The Nature of Chemical Hazards

&

Implications of GHS Applied to Industry

4 Hour Workbook

First Edition

Globally Harmonized System

Of Classification and Labeling of Chemicals

University of Medicine & Dentistry of New Jersey (UMDNJ)

School of Public Health (SPH)

Office of Public Health Practice (OPHP)

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Introduction

The two primary goals of this training are first to introduce a means of integrating the Department of Labor's Occupational Safety and Health Administration's (OSHA) revised Hazard Communication Standard (HCS) aligning with the Globally Harmonized System (GHS) of Classification and Labeling of Chemicals into proper use within existing *Hazard Communication* programs and second provide basic training modules to better help employers effectively train their employees by emphasizing the nature of chemical hazards to make them more understandable in a practical manner. Both employers and employees should not only *know* what chemical hazards are in the workplace but also *understand* how to work with them safely to prevent exposures.

The new GHS initiative gives all of industry an opportunity to start fresh and utilize a new model Hazard Communication program that stresses a right to understand. After many years of international development, The Hazard Communication Standard (HCS) is now aligned with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). This update to the Hazard Communication Standard (HCS) provides a common and coherent approach to classifying chemicals and communicating hazard information on labels and safety data sheets.

This training will demonstrate how the revised standard will improve the quality and consistency of hazard information in the workplace, making it safer for workers to work with chemicals in the workplace. This training provides easily understandable information on appropriate handling and safe use of hazardous chemicals. When employees have this information, they may effectively participate in their employers' protective hazard communication programs and take steps to protect themselves. This training with help employers provide a practical means of designing, implementing and monitoring a more effective protective program for employees potentially exposed to hazardous chemicals.

The GHS initiative was intended to reduce trade barriers and increase productivity for American businesses that regularly handle, store, and use hazardous chemicals while providing cost savings for American businesses that periodically update safety data sheets and labels for chemicals covered under the hazard communication standard, but most importantly, the updates to the Hazard Communication Standard will save lives and prevent illness and injury.

The training itself is intended to be interactive and relies on the participation of trainees to share experiences and ask questions, because we learn best by practical application of instructional concepts.

Section One: Rights and Responsibilities

Responsibilities under the OSH Act: General Duty Clause

It is both wise and mandatory for an employer to start any undertaking with some reasonable anticipation of what hazards and obstacles you may likely encounter because it is essential that in each workplace an employer provides the means of assessing and identifying potential hazards and where applicable utilize measures that seek to eliminate, prevent and protect such hazards from causing harm. In a sense, an assessment phase of your existing hazard communication program is an investigation phase, based on an inventory of chemicals and their interaction with employees so we can determine what can go wrong. In our assessments we must keep in mind that we are evaluating a matrix and interaction of people, chemicals, materials, equipment, the environments and existing processes.

We must always keep in mind the mandatory nature of hazard communication flow directly from The Williams-Steiger Occupational Safety and Health Act of 1970, which can also be referred to as, "The Occupational Safety and Health Act of 1970" (OSH Act). The primary purpose of the OSH Act is to assure, so far as possible, safe and healthful working conditions for every working man and woman, but in various places the OSH Act or OSHA regulations clearly spells out the responsibility of an employer and employees:

The Occupational Safety and Health Act of 1970: "General Duty Clause"

5. General Duties

(a) Each employer

(1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees;

(2) shall comply with occupational safety and health standards promulgated under this Act.

(b) Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct.

Mandatory Training

OSHA's Hazard Communication requirements are Identical in General Industry, Construction, and Maritime industries. It is found in the Code of Federal Regulations (CFR) Title 29 §1910.1200 and has specific mandatory language that spells out required employee training in the workplace:

Hazard communication

Purpose.

1910.1200(a)(1)

The purpose of this section is to ensure that the hazards of all chemicals produced or imported are classified, and that information concerning the classified hazards is transmitted to employers and employees. The requirements of this section are intended to be consistent with the provisions of the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS), Revision 3. The transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, safety data sheets and employee training

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1910.1200(h)

Employee information and training.

1910.1200(h)(1)

Employers shall provide employees with effective information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new chemical hazard the employees have not previously been trained about is introduced into their work area. Information and training may be designed to cover categories of hazards (e.g., flammability, carcinogenicity) or specific chemicals. Chemical-specific information must always be available through labels and safety data sheets.

1910.1200(h)(2) Information. Employees shall be informed of:

1910.1200(h)(2)(i) The requirements of this section;

1910.1200(h)(2)(ii) Any operations in their work area where hazardous chemicals are present; and,

1910.1200(h)(2)(iii) The location and availability of the written hazard communication program, including the required list(s) of hazardous chemicals, and safety data sheets required by this section.

1910.1200(h)(3) Training. Employee training shall include at least:

1910.1200(h)(3)(i)

Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (such as monitoring conducted by the employer,

continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

1910.1200(h)(3)(ii)

The physical, health, simple asphyxiation, combustible dust, and pyrophoric gas hazards, as well as hazards not otherwise classified, of the chemicals in the work area;

1910.1200(h)(3)(iii)

The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used; and,

1910.1200(h)(3)(iv)

The details of the hazard communication program developed by the employer, including an explanation of the labels received on shipped containers and the workplace labeling system used by their employer; the safety data sheet, including the order of information and how employees can obtain and use the appropriate hazard information.

