat operations such as welding, soldering or foundry work. They are formed when hot vapors cool rapidly and condense into fine particles. For example, lead fumes are created during soldering. When solder melts, some lead vaporizes. The vapor immediately reacts with oxygen in the air and condenses into tiny lead-oxide fume particles.

Fume particles are measured in microns. A micron is a metric system unit of measurement equaling one millionth of a meter. There are about 25,640 microns in an inch. Respirable fume and dust particles are in the range of 0.01 to 10 microns in diameter. Fume particles are so small (0.01 to 0.5 microns in diameter) that they tend to remain airborne for long periods of time. Eventually, however, they will settle to contaminate dust in the workplace, *e.g.*, in the ventilation ducts, in your hair or clothing or wherever air currents carry them. Although fume particles are too small to be seen by the naked eye, they sometimes can be perceived as a bluish haze rising like cigarette smoke from soldering or welding operations.

Fuming tends to increase the toxicity of a substance because the small particle size enables it to be inhaled deeply into the lungs. Because it presents more surface area to lung fluids, it is more soluble.

In addition to many metals, some organic chemicals, plastics and silica (at very high temperatures) will fume. Smoke from burning organic materials may also contain fumes.

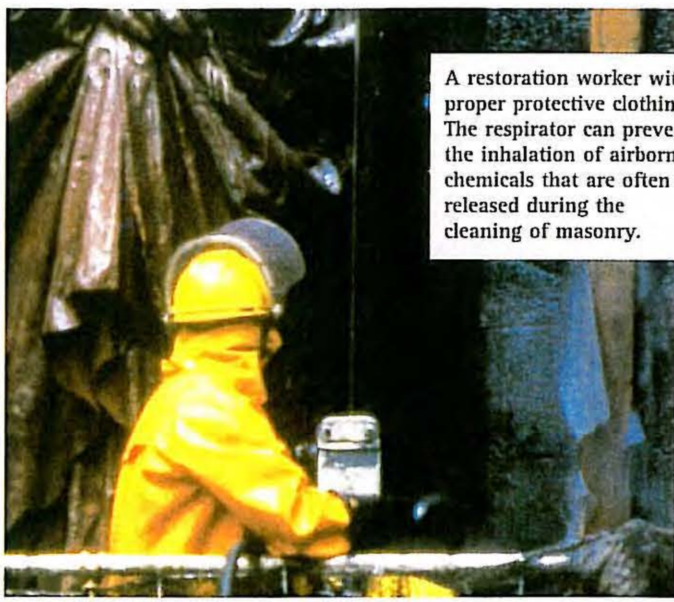


Excuses may not be enough, depending on the hazardous particles carried by this dust.

DUSTS. Dusts are formed when solid materials are broken down into small particles by natural or mechanical forces. Natural wind and weathering produce dusts from rocks. Sanding and sawing are examples of mechanical forces that produce dusts.

The finer the dust, the deeper it can be inhaled into the lung and the more toxic it will be. Respirable dusts – those that can be inhaled deeply into the lung's alveoli – are too small to be seen with the naked eye (0.5 to 10 microns in diameter).

SMOKE. Smoke is formed from burning organic matter. Burning wood and hot wire-cutting plastics are two smoke-producing activities. Smoke is usually a mixture of many gases, vapors and fumes. For example, cigarette smoke contains over four thousand chemicals, including carbon monoxide gas, benzene vapor and fume-sized particles of tar.



A restoration worker with proper protective clothing. The respirator can prevent the inhalation of airborne chemicals that are often released during the cleaning of masonry.

Exposure Standards

Exposure to airborne chemicals in the workplace is regulated in the United States and Canada. The United States limits are called OSHA Permissible Exposure Limits (PELs). The Canadian limits are called Occupational Exposure Limits (OELs).

Although the levels at which various chemicals are regulated may differ occasionally, both countries' regulations are based on standards called Threshold Limit Values (TLVs). Threshold Limit Values are airborne substance standards set by the American Conference of Governmental Industrial Hygienists (ACGIH). The Permissible Exposure Limit and Occupational Exposure Limit for most substances are identical to the Threshold Limit Values for general industry.

In the U.S. the General Industry Standards (29 CFR 1900-1910) and the Construction Industry Standards (29 CFR 1926) have very different PELs. Those for the construction industry are far less protective and OSHA is in the process of revising these air-quality standards to make them more consistent with general industry. In addition, there is currently a court-imposed stay on hundreds of PELs. For this reason, this Field Guide will concentrate on the Threshold Limit Values on which all the other limits are based.

Copies of the Threshold Limit Values can be obtained from the ACGIH (see the Bibliography). The following three types of Threshold Limit Values are designed to protect most healthy adult workers from adverse effects:

1. Threshold Limit Value – Time Weighted Average (TLV-TWA). Threshold Limit Value – Time Weighted Averages are airborne concentrations of substances averaged over eight hours. They are meant to protect from adverse effects those workers who are exposed to substances at this concentration over the normal eight-hour day and forty-hour workweek.

