

## CHAPTER 1 CHEMICALS

### 1.1 INTRODUCTION

Chemicals are used on a routine basis at the Laboratory. Most chemicals possess some potential hazards which can result in serious consequences if handled improperly. This section covers the safe handling and storage of these substances.

### 1.2 SCOPE

This section covers the use, handling, and storage of all chemicals and chemical-like substances at PPPL and applies to all Laboratory personnel and contractors.

### 1.3 DEFINITIONS (Refer to Section 8, Chapter 12, "Hazard Communication," for a more complete chemical glossary)

**Chemical** - Any material (solid, liquid, or gas) that could cause a chemical change in any substances during any process. This includes solvents, paints, oils, cleaning fluids, and any other compounds.

**Hazardous Material or Chemical** - Any substance that has the capability of producing adverse effects on the health and safety of humans. This may be defined by relative measures of toxicity, corrosiveness, flammability, or reactivity. A material shall be considered hazardous if it is deemed so by any regulatory or recognized advisory agency (e.g. NFPA, OSHA, NJ Department of Health, ACGIH, NIOSH, etc.)

**Material Safety Data Sheets (MSDS)** - Forms which contain hazard communication information on materials found in the workplace. Refer to Section 8, Chapter 12 of this manual for further information on MSDS and chemical information.

**Permissible Exposure Limit (PEL)** - The Occupational Safety and Health Administrations' (OSHA) maximum airborne exposure level for a substance to a worker, as stated in 29 CFR 1910.1000 to -.1046.

**Threshold Limit Value (TLV)** - The American Conference of Governmental Industrial Hygienists' (ACGIH) guidelines which refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects.

### 1.4 RESPONSIBILITIES

1.4.1 Department/Division Heads are responsible for ensuring implementation of this section. Some responsibilities in Section 8, Chapter 1.4.2 may rest directly with these responsible persons.

1.4.2 Line Supervisors are responsible for:

- A. Reviewing the type of work to be performed.
- B. Reviewing the hazards associated with the substances that will be used.
- C. Ensuring that employees are not being exposed to air concentrations of substances over the materials' PEL and TLV (this should be done in cooperation with the Industrial Hygienist).
- D. Establishing safe practices for working with the chemicals.
- E. Providing proper and safe storage for all chemical substances.
- F. Procuring the proper protective equipment needed to work safely with the chemicals in question.

- G. Instructing their workers about:
  - 1. The possible hazards associated with the chemicals.
  - 2. The safety precautions that must be observed.
  - 3. The consequences of an accident.
  - 4. The proper actions to take if an accident were to occur.
- H. Reviewing the hazards and intended use of chemicals, before purchasing, with the **Industrial Hygienist (IH)** by complying with Chapter 13 of this Section, "ES&H Review of Procurements."
- I. Properly disposing of chemicals which have been stored longer than the appropriate storage time (refer to Section 8, Chapter 1.8.5).

1.4.3 The **Industrial Hygienist (IH)** is responsible for:

- A. Assisting supervisors and workers with information on the hazardous properties of materials.
- B. Recommending methods for controlling the hazards of specific operations.
- C. Training supervisors and workers regarding the proper way to handle chemicals.
- D. Monitoring the work environment to assess employees' exposures to hazardous chemicals.
- E. Reviewing and approving/disapproving procedures and facilities used for chemical handling.
- F. Reviewing and approving/disapproving the acquisition of chemicals in accordance with **Section 8, Chapter 13**.
- G. Assisting in finding suitable replacement chemicals for substitution of hazardous materials.

1.4.4 **The Maintenance and Operations Division** is responsible for designing, installing, and maintaining engineering controls (see Section 8, Chapter 4, "Ventilation") incorporating the criteria developed by the **IH** and the line supervisor.