A Right to Be Heard: Your Rights as a Whistleblower

An employee may file a complaint with OSHA if the employer retaliates against them or takes unfavorable personnel action because the employee engaged in protected activity relating to workplace safety and health.

Whistleblower Laws Enforced by OSHA

- Complaints need to be filed within 30 days after an alleged retaliation.
- You may file complaints by: telephone calling (800) 321-OSHA for situations where you believe there is an immediate risk that threatens life or injury or call a local area office (number listed below) , you can also go online at http://www.osha.gov/as/opa/worker/complain.html and download forms for faxing OSHA at: http://www.osha.gov/oshforms/osha7.pdf Contact your local OSHA office as soon as possible, because you must file your complaint within the legal time limits. New York (212) 337-2378
- OSHA will conduct an in-depth interview with each complainant.
  The investigation must reveal that:
  - The employee engaged in protected activity;
  - The employer knew about the protected activity;
  - The employer took an adverse action; and
  - The protected activity was the motivating factor, or under some laws, a contributing factor in the decision to take the adverse action against the employee.

Limited Right to Refuse to Work

- Employees have a limited right under the OSH Act to refuse to do a job because conditions are hazardous. You may do so under the OSH Act only when:

(1) You believe that you face death or serious injury (and the situation is so clearly hazardous that any reasonable person would believe the same thing);

(2) you have tried to get your employer to correct the condition, and there is no other way to do the job safely; and

(3) the situation is so urgent that you do not have time to eliminate the hazard through regulatory channels such as calling OSHA.

- Regardless of the unsafe condition, you are not protected if you simply walk off the job

Complaint Filing Options

You have these options to file your safety and health complaint:

1. **Online**
2. **Download and Fax/Mail**. Written complaints that are signed by a worker or representative and submitted to the closest OSHA Area Office are more likely to result in onsite OSHA inspections. Please include your name, address and telephone number so we can contact you to follow up. This information is confidential.
3. **Telephone** - your local OSHA Regional or Area Office http://www.osha.gov/html/RAmap.html. OSHA staff can discuss your complaint and respond to any questions you have. **If there is an emergency or the hazard is immediately life-threatening, call your local 1-800-321-OSHA.**

To File your Discrimination Complaint

File a **discrimination** complaint if your employer has punished you for using any employee rights http://www.osha.gov/workers.html established under the OSH Act or for refusing to work http://www.osha.gov/as/opa/worker/refuse.html when faced with an imminent danger of death or serious injury and there is insufficient time for OSHA to inspect. If you have been punished or discriminated against for using your rights, you must file a complaint with OSHA within 30 days of the alleged reprisal for most complaints. No form is required, but you must call or file a letter with the OSHA Area Office nearest you **within 30 days of the alleged discrimination**. In states with approved state plans, employees may file a complaint with both the state http://www.osha.gov/dcsp/osp/index.html and Federal OSHA http://www.osha.gov/html/RAmap.html.

******* When Can a Complaint Be Filed?**

OSHA recommends that employees try to resolve safety and health issues first by reporting them to their supervisors, managers or the safety and health committee. At any time, however, employees can complain to their local OSHA Area or Regional Office http://www.osha.gov/html/RAmap.html and ask for an inspection or an investigation. (Complaints to federal OSHA from workers in states with OSHA-approved state plans will be forwarded to the appropriate state plan for response.) *** Note: Discrimination complaints must be filed within 30 days of the alleged discrimination.**

Who Can Complain?

Employees or their representatives have a right to request an inspection of a workplace if they believe there is a violation of a safety or health standard, or if there is any danger that threatens physical harm, or if an **imminent danger** exists http://www.osha.gov/as/opa/worker/danger.html. Employee representatives, for the purposes of filing a complaint, are defined as any of the following:

a. An authorized representative of the employee bargaining unit, such as a certified or recognized labor organization.
b. An attorney acting for an employee.
c. Any other person acting in a bona fide representative capacity, including, but not limited to, members of the clergy, social workers, spouses and other family members, and government officials or nonprofit groups and organizations acting upon specific complaints and injuries from individuals who are employees.

In addition, anyone who knows about a workplace safety or health hazard may report unsafe conditions to OSHA, and OSHA will investigate the concerns reported.

What Information Must the Employee Provide?

Employees or their representatives must provide enough information for OSHA to determine that a hazard probably exists. Workers do not have to know whether a specific OSHA standard has been violated in order to file a complaint.