2. Threshold Limit Value – Short-Term Exposure Limit (TLV-STEL). Threshold Limit Value – Short-Term Exposure Limits are fifteen-minute-average concentrations that should not be exceeded at any time during a workday.

3. Threshold Limit Value – Ceiling (TLV-C). Threshold Limit Value – Ceilings are concentrations that should not be exceeded during any part of the workday exposure.

Threshold Limit Values should not be considered absolute guarantees of protiection. Threshold Limit Values previously thought adequate have repeatedly been revised as medical tests have become more sophisticated, and as long-term exposure studies reveal chronic diseases previously undetected.

At best, Threshold Limit Values are meant to protect most, but not all, healthy adult workers. They do not apply to children, people with chronic illnesses and other high-risk individuals.

Threshold Limit Value – Time Weighted Averages also do not apply to people who work longer than eight hours a day. This is especially true of people who live and work in the same environment, such as whose workshops are at home. In these cases, very high exposures have been noted, since the home worker is likely to be exposed to contaminants twenty-four hours a day. With no respite during which the body can detoxify, even low concentrations of contaminants become significant.

Expensive and complicated air-sampling and analysis are usually required to prove that Threshold Limit Values are exceeded. Air-sampling usually consists of placing small air-filtering devices in the workplace, *i.e.*, area sampling, or on the lapel of exposed workers, *i.e.*, personal sampling. After appropriate sampling time has passed, the filter material can be sent to a lab for analysis. There are also faster methods that involve filters that change color on exposure, or electronic direct reading equipment. Use of these devices usually requires the services of an industrial hygienist.

It is not always possible to do air-sampling for every situation. For this reason, Threshold Limit Values are primarily useful to restoration workers as proof that a substance is considered toxic, and that measures should be taken to limit exposure to substances with Threshold Limit Values.

When additional factors, such as evaporation rate, are considered, restoration workers also can use Threshold Limit Values to assess the relative toxicity of various

Threshold Limit Value Time Weighted Averages (TLV-TWA)** of Common Substances

GAS OR VAPOR	ppm***	mg/m^3***
argon and other inert gases (limited only in amounts that will not reduce oxygen in the air to below 18%)		
ethanol (grain alcohol)	1000	1880
acetone	750	1780
VM & P (paint thinner)	300	1370
turpentine	100	556
xylene	100	434
toluene	50	147
n-hexane (some rubber cement thinners)	50	176
ammonia	25	17
napthalene (mothballs)	10	52
nitric acid	2	5.2
fluorine	1	1.6
chlorine (swimming pools, bleach, *etc.*)	.5	1.5
acrolein (created when wax is burned/overheated)	.1	.23
TDI (from urethane casting/foaming)	.005	.036

FUME OR DUST	mg/m^3***
calcium carbonate (marble dust, limestone, whiting, *etc.*)	10
calcium sulfate (plaster of paris)	10
Portland cement	10
aluminum:	
aluminum oxide (abrasives)	10
metal dust	10
fume (*e.g.*, welding, casting, *etc.*)	5
mica	3
talc (industrial talcum powders containing no asbestos fibers)	2
copper:	
metal and compounds, dusts and mists	1
fume (*e.g.*, welding or brazing)	.2
silica:	
amorphous (unfired diatomaceous earth, silica gel)	10
crystalline (quartz, sand, flint, *etc.*)	.01
calcined/fired (cristobalite, tridymite)	.05
lead	.05
berylium (alloyed with copper in non-sparking tools)	.002

** Threshold Limit Value – Time Weighted Averages from the American Conference of Governmental Industrial Hygienists, 1996

*** ppm = parts per million mg/m^3 = miligrams per cubic meter chemicals. In general, the smaller the Threshold Limit Value, the more toxic the substance. Gases and vapors with Threshold Limit Value – Time Weighted Averages 100 parts per million (ppm) or lower can be considered highly toxic. Dusts whose Threshold Limit Value – Time Weighted Averages are set at ten milligrams per cubic meter (mg/m3) are considered only nuisance dusts. Particulates with Threshold Limit Value – Time Weighted Averages smaller than 10 mg/m3 are more toxic. The table on page 17 lists the Threshold Limit Value – Time Weighted Averages of some common air contaminants in order of increasing toxicity.

Workers should also be aware that many substances that are known to be toxic have no Threshold Limit Values. In some cases the reason for this is that there is insufficient data to quantify the risk from exposure. Restoration workers should be wary of phrases on labels or MSDSs such as "there are no industrial limits for this substance." This and similar statements should never be interpreted to mean the substance is not toxic.

The Material Safety Data Sheet

The concepts above are needed to understand Material Safety Data Sheets (MSDSs). The following section provides an explanation for each heading and topic on the average MSDS. The information is presented in the order that these contents appear on the typical MSDS. The order may vary on specific MSDSs, but each subject listed here should be covered for the MSDS to be legally complete. Workers should remember that blank spaces are not permitted. If items are not applicable, or no information is available, the company writing the MSDS must mark the space to indicate this.