1.4.5 Procurement is responsible for checking to see that the **IH** has approved the use of the chemical before a purchase order is drawn up. No purchase order for a chemical will be issued without this approval. (**Refer to Chapter 13 of this Section.**)

1.4.6 Quality Assurance is responsible for auditing compliance with this section.

1.4.7 All other employees are responsible for:

- A. Wearing and using personal protective and other equipment issued to them in accordance with instructions and training provided by their supervisors and the **IH**.
- B. Cleaning, maintaining and properly storing the protective equipment (**see Section 8, Chapter 6, "Personal Protective Equipment"**).
- C. Following handling instructions in accordance with procedures set down by their supervisors and the **IH**.

- D. Reporting malfunctioning engineering controls and ventilation systems to their supervisors.
- E. Using only personal protective equipment that has been designated and approved for that particular job.

1.4.8 **Human Resources and Training** is responsible for maintaining records of all training they provide on topics covered in this Chapter.

## 1.5 REQUIREMENTS

1.5.1 All acquisitions of chemical substances by any means (including but not limited to: requisition through Procurement, purchase by open order, **credit card purchase**, etc.) must have prior approval from **IH** in accordance with **Chapter 13 of this Section**.

1.5.2 All airborne chemical exposures to employees shall be maintained below the most recent ACGIH TLV's and the OSHA PEL's (whichever is most restrictive).

1.5.3 All precautions shall be taken to reduce the risk of chemical exposure through oral, cutaneous, and optical routes of exposure to as low as reasonably possible along with the inhalation route.

1.5.4 Carcinogens are covered in Section 8, Chapter 2.

## 1.6 GENERAL PRACTICES

The following general safety precautions shall always be observed when working with chemicals.

- A. Keep the work area clean and orderly.
- B. Use stipulated safety equipment.
- C. Carefully label every container with the identity of its contents according to Section 8, Chapter 12, of this Manual.
- D. Store incompatible chemicals so that they are separated by structural barriers such as walls. Contact the **IH** for more information.
- E. Limit the volume of volatile, flammable, toxic, or otherwise hazardous material to the minimum needed for short operation periods (1 week supply).
- F. Provide secondary means of containing the material if equipment or containers should break or spill their contents.
- G. Isolate hazardous operations in separate rooms and limit access and the number of personnel involved.
- H. Substitute a less toxic material whenever possible.
- I. Follow the requirements of Section 9.11 (Pressure Vessels) when systems that can generate pressure or are operated under pressure are involved.
- J. Do not dump chemicals down the sanitary or storm sewer system without prior approval from the **IH and Environmental Engineer**.

- K. Use adequate ventilation. This may include the use of laboratory fume hoods, dust collecting systems, and cooling fans. Never use a chemical in a confined area without proper ventilation and IH approval. If the chemical is flammable, ensure that the ventilation system motor is listed for the appropriate atmosphere. Above all, remember that the purpose of ventilation is to remove the air contaminant from a worker's breathing zone. (See Section 8, Chapter 4 "Ventilation".)
- L. Wear good, impermeable gloves as specified by the IH. Many chemicals can enter the body through the skin and improper gloves may provide no protection at all from contact with the chemical. Never wear cloth or leather gloves for handling chemicals.
- M. If there is a potential for the chemical to splash or spill, as in most situations, then chemical splash goggles, boots, and aprons should be worn.
- N. Never wear contact lenses when working with chemicals. If a chemical splashes into the eyes with contacts in, the lenses must be removed before irrigation begins.
- O. Food and drink should never be stored, prepared, or consumed in a place where chemicals are stored or used.
- P. Chemicals shall not be stored in refrigerators marked "Food Only," and food shall not be kept in "Chemicals Only" refrigerators.
- Q. Never mix chemicals together when you are not sure of the end result. Many chemicals can react violently or may give off heat and toxic vapors.
- R. When leaving a work area where chemicals are used, cleanse the skin thoroughly with a mild soap and water.
- S. Provide a back-up method of shutting off power to any heat source in case of emergency involving chemical spill or fire.
- T. Never smoke in a room where chemicals are stored or used. In addition to the flammability hazard, many chemical vapors become more hazardous when heated or combined with tobacco smoke.
- U. Know where the nearest eyewash, safety shower, and telephone are in case of emergency.