The following are examples of the type of information that would be useful to OSHA when receiving a complaint. It is not necessary to have the answers to all these questions in order to file a complaint. The list is provided here as a guide to help you provide as much complete and accurate information as possible:

- How many employees work at the site and how many are exposed to the hazard?
- How and when are workers exposed?
- What work is performed in the unsafe or unhealthful area?
- What type of equipment is used? Is it in good condition?
- What materials and/or chemicals are used?
- Have employees been informed or trained regarding hazardous conditions?
- What process and/or operation is involved?
- What kinds of work are done nearby?
- How often and for how long do employees work at the task that leads to their exposure?
- How long (to your knowledge) has the condition existed?
- Have any attempts been made to correct the problem?
- On what shifts does the hazard exist?
- Has anyone been injured or made ill as a result of this problem?
- Have there been any "near-miss" incidents?

Right to Know vs. Right to Understand

Activity One: Critical Assessment: Rights and Responsibilities: Can you remember receiving right-to-know training yourself? If so can you describe what you learned, who performed the training and where in the workplace your certifications and chemical hazard information are kept and how were you trained. Do you feel your training was effective, why or why not? (In the space below provide your observations, remarks and comments.)

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Key elements of an effective Hazard Communication Program

- Company Policy
- Container Labeling (HCS 2012 Compliant)
- Safety Data Sheet (HCS 2012 Compliant)
- Employee Training and Information
- Procedures and Communication for Non Routine Tasks
- Procedures and Communication for third party contractors
- Hazardous Materials Inventory/Lists
- Chemicals in Unlabeled Pipes

- Program documentation and availability
- Periodic regular program maintenance

Section Two: Global Harmonization and Hazard Communication

The Globally Harmonized System (GHS) is an international approach to hazard communication, providing agreed criteria for classification of chemical hazards, and a standardized approach to label elements and safety data sheets. The GHS was negotiated in a multi-year process by hazard communication experts from many different countries, international organizations, and stakeholder groups. It is based on major existing systems around the world, including OSHA's Hazard Communication Standard and the chemical classification and labeling systems of other US agencies.

Since it was first promulgated in 1983, the HCS has provided employers and employees extensive information about the chemicals in their workplaces. The original standard is performance-oriented, allowing chemical manufacturers and importers to convey information on labels and material safety data sheets in whatever format they choose. While the available information has been helpful in improving employee safety and health, a more standardized approach to classifying the hazards and conveying the information will be more effective, and provide further improvements in American workplaces. The GHS provides such a standardized approach, including detailed criteria for determining what hazardous effects a chemical poses, as well as standardized label elements assigned by hazard class and category

In order to ensure chemical safety in the workplace, information about the identities and hazards of the chemicals must be available and understandable to workers. OSHA's

Hazard Communication Standard (HCS) requires the development and dissemination of such information:

- Chemical manufacturers and importers are required to evaluate the hazards of the chemicals they produce or import, and prepare labels and safety data sheets to convey the hazard information to their downstream customers;
- All employers with hazardous chemicals in their workplaces must have labels and safety data sheets for their exposed workers, and train them to handle the chemicals appropriately.

Major changes to the Hazard Communication Standard

- **Hazard classification**: Provides specific criteria for classification of health and physical hazards, as well as classification of mixtures. Under both the current Hazard Communication Standard (HCS) and the revised HCS, an evaluation of chemical hazards must be performed considering the available scientific evidence concerning such hazards. The hazard classification approach in the revised HCS is quite different. The revised HCS has specific criteria for each health and physical hazard, along with detailed instructions for hazard evaluation and determinations as to whether mixtures or substances are covered. It also establishes both hazard classes and hazard categories—for most of the effects; the classes are divided into categories that reflect the relative severity of the effect. The current HCS does not include categories for most of the health hazards covered, so this new approach provides additional information that can be related to the appropriate response to address the hazard.

- **Labels**: Chemical manufacturers and importers will be required to provide a label that includes a harmonized signal word, pictogram, and hazard statement for each hazard class and category. Precautionary statements must also be provided.
- **Safety Data Sheets:** Will now have a specified 16-section format.

- **Information and training:** Employers are required to train workers by December 1, 2013 on the new labels elements and safety data sheets format to facilitate recognition and understanding

Unchanged Parts of the Hazard Communication Standard

The revised Hazard Communication Standard (HCS) is a modification to the existing standard. The parts of the standard that did not relate to the GHS (such as the basic framework, scope, and exemptions) remained largely unchanged. There have been some modifications to terminology in order to align the revised HCS with language used in the GHS. For example, the term "hazard determination" has been changed to "hazard classification" and "material safety data sheet" was changed to "safety data sheet."

In regards to labeling, the current standard provides employers with flexibility regarding the type of system to be used in their workplaces and OSHA has retained that flexibility in the revised Hazard Communication Standard (HCS). Employers may choose to label workplace containers either with the same label that would be on shipped containers for the chemical under the revised rule, or with label alternatives that meet the requirements for the standard. Alternative labeling systems such as the National Fire Protection Association (NFPA) 704 Hazard Rating and the Hazardous Material Information System (HMIS) are permitted for workplace containers. However, the information supplied on these labels must be consistent with the revised HCS, e.g., no conflicting hazard warnings or pictograms.