There is slightly different information required in the U.S. and Canada on MSDSs. However, manufacturers must supply MSDSs that meet the requirements of the user's country.

Molds Are Nothing to Sneeze At

New York *Observer*, Warren St. John, reporter, February 21, 1994, pp. 1, 17 (May 1994 ACTS FACTS)
BNA-OSHR, 25(48), May 8, 1996, (June 1996 ACTS FACTS)
MMWR, 46(2), January 17, 1997, pp. 33-35 (March 1996 ACTS FACTS)

One type of mold, *Stachybotrys chartarum* or *atra*, or "Stachy," can cause dermatitis, burning sensations in the mouth and nasal passages, coughs and congestions and neurological damage. It has been known to kill horses, cattle and humans. It was thought to be a component of the Soviet Union's biological warfare arsenal. In the U.S. Stachy exists primarily in buildings in association with standing water, heavily wetted wall board or similarly damp conditions.

A nearly $400 million class-action lawsuit was filed by eleven current and former employees against the New Museum of Contemporary Art in New York City's SoHo district. The toxic black Stachy was growing for three years in the sub-basement of the museum's exhibition space. Dr. Eckardt Johanning of Mt. Sinai Hospital's Occupational Health Clinic examined some of the plaintiffs. Dr. Johanning noted that this was not a case of "sick building" syndrome; instead, these people's symptoms were more like people who had been poisoned.

In addition to many documented cases of illness in adults, an investigation by the Centers for Disease Control documented an association between the presence of Stachy molds in homes and cases of sudden infant death syndrome (SIDS).

Stachy was found again recently by the Department of Transportation (DOT) in a gymnasium in its Washington, DC office building. According to the DOT, renovation workers will wear respiratory protection, the area will be sealed to prevent contamination of the rest of the building and air will be released into the atmosphere only through a high-efficiency filter. Molds should be identified before planning renovations.

Section I

IDENTITY OF THE PRODUCT. The identifying chemical name or product name should be the same as that on the label. Some state Right-to-Know laws also specify common names and Chemical Abstract Service numbers (see CAS below) must be listed. Be familiar with the requirements of the law that applies to you.

EMERGENCY TELEPHONE NUMBER. This must be included, but it does not need to be toll-free.

TELEPHONE NUMBER FOR INFORMATION. This may be the same as above for small companies.

NAME OF THE MANUFACTURER OR IMPORTER. Be sure this name is exactly the same as the name of the manufacturer listed on the product label. Small manufacturers sometimes send out MSDSs from the manufacturer of the raw materials they mixed to make the product or that they repackaged. This is improper.

ADDRESS OF THE MANUFACTURER. Be sure this address is complete: street or box, town, state, zip.

DATE PREPARED. MSDSs prepared more than three years ago are acceptable in the U.S., but an attempt should be made to get an updated version. Three-year-old MSDSs are automatically invalid in Canada.

SIGNATURE OF THE PREPARER (OPTIONAL).

Section II Hazardous Ingredients And Identity Information

SPECIFIC CHEMICAL NAME/IDENTITY. Should be as listed above.

COMMON NAME(S) and synonyms.

CAS # (CHEMICAL ABSTRACTS SERVICE REGISTRY NUMBER, OPTIONAL). A good MSDS will provide this optional number. It is required by some state Right-to-Know laws.

CHEMICALS IN PRODUCTS WHICH ARE MIXTURES. In the past it was common for MSDSs to list only ingredients that had TLVs or PELs. Now any chemical for which there is even one study that shows it may be capable of causing harm should be listed. Toxic chemicals that comprise more than 1% of the product by weight must be listed. Cancer-causing chemicals that comprise 0.1% of the product must be listed.

If it is known that amounts even smaller than the required 1.0 or 0.1% are hazardous in some way, the manufacturer also must list them. In practice, however, such hazardous ingredients often go unlisted. For example, many pigments are contaminated with chemicals such as dioxins, furans, PCBs, or other substances that are toxic in even trace amounts. An example was seen recently when paint containing a mercury preservative off-gassed from walls and poisoned a young child and his family. The EPA found out it was common practice not to list these chemicals on MSDSs because they are present in amounts under 1%.

TRADE SECRETS EXEMPTION. If the above information on hazardous ingredients is not present, the MSDS may indicate some or all of the ingredients are trade secrets or proprietary. If so, the MSDS should state by whose authority (usually the state health department) the product's identity can be withheld. Trade secret products should not be used on historic or landmarked sites.

OSHA PEL or OHSA OEL (depending on the purchaser's country). Here, the eight-hour Time Weighted Average (PEL/OEL-TWA) should be listed. The TWA is the amount of the substance in the air to which most healthy adult workers may be exposed each workday without adverse effect. In general, the smaller the PEL/OEL, the more toxic the substance. These limits can be enforced by law. (See full discussion in "EXPOSURE STANDARDS.")