## 1.7 CHEMICAL HAZARDS

The number of hazardous chemicals is so large that knowledge of all of them cannot be assumed, even of chemists. Therefore, when the chemical properties of a material and its reactions are not fully known, it should be treated as toxic and otherwise hazardous. Initial testing and research of the material should be carried out with the utmost safety precautions to reduce the magnitude of unexpected events.

### 1.7.1 Toxicity

Toxicological information discussed in this section includes systemic hazards due to ingestion or inhalation, as well as hazards to external structures such as skin and eyes. The Laboratory is concerned with any adverse effect to an employee's health. This includes simple discomfort due to irritation or odor, as well as a complex physiological change due either to chronic or acute chemical exposure. It must be realized that numbers used as hygienic guidelines (e.g. TLV's or PEL's) are only guidelines and cannot be regarded as the boundary between safe and dangerous conditions or concentrations. Because these guides are not intended as relative indices of toxicity, they must be interpreted by trained personnel. The guides are developed and regularly reviewed by several national groups. With adequate safeguards, any compound can be used safely, but the need for a specific material must justify the hazards presented and the controls necessary to protect employees from injury or illness.

## A. Definitions

1. Acute Effects - Physiological changes, usually severe and rapid, following exposure to a substance, and involving either:
  - a. temporary conditions from a single exposure or
  - b. abrupt onset of a condition after repeated exposures; may later change to chronic effects.
2. Acute Exposure - Exposure to high concentrations of toxic substances over a short period of time. May result in Acute Effects.
3. Allergy - A condition of unusual or exaggerated specific susceptibility to a substance which in similar amounts is harmless to the majority of the population.
4. Anesthesia - A partial or entire loss of feeling or sensation; unconsciousness.
5. Central Nervous System (CNS) - The system which coordinates and regulates nerves and nerve centers, and which directly controls behavior and consciousness. Symptoms of damage can include headache, irritability, lassitude, disorientation, and finally stupor and unconsciousness.
6. Chronic Effects - Physiological changes, from exposure to a compound, involving any of the following:
  - a. irreparable damage from repeated exposure
  - b. accumulative damage from repeated exposures
  - c. delayed damage following either single or repeated exposures, even after cessation of the exposure and regardless of the time interval.
7. Chronic Exposure - Exposure to low levels of toxic substances over a long period of time. May result in Chronic Effects.
8. Narcosis - A state of stupor or unconsciousness.
9. Sensitization - A process of rendering a specific system sensitive to an agent or a complement of the agent.
10. Systemic - Pertaining to or affecting the body as a whole. (Systemic changes generally refer to nonspecific physiological changes.)

## B. Routes of Exposure

1. Inhalation - The lungs represent the greatest body surface exposure to potentially hazardous compounds, and lung tissue acts as a selective barrier for sorption and desorption of gases. In addition to the sensitive and easily damaged barrier mechanism, the lungs are the main port of entry of contaminants into the body.