Effective Dates: The table below summarizes the phase-in dates required under the revised Hazard Communication Standard (HCS):

Effective Completion	Requirement(s)	Who

Date		
December 1, 2013	Train employees on the new label elements and safety data sheet (SDS) format.	Employers
June 1, 2015* December 1, 2015	Compliance with all modified provisions of this final rule, except: The Distributor shall not ship containers labeled by the chemical manufacturer or importer unless it is a GHS label	Chemical manufacturers, importers, distributors and employers
June 1, 2016	Update alternative workplace labeling and hazard communication program as necessary, and provide additional employee training for newly identified physical or health hazards.	Employers
Transition Period to the effective completion dates noted above	May comply with either 29 CFR 1910.1200 (the final standard), or the current standard, or both	Chemical manufacturers, importers, distributors, and employers

Anticipated Statistical Shifts, Costs and Benefits

OSHA expects that the modifications to the Hazard Communication Standard (HCS) will result in increased safety and health for the affected employees and reduce the numbers of accidents, fatalities, injuries, and illnesses associated with exposures to

hazardous chemicals. The GHS revisions to the HCS standard for labeling and safety data sheets would enable employees exposed to workplace chemicals to more quickly obtain and to more easily understand information about the hazards associated with those chemicals. In addition, the revisions to HCS are expected to improve the use of appropriate exposure controls and work practices that can reduce the safety and health risks associated with exposure to hazardous chemicals. The following are some of the anticipated shifts in statistics and cost/benefits to the implementation of the GHS:

- Number of workers affected by HCS: Over 40 million workers
- Affected Industries: Over 5 million workplaces
- According to OSHA, the revised Hazard Communications Standard's (HCS) total cost, an estimated $201 million a year on an annualized basis for the entire United States, is the sum of four major cost elements.

  (1) OSHA estimates that the cost of classifying chemical hazards in accordance with the GHS criteria and revising safety data sheets and labels to meet new format and content requirements would be $22.5 million a year on an annualized basis.

  (2) OSHA estimates that training for employees to become familiar with new warning symbols and the revised safety data sheet format under GHS would cost $95.4 million a year on an annualized basis.

  (3) OSHA estimated annualized costs of $59 million a year for management to become familiar with the new GHS system and to engage in other management-related activities as may be necessary for industry's adoption of GHS.

  (4) OSHA estimated annualized costs of $24.1 million for printing packaging and labels for hazardous chemicals in color.
- Prevent 43 fatalities
- Prevent 585 injuries and illnesses annually.
- Prevent 318 non-lost-workday injuries and illnesses.
- Prevent 203 lost-workday injuries and illnesses.

- Prevent 64 chronic illnesses annually.
- Generate net monetized benefits of $556 million annually, using a discount rate of 7 percent to annualize costs and benefits. (Using a 3 percent discount rate instead would have the effect of lowering the costs to $161 million per year and increasing the gross benefits to $839 million per year. The result would be to increase net benefits from $556 million to $678 million per year.)

Practical Advantages of Global Harmonized System (GHS) to Industry

Historically, under the current Hazard Communication Standard there are no firm rules for what a label or material safety data sheet should look like or how information is presented. Under the incorporation of the GHS infused standard, instead of having a variety of different safety data sheets and labels, the hazard warnings will now be the same format regardless of who produces it or where it is produced. Beside uniformity, the universally consistent format creates tremendous opportunity for greater dissemination of safety and health training and implementations of controls into the workplace as well an opportunity to advantageously streamline the Hazard Communication system.

The new labels alert employees to potential hazards and provide important details on how to handle chemicals safely. These labels illustrate and explain not only what you need to know about applicable chemicals but also what you need to do in a way that everyone can clearly and easily understand. Utilizing the universal language of symbols the new standard uses pictograms and labels to classify chemicals. Behind every image are uniform organization and classification systems that spell out the potential hazards and protections in terms that everyone, worldwide, can understand ... whether you are working with chemicals, manufacturing them, transporting them or supervising employees exposed to them; all in a simple alert system.

Chemicals pose a wide range of health hazards (such as irritation, sensitization, and carcinogenicity) and physical hazards (such as flammability, corrosion, and reactivity).

OSHA's Hazard Communication Standard (HCS) is designed to ensure that information about these hazards and associated protective measures is disseminated.

The harmonized format of the safety data sheets will enable employers, workers, health professionals, and emergency responders to access the information more efficiently and effectively, thus increasing their utility. From a practical standpoint the implementation of the Hazard Communication Program becomes easier These administrative advantages of the new GHS translate into lower incidents affecting worker safety and health, such as:

- More efficient dissemination of information: Since SDS are arranged in uniform order, an employer can choose to training by categories comparing "apples to apples" and more effectively train right-to-know details. Easier means of training results in more compliance and less exposures in the workplace. Categorical training modules by similar hazard groupings, hence flammables, corrosives, caustics with each grouping side-by-side.
- Hazard grouping of category matrix: An inventory of chemical product SDS's can translate to an employer creating a cross-matrix according to hazards that shortens retrieval and response times.
- International uniformity allows companies that work in the global economy to work with less lose of vital information due to errors in translation.
- Easier selection of hazards controls such as personal protection equipment.
- Readily understandable: Since pictograms, once familiarized, are so much easier to recognize at a glance than various texts and non-uniform symbols, employees can have faster warnings.