ACGIH TLV. Here, the eight-hour Time Weighted Average (TLV-TWA) should be listed. TLV-TWAs are standards for workplace air quality developed by the American Conference of Governmental Industrial Hygienists (ACGIH). In general, the smaller the TLV, the more toxic the substance. (See full discussion in "EXPOSURE STANDARDS.")

OTHER LIMITS (OPTIONAL). NIOSH RELs (National Institute for Occupational Safety and Health Recommended Exposure Limits), MRLs (Manufacturer's Recommended Limits), MAKs (Federal Republic of

Germany Maximum Concentration Values in the Workplace), and others may be listed here voluntarily.

ODOR THRESHOLD (OPTIONAL). The odor threshold (OT) is the concentration in air at which most people can smell the chemical. If the OT is smaller than the TLV, then the chemical provides warning before health effects are expected. If the OT is larger than the TLV, one is already at risk by the time the odor can be detected. OTs are required on Canadian MSDSs.

PERCENT (OPTIONAL). If the percentages are listed, check to see if they add up to 100%. Check to see if toxic substances are a small or large proportion of the product.

Section III
Physical and Chemical Characteristics

This section provides a physical profile of the chemical through its various characteristics. Some physical data may be omitted on the MSDSs when it is not applicable. For example, some chemicals have no boiling point because they do not boil. However, this same chemical may dissociate (*e.g.*, break down) with heat. This fact and the chemicals into which it dissociates should appear on a good MSDS. If data does not exist, the line on the MSDS where it ordinarily would appear must be filled in to indicate this. Blank spaces are not proper on MSDSs.

BOILING POINT (BP). The BP is the temperature at which the substance changes rapidly, usually with bubbling, from a liquid to a vapor. Sometimes called the "vaporization point," liquids with low BPs usually expose workers to large amounts of the vapor. If the vapor is also flammable, liquids with low BPs are also fire hazards. A common error is the assumption that no vapor is formed (*e.g.*, from metals) until the BP is reached. However, vapor is formed at far lower temperatures, just as water evaporates at room temperature, which is below its boiling point.

VAPOR PRESSURE (mm Hg). VP is the pressure exerted by a saturated vapor above its own liquid in a closed container. VPs combined with evaporation rates are useful in determining how quickly a material becomes airborne, and thus how quickly a worker is exposed to it. They are usually reported in millimeters of mercury (mm Hg) at 68° F (20° C) unless otherwise stated. Substances with VPs above 20 mm Hg may present a hazard due to their extreme volatility.

VAPOR DENSITY (AIR = 1). VD is the weight of a vapor or gas compared to an equal volume of air. Materials with a VD less than 1.0 are lighter than air. Materials with a VD greater than 1.0 are heavier than air. While all vapors and gases will mix with air and disperse, large quantities of unmixed vapor or gas in locations without much air movement such as storage rooms will tend to rise or sink depending on their VD. Flammable vapors that are heavier than air can spread to sources of ignition and flash back to the source.

SOLUBILITY IN WATER. This term represents the amount by weight of a substance that will dissolve in water at ambient temperature. Solubility is an important factor in determining suitable cleanup and extinguishing methods. Solubility is usually reported in grams per liter (g/l) or general categories such as:

negligible or insoluble =	< 0.1 percent
slight =	0.1 - 1.0 percent
moderate =	1 - 10 percent
appreciable =	> 10 percent
complete =	soluble in all proportions

APPEARANCE AND ODOR. Comparing this description to the actual product is a good way to be sure the right MSDSs have been obtained.

SPECIFIC GRAVITY. This describes the heaviness of a material as compared to a reference substance. When the reference substance is water ($H_2O = 1$), it will tell you whether it will float or sink. Specific gravity for solids and liquids compared to water numerically equals density (see above). Specific gravity for gases does not equal density because the density of air is not 1.0 but 1.29.

MELTING POINT. This is only applicable to solid materials. The MP is the temperature at which a solid changes to a liquid.

EVAPORATION RATE. This is the rate at which a material will vaporize (*e.g.*, volatilize, evaporate) from the liquid or solid state when compared to another material. The two common liquids used for comparison are butyl acetate and ethyl ether.

WHEN BUTYL ACETATE = 1.0	WHEN ETHYL ETHER = 1.0
> 3.0 = FAST	< 3.0 = FAST
0.8 - 3.0 = MEDIUM	3.0 - 9.0 = MEDIUM
< 0.8 = SLOW	> 9.0 = SLOW

A mobile safety station that can easily be moved onto and around the worksite.

Section IV
Fire and Explosion Hazard Data

FLASH POINT. This refers to to the lowest temperature at which a flammable liquid gives off sufficient vapor to form an ignitable mixture with air near its surface or within a vessel. Combustion does not continue. The METHOD USED should also be designated here. There are various tests for determining flash point and these should also be designated here for accuracy. The four test methods recognized by the National Fire Protection Association are: Tag Open-Cup test, Tag Closed-Cup test, Cleveland Open-Cup, and Pensky-Martens Closed-Cup.