- a. Upper Respiratory Irritants - Irritants and corrosive chemicals, such as acids, alkalis, solvents, and many other substances may cause direct inhalation damage in the nasopharyngeal and upper bronchial regions. The damage is usually reversible except after repeated exposures to high concentrations or exposure to extreme conditions. Many exposure limits, such as those for butyl acetate and some acids, are based on the irritating properties of the substance even though concentrations higher than the limit may not cause systemic poisoning.
  - b. Non-Irritants - Irritation is one of the body's warning mechanisms; gases and vapors which do not irritate the upper respiratory system may be inhaled deeper into the respiratory tract, and into the lungs, where they may be absorbed, or cause local damage to the alveolar walls. This form of damage may be reversible, such as a transient pneumonitis, but is often irreversible, such as in an emphysema or the production of non-functioning scar tissue.
  - c. Sensitizers - Some gases, vapors, and fumes are capable of causing an asthma-like reaction at extremely low concentrations. TDI (toluene diisocyanate) vapors, epoxy resins, some insecticides, and many chemicals encountered in pharmaceutical and organic research are known sensitizers. If the lungs become sensitized to a material, succeeding exposures may produce an asthma-like reaction, such as tightness in the chest, wheezing, non-productive cough and, in some cases, vocal disturbances and elevated temperature. It is impossible to predict who may become sensitized, and even the degree of severity is unpredictable. Individuals who are naturally sensitive, or who become sensitized through exposure, to certain compounds must be removed completely from any potential exposure if repeat attacks are to be prevented.
  - d. Means of Toxicity - The primary mode of entry for toxic gases and vapors is sorption through the lungs to various organs in the body. Either the inhaled substance or the products formed from its metabolism may damage tissue cells. Compounds such as alcohol and trichloroethylene (TCE) are only moderately toxic to living cells, but the metabolic products are highly toxic.
  - e. Toxic Dusts - The upper respiratory system separates inhaled particulate matter selectively, according to size. The size range of unit density particles penetrating into the lower lungs is less than 10 microns. Larger particles are removed in the upper respiratory tract by phagocytosis or by ciliary action at the walls of the bronchi and bronchioles. A limited number of substances cause lung damage without being absorbed. They include silica (silicosis), asbestos (asbestosis), beryllium (berylliosis), and some other substances. Other particulates are more readily dissolved, and may thereby, cause damage to various organs. Lead, mercury, cadmium, and other metals and metal oxides produce first a lung response, then after dissolution and concentration in various organs, they produce reactions through toxic mechanisms.
  - f. Exposure Control - The exposure of any worker to environments known to contain toxic substances must be controlled, especially when exposure to concentrations in excess of the TLV is possible. Adequate engineering control and/or respiratory protection must be provided. The ES&H Division should be contacted before starting a program requiring the use of unfamiliar or toxic substances so that potential hazards can be evaluated and control procedures recommended.
2. Skin - There are four major concerns with skin toxicology: surface absorption, sensitivity and allergic reactions, surface corrosion, and carcinogenesis.

- a. Absorption - Although the skin is an excellent protective barrier, many chemicals, even in the vapor phase, can be absorbed through it. Skin absorption is more often a surface contact problem. Atmospheric concentrations high enough to cause toxic reactions via skin absorption present an even greater inhalation hazard. The most common and difficult exposure to control are to substances such as cleaning solvents, because the skin is in direct contact with the unit being cleaned, facilitating solvent absorption through the skin unless precautionary measures are taken.

#### EXAMPLES OF HAZARDOUS CHEMICALS ABSORBED THROUGH INTACT SKIN

|                  |                       |                                                                                                         |
|------------------|-----------------------|---------------------------------------------------------------------------------------------------------|
| Allyl alcohol    | Dimethylformamide     | Xylene                                                                                                  |
| Carbon disulfide | Dimethyl Sulfoxide    | Almost all nitro compounds                                                                              |
| Carbon monoxide  | Dinitrobenzene        | Almost all halogen compounds including carbon tetrachloride, the most hazardous of the common solvents. |
| Cresols          | Ethylene chlorohydrin |                                                                                                         |
| Cyanides         | Phenol                |                                                                                                         |
| Decaborane       | Tetryl                |                                                                                                         |
| Dimethylaniline  | TNT                   |                                                                                                         |

- b. Sensitizers/Allergic Reactions - Allergic or sensitivity reactions may be caused by surface contact as well as by inhalation. Skin sensitivity reactions resemble those of poison ivy and result from repeated contact with the sensitizing material.