Hazard Communication Safety Data Sheets

The Hazard Communication Standard (HCS) requires chemical manufacturers, distributors, or importers to provide Safety Data Sheets (SDSs) (formerly known as Material Safety Data Sheets or MSDSs) to communicate the hazards of hazardous chemical products. As of June 1, 2015, the HCS will require new SDSs to be in a

uniform format, and include the section numbers, the headings, and associated information under the headings.

The SDS includes information such as the properties of each chemical; the physical, health, and environmental health hazards; protective measures; and safety precautions for handling, storing, and transporting the chemical. The information contained in the SDS must be in English (although it may be in other languages as well). In addition, OSHA requires that SDS preparers provide specific minimum information as detailed in Appendix D of 29 CFR 1910.1200. The SDS preparers may also include additional information in various section(s).

Sections 1 through 8 contain general information about the chemical, identification, hazards, composition, safe handling practices, and emergency control measures (e.g., fire fighting). This information should be helpful to those that need to get the information quickly. Sections 9 through 11 and 16 contain other technical and scientific information, such as physical and chemical properties, stability and reactivity information, toxicological information, exposure control information, and other information including the date of preparation or last revision. The SDS must also state that no applicable information was found when the preparer does not find relevant information for any required element.

The SDS must also contain Sections 12 through 15, to be consistent with the UN Globally Harmonized System of Classification and Labeling of Chemicals (GHS), but OSHA will not enforce the content of these sections because they concern matters handled by other agencies.

Required Information for SDS for Substances

- Chemical name;
- Common name and synonyms;
- CAS number and other unique identifiers;

- Impurities and stabilizing additives which are themselves classified and which contribute to the classification of the substance.

Required Information for SDS for Mixtures: (In addition to the information required for substances)

- The chemical name and concentration (exact percentage) or concentration ranges of all ingredients which are classified as health hazards in accordance with paragraph (d) of §1910.1200 and
- are present above their cut-off/concentration limits; or
- Present a health risk below the cut-off/concentration limits.
- The concentration (exact percentage) shall be specified unless a trade secret claim is made in accordance with paragraph (i) of §1910.1200, when there is batch-to-batch variability in the production of a mixture, or for a group of substantially similar mixtures (See A.0.5.1.2) with similar chemical composition. In these cases, concentration ranges may be used.

Employer Responsibilities

Employers must ensure that the SDSs are readily accessible to employees for all hazardous chemicals in their workplace. This may be done in many ways. For example, employers may keep the SDSs in a binder or on computers as long as the employees have immediate access to the information without leaving their work area when needed and a back-up is available for rapid access to the SDS in the case of a power outage or other emergency. Furthermore, employers may want to designate a person(s) responsible for obtaining and maintaining the SDSs. If the employer does not have an SDS, the employer or designated person(s) should contact the manufacturer to obtain one.

A description of all 16 sections of the SDS, along with their contents, is presented below:

Section 1: Identification

This section identifies the chemical on the SDS as well as the recommended uses. It also provides the essential contact information of the supplier. The required information consists of:

- Product identifier used on the label and any other common names or synonyms by which the substance is known.
- Name, address, phone number of the manufacturer, importer, or other responsible party, and emergency phone number.
- Recommended use of the chemical (e.g., a brief description of what it actually does, such as flame retardant) and any restrictions on use (including recommendations given by the supplier).

Section 2: Hazard(s) Identification

This section identifies the hazards of the chemical presented on the SDS and the appropriate warning information associated with those hazards. The required information consists of:

- The hazard classification of the chemical (e.g., flammable liquid, category[1]).
- Signal word.
- Hazard statement(s).
- Pictograms (the pictograms or hazard symbols may be presented as graphical reproductions of the symbols in black and white or be a description of the name of the symbol (e.g., skull and crossbones, flame).

- Precautionary statement(s).
- Description of any hazards not otherwise classified.
- For a mixture that contains an ingredient(s) with unknown toxicity, a statement describing how much (percentage) of the mixture consists of ingredient(s) with unknown acute toxicity. Please note that this is a total percentage of the mixture and not tied to the individual ingredient(s).

Section 3: Composition/Information on Ingredients

This section identifies the ingredient(s) contained in the product indicated on the SDS, including impurities and stabilizing additives. This section includes information on substances, mixtures, and all chemicals where a trade secret is claimed. The required information consists of:

Substances

- Chemical name.
- Common name and synonyms.
- Chemical Abstracts Service (CAS) number and other unique identifiers.
- Impurities and stabilizing additives, which are themselves classified and which contribute to the classification of the chemical.

Mixtures

- Same information required for substances.

- The chemical name and concentration (i.e., exact percentage) of all ingredients which are classified as health hazards and are:

  – Present above their cut-off/concentration limits or

- Present a health risk below the cut-off/concentration limits.