FLAMMABLE LIMITS. This section is only applicable to flammable liquids and gases. These are the minimum and maximum concentrations in air between which ignition can occur. Concentrations below the lower flammable limit (LFL) are too lean to burn, while concentrations above the upper flammable limit (UFL) are too rich. All concentrations in between can burn or explode. (Sometimes called lower and upper explosion limits — LEL and UEL)

EXTINGUISHING MEDIA. The type of extinguisher or suppression system needed to put out a fire involving the substance. The types of fire extinguishers are often referred to by letters indicating which type of fire they will extinguish:

A — wood, paper, ordinary combustibles
B — solvents and grease
C — electrical equipment
D — combustible metals (not a likely material to be found on restoration or construction sites)

SPECIAL FIRE-FIGHTING PROCEDURES. This section notes any special methods needed to fight fires involving the substance listed. Peroxides, for example, that supply oxygen when burned and cannot be extinguished by ordinary methods that smother or cut off air.

UNUSUAL FIRE AND EXPLOSION HAZARD. This refers to unusual hazards such as those of some organic peroxides that ignite spontaneously under certain conditions or that become explosive when old.

Long-Lasting Legacy of Lead

Hazardous Substances & Public Health, ATSDR, 7(3) Fall 1997
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New York Times, Susan Gilbert, June 18, 1996, p. C7

Both men and women who have young children need to consider the lead dust they bring home from restoration sites on their clothing and shoes. Many studies heve shown that "take home lead" is a hazard. Recently, a study of New Jersey construction workers doing renovation jobs found they had children who are six times more likely to have high lead blood levels than the children of their neighbors.

We also know that children pay for the rest of their lives for lead exposure. A study recently showed that adults who were lead-exposed at between 6 months and 9 years of age still were found to have lead-related health problems 20 years later. These included difficulty reading, concentration, and remembering; higher prevalence of difficulty conceiving children; a higher number of medical conditions including anemia, anxiety, history of high blood pressure, urinary tract conditions, ulcers, arthritis, poor circulation, and history of dialysis among family members.

And the problem can affect the next generation. Lead to which females were exposed to as children is released from their bones and transferred to the fetuses when they, in turn, become pregnant.

Contractors must follow all the OSHA Lead in Construction regulations on projects that involve old lead paint. OSHA's rules requiring showering and changing before leaving work are vital in prevention of "take home lead."

Section V Reactivity Data

This section must be completely understood before doing any kind of experimenting with the material. Restorers also should be aware that the manufacturer usually has no liability for damages caused when their products are not used as directed.

STABILITY: STABLE OR UNSTABLE. Stability is the ability of the material to remain unchanged under reasonable conditions of storage and use.

CONDITIONS TO AVOID. These are the conditions that will render a material more unstable. For example, storage at above-normal temperatures may cause the material to change rapidly.

INCOMPATIBILITY. The MSDS should list substances that will react dangerously with the product. Workers should also use this to determine which substances also should not be stored in proximity to the product.

HAZARDOUS DECOMPOSITION PRODUCTS. This section should list any hazardous chemicals given off when the product burns or when it degrades or decomposes without burning. However, manufacturers often only report the results of high-temperature incineration with all the oxygen necessary for complete combustion. Under these conditions, most organic chemicals will give off carbon dioxide, water, and a few other low-molecular-weight chemicals. Actual burning in open air, heating with torches, or hot wire cutting, are ways in which the product may be decomposed. These methods of decomposition will produce very different results. Workers should be aware that the information provided in this section may not be relevant to the way in which the product actually may burn during these uses.

HAZARDOUS POLYMERIZATION. Polymerization is the process by which the molecules of a chemical can combine to form larger molecules. Polymerization is hazardous if during the reaction excessive heat, gases or some other by-product is given off in amounts sufficient to cause fires, burst containers, or cause some other kind of harm.

CONDITIONS TO AVOID. Listed here are conditions such as high temperatures that must be avoided to prevent hazardous polymerization from occurring.

Section VI Health Hazard Data

ROUTES OF ENTRY are the ways in which chemicals can enter the body.

INHALATION is the most common route. Vapors or dusts can be inhaled and absorbed by the body.

SKIN. If this route is checked, the material can be absorbed by the skin in significant amounts. Often it is also checked if it only damages the skin itself. Good MSDSs clarify whether skin damage and/or absorption can occur.

INGESTION. If this route is checked, the material can enter the body by being eaten, drunk or swallowed, or inhaled particles can be expelled from the lungs and swallowed.

HEALTH HAZARDS, ACUTE AND CHRONIC. This section usually varies greatly in quality. Some manufacturers supply detailed data on both chronic and acute health effects. Others provide very little. Workers should not consider this section sufficient and should supplement it from additional references.