#### EXAMPLES OF SKIN SENSITIZERS

|                              |                                 |
|------------------------------|---------------------------------|
| Epoxide monomers & catalysts | Aliphatic mono and polyamines   |
| Aromatic amines              | Aromatic hydrazines             |
| Aromatic isocyanates         | Aromatic nitro compounds (some) |
| Chlorinated biphenyls        | Toluene diisocyanate (TDI)      |

### 1.7.2 Corrosiveness

#### A. Definitions

1. Corrosive - A substance which possesses the property of severely damaging living tissue and of attacking other materials such as metals, wood, or glass.
2. Acid - A substance which in solution will donate a proton. Typically, an acid will have a pH of less than 7.0.
3. Base - A compound that reacts with an acid to form a salt. It is another term for alkali. Bases will, typically, have a pH of greater than 7.0.
4. Vesicant - A substance which will produce blistering of the skin.

#### B. Controls and requirements

Whenever corrosive chemicals are used, a safety shower and eye wash fountain must be located in the immediate vicinity. Face shields, safety goggles, water-proof aprons, and rubber or neoprene gloves must be worn at all times when handling corrosive chemicals.

### EXAMPLES OF CORROSIVES AND THEIR EFFECTS ON SKIN

| Burns, Corrosion,<br>Ulceration            | Vesicants                                                                                    |                                                       | Drying, Scaling,<br>Cracking          |
|--------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------------|---------------------------------------|
| Acetic acid<br>Ammonia<br>Arsenic trioxide | Alkalis (NaOH, Lime)<br>Carbon disulfide<br>Hydrofluoric Acid<br>Hydrogen Peroxide<br>Iodine | Nitric Acid<br>Phenols<br>Phosphorus<br>Sulfuric Acid | Soaps and detergents<br>Most Solvents |

#### 1.7.3 Flammability

For the safe handling of flammable and combustible chemicals, refer to Section 5 , Fire Safety, of the ES&H Manual, ESH D 5008.

#### 1.7.4 Reactivity

The range of reactions possible between chemicals is so wide and varied that no one can predict all of the possible outcomes of a mixture of chemicals, as random factors may produce an odd or unexpected result. Some general guidelines are:

- A. Never mix chemicals together unless the outcome is known with a large degree of confidence.
- B. Never mix or store acids and bases together.
- C. Never mix or store acids and oxidizing compounds together.
- D. Never mix or store acids or oxidizers and flammables together.**
- E. Always add acid to water, never water to acid. This could result in a violent reaction.
- F. Never pour chemicals down the sink; you never know what may already be down there.
- G. Never put chemicals into a container that has been used for something else. You could cause a reaction with any chemical residues or water which is left in the container from its previous use.
- H. The **IH** shall be consulted before any chemicals are used or mixed for the first time and for storage compatibility of chemicals.

## 1.8 CHEMICAL STORAGE

The storage of chemicals plays a major role in how safely they are being handled, and how much exposure is present.

### 1.8.1 Definitions

- A. Incompatible - A liquid or solid which cannot be mixed with another specified material without the possibility of a dangerous reaction.
- B. Secondary Containment - A storage container other than the one in direct contact with the chemical (which is the primary container). Examples are: flammable storage cabinets, retention basins, etc. A secondary containment must be able to hold, at a minimum, the quantity of liquid kept in the largest primary container within its confines.

### 1.8.2 Incompatibles

Many chemicals are incompatible with one another and must be kept separate. This can be accomplished by distance (as in one room to another) or by secondary containments, depending on the type of incompatibility, the severity of any possible reactions, and the quantities of the respective chemicals.

### 1.8.3 Flammable liquids

Liquids which are flammable must be stored in accordance with Section 5, Fire Safety, of the ES&H Manual, ESH D 5008.

### 1.8.4 Corrosives

Quantities of corrosive chemicals in excess of 5 gallons must be kept in a metal cabinet, and quantities in excess of 25 gallons must be kept in a corrosives storage cabinet. All corrosives shall have a secondary containment. This may include a bin or bucket constructed of plastic or other corrosion-resistant material.