- The concentration (exact percentages) of each ingredient must be specified except concentration ranges may be used in the following situations:

  - A trade secret claim is made,
  - There is batch-to-batch variation, or
  - The SDS is used for a group of substantially similar mixtures.

Chemicals where a trade secret is claimed

- A statement that the specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret is required.

Section 4: First-Aid Measures

This section describes the initial care that should be given by untrained responders to an individual who has been exposed to the chemical. The required information consists of:

- Necessary first-aid instructions by relevant routes of exposure (inhalation, skin and eye contact, and ingestion).
- Description of the most important symptoms or effects, and any symptoms that are acute or delayed.
- Recommendations for immediate medical care and special treatment needed, when necessary.

Section 5: Fire-Fighting Measures

This section provides recommendations for fighting a fire caused by the chemical. The required information consists of:

- Recommendations of suitable extinguishing equipment, and information about extinguishing equipment that is not appropriate for a particular situation.
- Advice on specific hazards that develop from the chemical during the fire, such as any hazardous combustion products created when the chemical burns.
- Recommendations on special protective equipment or precautions for firefighters.

Section 6: Accidental Release Measures

This section provides recommendations on the appropriate response to spills, leaks, or releases, including containment and cleanup practices to prevent or minimize exposure to people, properties, or the environment. It may also include recommendations distinguishing between responses for large and small spills where the spill volume has a significant impact on the hazard. The required information may consist of recommendations for:

- Use of personal precautions (such as removal of ignition sources or providing sufficient ventilation) and protective equipment to prevent the contamination of skin, eyes, and clothing.
- Emergency procedures, including instructions for evacuations, consulting experts when needed, and appropriate protective clothing.
- Methods and materials used for containment (e.g., covering the drains and capping procedures).
- Cleanup procedures (e.g., appropriate techniques for neutralization, decontamination, cleaning or vacuuming; adsorbent materials; and/or equipment

required for containment/clean up)

Section 7: Handling and Storage

This section provides guidance on the safe handling practices and conditions for safe storage of chemicals. The required information consists of:

- Precautions for safe handling, including recommendations for handling incompatible chemicals, minimizing the release of the chemical into the environment, and providing advice on general hygiene practices (e.g., eating, drinking, and smoking in work areas is prohibited).

Recommendations on the conditions for safe storage, including any incompatibilities. Provide advice on specific storage requirements (e.g., ventilation requirements)

Section 8: Exposure Controls/Personal Protection

This section indicates the exposure limits, engineering controls, and personal protective measures that can be used to minimize worker exposure. The required information consists of:

- OSHA Permissible Exposure Limits (PELs), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the safety data sheet, where available.
- Appropriate engineering controls (e.g., use local exhaust ventilation, or use only in an enclosed system).

- Recommendations for personal protective measures to prevent illness or injury from exposure to chemicals, such as personal protective equipment (PPE) (e.g., appropriate types of eye, face, skin or respiratory protection needed based on

hazards and potential exposure).

- Any special requirements for PPE, protective clothing or respirators (e.g., type of glove material, such as PVC or nitrile rubber gloves; and breakthrough time of the glove material).

Section 9: Physical and Chemical Properties

This section identifies physical and chemical properties associated with the substance or mixture. The minimum required information consists of:

- Appearance (physical state, color, etc.);
- Upper/lower flammability or explosive limits;
- Odor;
- Vapor pressure;
- Odor threshold;
- Vapor density;
- pH;
- Relative density;
- Melting point/freezing point;
- Solubility(ies);
- Initial boiling point and boiling range;
- Flash point;
- Evaporation rate;
- Flammability (solid, gas);
- Upper/lower flammability or explosive limits;
- Vapor pressure;
- Vapor density;
- Relative density;
- Solubility(ies);

- Partition coefficient: n-octanol/water;
- Auto-ignition temperature;
- Decomposition temperature; and
- Viscosity.

The SDS may not contain every item on the above list because information may not be relevant or is not available. When this occurs, a notation to that effect must be made for that chemical property. Manufacturers may also add other relevant properties, such as the dust deflagration index (Kst) for combustible dust, used to evaluate a dust's explosive potential

Section 10: Stability and Reactivity

This section describes the reactivity hazards of the chemical and the chemical stability information. This section is broken into three parts: reactivity, chemical stability, and other. The required information consists of:

Reactivity

- Description of the specific test data for the chemical(s). This data can be for a class or family of the chemical if such data adequately represent the anticipated hazard of the chemical(s), where available.

Chemical stability

- Indication of whether the chemical is stable or unstable under normal ambient temperature and conditions while in storage and being handled.
- Description of any stabilizers that may be needed to maintain chemical stability.
- Indication of any safety issues that may arise should the product change in physical appearance.
- **Other**

- Indication of the possibility of hazardous reactions, including a statement whether the chemical will react or polymerize, which could release excess pressure or heat, or create other hazardous conditions. Also, a description of the conditions under which hazardous reactions may occur.
- List of all conditions that should be avoided (e.g., static discharge, shock, vibrations, or environmental conditions that may lead to hazardous conditions).
- List of all classes of incompatible materials (e.g., classes of chemicals or specific substances) with which the chemical could react to produce a hazardous situation.
- List of any known or anticipated hazardous decomposition products that could be produced because of use, storage, or heating. (Hazardous combustion products should also be included in Section 5 (Fire-Fighting Measures) of the SDS.)