ACUTE. Information about short-term exposure hazards belongs here. Many MSDSs report OSHA/OHSA and ACGIH short-term exposure limits (STELs) and Ceiling Limits (CLs) here. The STELs usually are 15-minute exposures, while the Ceiling Limits are not to be exceeded at any time. (See full discussion in "EXPOSURE STANDARDS.")

Other data commonly found here are LD_{50}s and LC_{50}s. The LC_{50} is the concentration in the air that will kill 50% of the test animals when administered in a single exposure in a specific time period, usually one hour. LD_{50} is the single dose that will kill 50% of the test animals by any route other than inhalation, such as ingestion or skin contact. These tests establish the degree to which a chemical is acutely hazardous and determine if it will be designated "nontoxic," "toxic," or "highly toxic."

LABEL DEFINITIONS
OF TOXICITY IN THE U.S. AND CANADA

Label Term	LD_{50}	LC_{50}
Nontoxic	> 5.0 g/kg*	>20,000 ppm**
Toxic	0.05-5.0 g/kg*	200-20,000 ppm**
Highly Toxic	< 0.05 g/kg*	< 200 ppm**

* grams per kilogram of body weight.
** parts per million: parts of substance in 1 million parts of air.

As defined by the Federal Hazardous Substances Act (FHSA) in the U.S., and the Federal Hazardous Products Act in Canada, "nontoxic" means anything that passes the LD_{50} and LC_{50} animal tests. Workers need to understand that long-term damage such as cancer and birth defects are not detected by these tests. Since these tests reflect only acute hazards, powdered asbestos can legitimately be called "non-toxic" under these rules. In fact, asbestos gets a perfect score on these tests because it will not harm any animals within the two-week duration of the tests.

For this reason, the FHSA recently has been amended to provide chronic hazard labeling for consumer product art materials. These labels must identify any known chronic hazards associated with the product's ingredients. Unfortunately, ingredients that have never been studied, and for which there is no data, can still be labeled "nontoxic."

CHRONIC. This section should report any known chronic hazards such as cancer, reproductive or developmental damage, neurological or other organ damage to animals or humans related to repeated or long term exposure. Unfortunately, a great number of the chemicals used in restoration and renovation have never been studied for long-term hazards. Failure to see data in this section should not be interpreted as a lack of chronic hazards.

CARCINOGENICITY. There are three agencies whose decisions regarding carcinogenicity must be reported on U.S. MSDSs. These are: NTP (the National Toxicology Program); IARC (the International Agency for Research on Cancer); and OSHA. The cancer ratings assigned by each agency are as follows:

AGENCY CATEGORY AND EXPLANATION

IARC:
1. Carcinogenic to humans: sufficient evidence of carcinogenicity.
2A. Probably carcinogenic to humans; limited human evidence; sufficient evidence in experimental animals.

2B. Possibly carcinogenic to humans; limited human evidence in the absence of sufficient evidence in experimental animals.
3. Not classifiable as to carcinogenicity to humans.
4. Probably not carcinogenic to humans.

NTP: 1. Known to be carcinogenic, with evidence from human studies
2. Reasonably anticipated to be a carcinogen, with limited evidence in humans or sufficient evidence in experimental animals.

OSHA: X. Carcinogen defined with no further categorization.

Some MSDSs will state cancer data in words rather than simply listing categories. This practice should be suspect if statements are made such as, "This chemical is not considered to be a carcinogen by NTP, IARC, or OSHA." This wording makes it appear that the chemical has been evaluated by these agencies and found safe. Unless the chemical has an IARC 4 rating, it is far more likely that the agencies have never evaluated the chemical because there are no cancer studies.

A portable eye wash station.

SIGNS AND SYMPTOMS OF EXPOSURE. These are usually acute or sub-acute manifestations of the chemical, since chronic exposure often produces no clear symptoms for years. If chronic symptoms are given, they usually are identified as such.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE. Here the MSDS should list medical conditions that are known or suspected to be exacerbated by the chemical. For example, chemicals that are respiratory irritants may aggravate chronic lung conditions such as asthma or emphysema.

EMERGENCY AND FIRST AID PROCEDURES should be listed here.

Section VII Precautions For Safe Handling And Use

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED. The MSDS should list preferred methods for spill control (*e.g.*, chemical sorbants, Fuller's earth, *etc.*) and protective equipment (respirators, gloves, emergency ventilation, *etc.*) needed to keep workers safe during cleanup of large spills or accidents.

WASTE DISPOSAL METHOD. Unless the material can be rendered completely innocuous, the MSDSs can only tell users to dispose of the material in accordance with local, state, and federal regulations. Disposal has become an extraordinarily complex problem and cannot be addressed in a few lines on an MSDS. It is likely that substances that pose severe environmental threats or whose release (spills) must be reported to the EPA will soon have to be identified here on U.S. MSDSs.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING. Here the MSDS should list safe storage conditions (*e.g.*, cool, dry area).