### 1.8.5 Aging of Chemicals

Some chemicals lose effectiveness with age while others, notably peroxides, become more hazardous and often explosive when aged. Corrosives have been demonstrated to cause fatiguing and leaking if they are kept in plastic or polyethylene containers, including manufacturer's shipping containers, for longer than six months. In general, no chemical should be kept longer than six months for these reasons. Materials with a listed shelf life of greater than six months may be kept for the time period listed. Other materials may be kept for extended periods of time only with approval of the IH. Therefore, all chemicals should be ordered in quantities which will be used within this time period.

### 1.8.6 Quantities of Stored Chemicals

In any single room or laboratory, the maximum allowable quantity of any one chemical is a one week supply or one gallon, whichever is greater. Chemicals which must be ordered in larger quantities may be kept in outdoor storage facilities and transferred to smaller containers for inside use. Any exceptions to this rule must be approved by the IH.

## 1.9 EMERGENCY PROCEDURES

Installation or change of location for any chemical emergency equipment (such as eye washes and safety showers) must have prior approval by the IH.

### 1.9.1 Eye Contact

Most chemicals will damage the eyes if contact occurs. If a chemical contacts the eyes, immediately flush the eyes with copious amounts of water, preferably at the nearest eyewash station. A minimum of 15 minutes rinse time is required. The Emergency Services Unit (ESU) should be called as soon as possible at ext. 3333. Do not stop flushing the eyes until ESU personnel arrive on the scene and inform you to do so.

### 1.9.2 Skin Contact

If a chemical comes into contact with the skin, immediately rinse the affected area with large amounts of running water. This may be done in a sink if the hands are the only portion of the body contacted, or under a safety shower if the contact is more extensive. ESU should be notified immediately if the chemical is a corrosive or may be absorbed through the skin. Remove contaminated clothing while under the shower and do not put clothing back on until it has been decontaminated. Remain under the shower until ESU personnel inform you to stop.

### 1.9.3 Spills

A spill is any uncontrolled release, drip, leak, etc. of a chemical which escapes from its primary container. Any spill involving a hazardous material will be handled by ESU and the Environmental Restoration/Waste Management (ER/WM) Division. If the chemical spilled is considered to be non-hazardous, then it is the responsibility of the personnel who created the spill, or the person responsible for the area, to clean up the spill immediately. This includes food and beverage spills as well as "chemical" spills. If the substance released is of hazardous or unknown properties, the area should be evacuated immediately, and ESU notified. Untrained personnel should not try to clean or contain spills of hazardous materials because of the possibility of creating a worse scenario, e.g., igniting a flammable liquid.

## 1.10 RESTRICTED CHEMICALS

Certain chemicals and compounds are restricted or banned from use at PPPL and require special procedures.

1.10.1 The following chemicals are banned from use at the Lab except under extreme conditions where no substitute can be found and with special written approval from the IH. Notify the IH if any of these chemicals are found in storage or in use. They are extremely toxic, both as individual chemicals and as components of other products. Effective substitutes are available for most uses. The use and handling of these chemicals is extremely hazardous and requires extreme protective measures.

### CARBON TETRACHLORIDE CARBON DISULFIDE

### HYDROFLUORIC ACID BENZENE

1.10.2 The following materials are a selection of the many chemicals which require special handling for safe use. Contact the IH if any of these are found in use or in storage.