Section 11: Toxicological Information

This section identifies toxicological and health effects information or indicates that such data are not available. The required information consists of:

- Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact). The SDS should indicate if the information is unknown.
- Description of the delayed, immediate, or chronic effects from short- and long-term exposure.
- The numerical measures of toxicity (e.g., acute toxicity estimates such as the LD50 (median lethal dose)) - the estimated amount [of a substance] expected to kill 50% of test animals in a single dose.
- Description of the symptoms. This description includes the symptoms associated with exposure to the chemical including symptoms from the lowest to the most severe exposure.
- Indication of whether the chemical is listed in the National Toxicology Program

(NTP) Report on Carcinogens (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) Monographs (latest editions) or found to be a potential carcinogen by OSHA

Section 12: Ecological Information (non-mandatory)

This section provides information to evaluate the environmental impact of the chemical(s) if it were released to the environment. The information may include:

- Data from toxicity tests performed on aquatic and/or terrestrial organisms, where available (e.g., acute or chronic aquatic toxicity data for fish, algae, crustaceans, and other plants; toxicity data on birds, bees, plants).
- Whether there is a potential for the chemical to persist and degrade in the environment either through biodegradation or other processes, such as oxidation or hydrolysis.
- Results of tests of bioaccumulation potential, making reference to the octanol-water partition coefficient (Kow) and the bioconcentration factor (BCF), where available.
- The potential for a substance to move from the soil to the groundwater (indicate results from adsorption studies or leaching studies).
- Other adverse effects (e.g., environmental fate, ozone layer depletion potential, photochemical ozone creation potential, endocrine disrupting potential, and/or global warming potential).

Section 13: Disposal Considerations (non-mandatory)

This section provides guidance on proper disposal practices, recycling or reclamation of the chemical(s) or its container, and safe handling practices. To minimize exposure, this section should also refer the reader to Section 8 (Exposure Controls/Personal

Protection) of the SDS. The information may include:

- Description of appropriate disposal containers to use.
- Recommendations of appropriate disposal methods to employ.
- Description of the physical and chemical properties that may affect disposal activities.
- Language discouraging sewage disposal.
- Any special precautions for landfills or incineration activities

Section 14: Transport Information (non-mandatory)

This section provides guidance on classification information for shipping and transporting of hazardous chemical(s) by road, air, rail, or sea. The information may include:

- UN number (i.e., four-figure identification number of the substance)[1].
- UN proper shipping name[1].
- Transport hazard class(es)[1].
- Packing group number, if applicable, based on the degree of hazard[2].
- Environmental hazards (e.g., identify if it is a marine pollutant according to the International Maritime Dangerous Goods Code (IMDG Code)).
- Guidance on transport in bulk (according to Annex II of MARPOL 73/78[3] and the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (International Bulk Chemical Code (IBC Code)).
- Any special precautions which an employee should be aware of or needs to comply with, in connection with transport or conveyance either within or outside their premises (indicate when information is not available).

Section 15: Regulatory Information (non-mandatory)

This section identifies the safety, health, and environmental regulations specific for the product that is not indicated anywhere else on the SDS. The information may include:

- Any national and/or regional regulatory information of the chemical or mixtures (including any OSHA, Department of Transportation, Environmental Protection Agency, or Consumer Product Safety Commission regulations)

Section 16: Other Information

This section indicates when the SDS was prepared or when the last known revision was made. The SDS may also state where the changes have been made to the previous version. You may wish to contact the supplier for an explanation of the changes. Other useful information also may be included here.

*Note: Since other Agencies regulate this information, OSHA will not be enforcing Sections 12 through 15(29 CFR 1910.1200(g)(2)).

Employers must ensure that SDSs are readily accessible to employees.
See Appendix D of 1910.1200 for a detailed description of SDS contents.