OTHER PRECAUTIONS, if needed, should include any special equipment that would be needed or that is required to be in a storage area with the material.

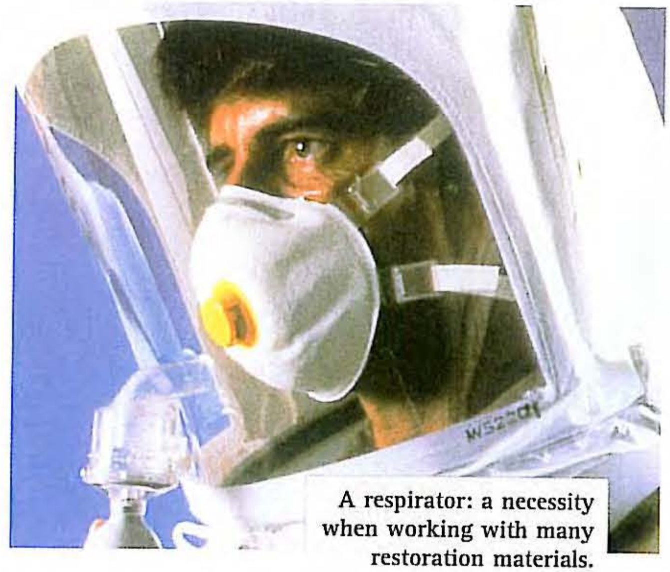
Section VII Control Measures

This section should provide information about protective equipment needed under normal use of the product. The manufacturer decides what constitutes this "normal use." If there is any doubt about what is normal, or if any unusual or experimental use is contemplated, the employer should contact the manufacturer first about additional protection. Manufacturers are usually not liable for damages if their products are used other than directed. For this reason, questions about the hazards of using the product in unusual circumstances should be answered in writing by the manufacturer or an industrial hygienist.

RESPIRATORY PROTECTION (SPECIFIC TYPE). If needed during normal use, a good MSDS explains precisely what type of respirator is proper. Even the cartridge type on air-purifying respirators should be specified. Both Canada and the U.S. recognize the National Institute for Occupational Safety and Health (NIOSH) standards for respiratory protection.

VENTILATION. If needed during normal use, a good MSDS specifies the type of ventilation system that provides proper protection. This includes recommendations about the use of general (mechanical) ventilation, local exhaust (which captures the contaminants at their source) or any special ventilation system that might be needed.

General rules for ventilation are that particulates such as spray mists and dusts be controlled with local exhaust systems such as paint-spray booths or flexible duct exhausts. Gases and vapors from moderately toxic solvents and acids in moderate amounts may be controlled by general or dilution ventilation, such as exhaust fans.



A respirator: a necessity when working with many restoration materials.

PROTECTIVE GLOVES. Good MSDSs list the specific type of glove material needed (rubber, nitrile, *etc.*) and other glove attributes such as length and thickness. Workers should know that some solvents dissolve gloves while others permeate them without changing the glove's appearance. Often permeating solvents are perceived only as perspiration. Good MSDSs indicate which gloves will resist the product. When in doubt, contact the technical department of your glove supplier.

EYE PROTECTION. Good MSDSs list precisely what type of goggles or glasses are needed by their ANSI (American National Standards Institute) Z87.1 standard classification. The MSDS at least should indicate whether vented or unvented chemical splash goggles, impact goggles or other specific types are needed.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT, such as aprons, boots, face shields or eye wash stations should be listed here if needed.

WORK/HYGIENIC PRACTICES. Practices such as proper daily cleanup methods and equipment after normal use should be detailed here. For example, recommendations for wet mopping rather than sweeping dusts and powders, or handcare advice may appear here.

Bibliography

The following books and periodicals are recommended to develop a professional quality library for a health and safety program and for Right-to-Know training materials.

Periodicals

- ACTS FACTS, Arts, Crafts and Theater Safety, New York. A monthly newsletter updating health and safety regulations and research affecting the arts. Available from ACTS, Attn: M. Rossol, 181 Thompson St., #23, New York, NY 10012.
- A.M. Best Company, Best's Safety Directory, 2 Volumes, Ambest Road, Oldwick, NJ 08858. (201)439-2200. Sources safety equipment and supplies. Published yearly.