|                                                                                                                                                         |                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <u>SOLVENTS</u>                                                                                                                                         | <u>METALS</u>                                                                                                                                |
| Ethers<br>Methylene Chloride<br>Hexane<br>Cellosolve<br>Cellosolve Acetate<br>Butyl Cellosolve<br>Butyl Cellosolve Acetate<br>Dimethyl Sulfoxide (DMSO) | Mercury and its compounds<br>Beryllium and its compounds<br>Lead and its compounds<br>Arsenic and its compounds<br>Cadmium and its compounds |
| <u>CORROSIVES</u>                                                                                                                                       | <u>MISCELLANEOUS</u>                                                                                                                         |
| Chromic acid<br>Perchloric acid<br>Picric acid<br>Nitric acid<br>Sulfuric acid<br>Hydrochloric acid                                                     | Isocyanates (TDI)<br>Phenol<br>Formaldehyde<br>Cyanide compounds<br>Asbestos<br>Sodium / Potassium hydroxide                                 |

1.10.3 Materials which are human, or suspect human, carcinogens must also be handled with care and only with Industrial Hygiene approval. See Chapter 2, "Carcinogens," of this section for more details.

## 1.11 SPECIFIC CHEMICAL REQUIREMENTS

Certain chemical substances have specific regulations which govern their use. Whenever such regulations exist, all requirements shall be followed as applicable. If conflicts occur between regulations and/or Lab policies, the most stringent requirements shall apply. One such material is Lead, for which an OSHA standard exists (29 CFR 1910.1025). The requirements of that standard are summarized here.

1.11.1 The permissible exposure limit (PEL) for airborne lead shall be 50  $\mu\text{g}/\text{m}^3$  averaged over an 8-hour period. When an action level of 30  $\mu\text{g}/\text{m}^3$  averaged over an 8-hour period is exceeded, certain actions must be taken (see below).

1.11.2 Exposure monitoring for any lead work shall be conducted at the beginning of the work by the IH and shall be repeated at least every 6 months if the action level is exceeded.

1.11.3 The preferred order for implementation of control measures is: engineering controls, administrative controls, and personal protective equipment.

1.11.4 Respiratory protection will be provided by PPPL if required to maintain levels below the PEL. Any personnel required to wear respirators must be trained, medically qualified and fit tested (see Chapter 7 of this Section).

1.11.5 In situations where an employee may be exposed above the PEL, protective work clothing and equipment shall be provided.

1.11.6 Good housekeeping shall be maintained to avoid accumulations of lead dust. Vacuuming using a high efficiency particulate air (HEPA) filter vacuum is the preferred method of cleaning.

1.11.7 In situations where an employee may be exposed above the PEL, showers, change rooms, lunchrooms and lavatories shall be provided. **NO FOOD, BEVERAGES, TOBACCO PRODUCTS, OR COSMETICS SHALL BE USED OR STORED IN A LEAD WORK AREA.**

1.11.8 Medical surveillance including blood tests shall be provided to all employees exposed above the action level for more than 30 days per year.

1.11.9 Personnel shall be removed from all lead associated work if their blood lead level is found to be greater than 50  $\mu\text{g}/100\text{g}$  blood and can not return to such work until their blood lead level drops below 40  $\mu\text{g}/100\text{g}$  of blood.

1.11.10 All employees shall be informed of the contents of the OSHA standard and shall undergo a training course if they are subject to lead exposure. The OSHA lead standard is available to all affected employees.

1.11.11 Signs stating "WARNING – LEAD WORK AREA – POISON – NO SMOKING OR EATING" shall be posted wherever the PEL is exceeded.

1.11.12 Records of lead monitoring must be kept for at least 40 years or for the duration of employment plus 20 years, whichever is greater. Record shall be made available to employees or designated representatives upon request.

1.11.13 During any monitoring, the employee being monitored has the right to act as or appoint an observer of monitoring. This observer will be informed of the monitoring procedures, may observe all monitoring steps, and record all results.

## 1.12 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH), TLV's - Threshold Limit Values and Biological Exposure Indices, current edition, Cincinnati, OH, .

American Industrial Hygiene Association (AIHA), Hygienic Guide Series, Akron, OH.  
National Safety Council, Fundamentals of Industrial Hygiene, Chicago, IL, 1988.

Occupational Safety and Health Administration (OSHA), 29 CFR 1910.1000 to -.1046.