Books, Pamphlets and Data Sheets

- American Conference of Governmental Industrial Hygienists, 6500 Glenway Ave., Bldg. D-7, Cincinnati, OH 45211-4438. (513) 661-7881. Publications are updated yearly.
  - Threshold Limit Values and Biological Exposure Indices.
  - Industrial Ventilation: A Manual of Recommended Practice.
- American National Standards Institute (ANSI), standards for performance of safety and protective equipment. For Example, ANSI Z358.1-1981 for eye wash fountains and emergency showers or ANSI Z87.1-1989 for face and eye protection. Available from ANSI, 1430 Broadway, NY, NY 10018. (212)642-4900.
- American Subcontractors Association, Inc., Hazard Communication: Reading OSHA's Mind, 1991. Can be obtained from ASA, 1004 Duke Street, Alexandria, VA 22314, (703)684-3450.
- Clark, Nancy; Cutter, Thomas; McGrane, Jean-Ann; Ventilation: A Practical Guide, Center for Safety in the Arts, New York, 1980. A guide to basic ventilation principles and step-by-step guidance for those who wish to evaluate, design and build an adequate ventilation system. Available from CSA, 2124 Broadway, P.O. Box 310, NYC 10023.
- Hawley, Gessner, Hawley's Condensed Chemical Dictionary, 11th Ed., revised by Sax, N. Irving and Lewis, Sr., Richard, Van Nostrand Reinhold Co., New York, 1987. (Also available from the ACGIH. Call (513)661-7881 for publications catalog.)
- Hazardous Substance Fact Sheets, New Jersey Department of Health, Trenton, NJ 08625. Call (609)984-2202 for information on ordering. These are excellent fact sheets on individual chemicals. Around 1,000 chemicals are covered.
- National Fire Protection Association, Batterymarch Park, Quincy, MA 02169. (800)344-3555. Obtain catalog of the 270 codes. Choose pertinent codes such as NFPA #30. Flammable and Combustible Liquids Code.
- National Institute of Occupational Safety and Health, Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, 1981-2 Edition plus yearly supplements. Reproduced by the National Technical Information Services, Port Royal Road, Springfield, VA 22161. May be too expensive for small businesses. OSHA technical services will look up substances for you in this reference.
- Patty, Frank, (ed.), Industrial Hygiene and Toxicology, Vol. II, 3rd edition, Part A, (1980), Part B, (1981), Part C, (1982), Interscience Publishers, New York. (Also available from the ACGIH. Call (513)661-7881 for publications catalog.)
- Rossol, Monona, The Artist's Complete Health and Safety Guide, Allworth Press, New York, 1990. A guide to safety and OSHA compliance for those using paints, pigments, dyes, metals, solvents and other art and craft materials. Available from Allworth Press, 10 East 23 Street, New York, NY 10010.
- Sax, N. Irving and Lewis, Sr., Richard J., Dangerous Properties of Industrial Materials, 7th Ed., Van Nostrand-Reinhold Co., New York, 1988. (Also available from the ACGIH. Call (513)661-7881 for publications catalog.)
- Shaw, Susan D. & Rossol, Monona Overexposure: Health Hazards in Photography. This book is the single most comprehensive reference text on the health hazards of materials used in photography and photoprintmaking processes. Available from Allworth Press, 10 East 23 Street. New York, NY 10010.
- The WHMIS Handbook, Corpus Information Services, 1450 Don Mills Road, Don Mills, Ontario M3B 2X7. (416)445-6641. A well-written, page-tabbed guide to WHMIS.

Government Publications: U.S.

- First find out if you are regulated under state or federal OSHA rules. State-regulated people should contact their state OSHA for publications and compliance materials. Those under the federal law should have a copy of the sections of the Code of Federal Regulations (CFR) that applies to their work. These are 29 CFR 1900-1910 (General Industry Standards) and 29 CFR 1926 (Construction Standards). Call your local OSHA office for information on obtaining copies.
- For extra help in complying with the Hazard Communication Standard (federal Right-To-Know), the following publications are available free from OSHA's Publications Office, Room N-3101, 200 Constitution Ave., N.W., Washington, DC 20210; (202)523-9667:
  1. "Chemical Hazard Communication" OSHA 3084, a booklet describing the rule's requirements; and
  2. "Hazard Communication Guidelines for Compliance," a booklet to help employers comply with the rule.
- Also available for $18 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20210; (202) 783-3238: "Hazard Communication—A Compliance Kit" OSHA 3104 GPO order No. 929-022-00000-9, a step-by-step guide to compliance.
- For general OSHA compliance for small businesses: "OSHA Handbook for Small Businesses," U.S. Department of Labor, 1990, OSHA No. 2209 (revised). To order a copy, call (202)523-9667.

Government Publications: Canada

- Call you local Department of Labour for publications about WHMIS. Most of these are free.
- WHMIS Core Material: A Resource Manual for the Application and Implementation of WHMIS. Contact the Community Relations Department, Worker's Compensation Board of BC, 6951 Westminster Highway, Richmond, British Columbia V7C 1C6. An excellent and inexpensive guide to compliance.

Sources of Help

- RESTORE, 152 Madison Avenue, #1603, New York, NY 10016. Call (212)213-2020. Refers technical health and safety inquiries to appropriate consultants and agencies.
- Arts, Crafts and Theater Safety (ACTS) 181 Thompson Street, # 23, New York, NY 10012-2586. Call (212)777-0062 or e-mail:75054.2542@compuserve.com or http://www.caseweb.com/acts/ Answers inquiries about health and safety by telephone or letter.