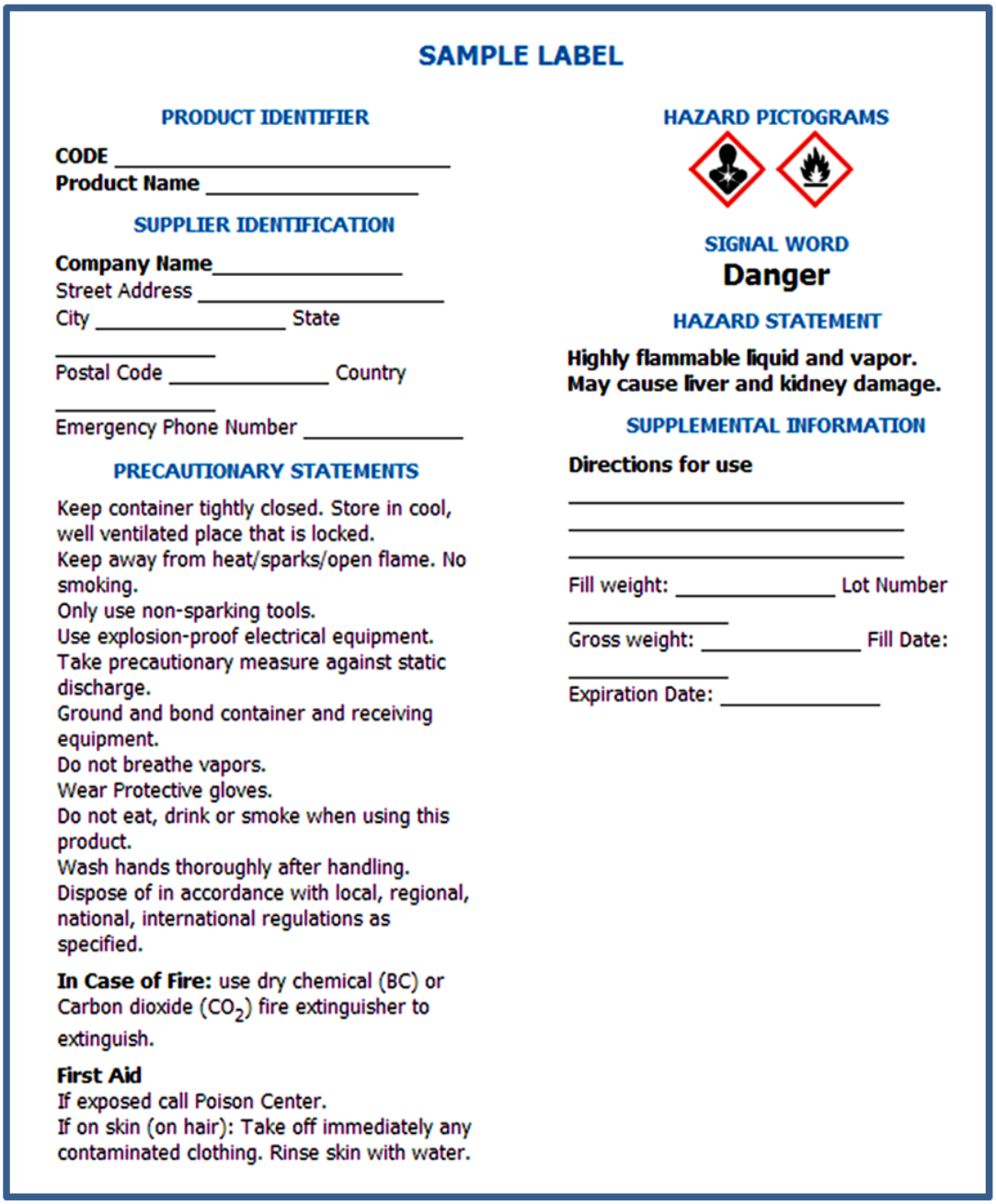
Hazard Communication Standard Pictogram

As of June 1, 2015, the Hazard Communication Standard (HCS) will require pictograms on labels to alert users of the chemical hazards to which they may be exposed. Each pictogram consists of a symbol on a white background framed within a red border and represents a distinct hazard(s). The pictogram on the label is determined by the chemical hazard classification.

Health Hazard  •Carcinogen •Mutagenicity •Reproductive Toxicity •Respiratory Sensitizer •Target Organ Toxicity •Aspiration Toxicity	**Flame**  •Flammables •Pyrophorics •Self-Heating •Emits Flammable Gas •Self-Reactives •Organic Peroxides	**Exclamation Mark**  •Irritant (skin and eye) •Skin Sensitizer •Acute Toxicity •Narcotic Effects •Respiratory Tract Irritant •Hazardous to Ozone Layer (Non-Mandatory)
Gas Cylinder  •Gases Under Pressure	**Corrosion**  •Skin Corrosion/Burns •Eye Damage •Corrosive to Metals	**Exploding Bomb**  •Explosives •Self-Reactives •Organic Peroxides
Flame Over Circle  Oxidizers	**Skull and Crossbones**  Acute Toxicity (fatal or toxic)	**Environment (OSHA Non-Mandatory)**  Aquatic Toxicity

Hazard Communication Standard Labels

OSHA has updated the requirements for labeling of hazardous chemicals under its Hazard Communication Standard (HCS). As of June 1, 2015, all labels will be required to have pictograms, a signal word, hazard and precautionary statements, the product identifier, and supplier identification.



SAMPLE LABEL

PRODUCT IDENTIFIER

CODE _____
Product Name _____

SUPPLIER IDENTIFICATION

Company Name_____
Street Address _____
City _____ State _____
Postal Code _____ Country _____
Emergency Phone Number _____

PRECAUTIONARY STATEMENTS

Keep container tightly closed. Store in cool, well ventilated place that is locked.
Keep away from heat/sparks/open flame. No smoking.
Only use non-sparking tools.
Use explosion-proof electrical equipment.
Take precautionary measure against static discharge.
Ground and bond container and receiving equipment.
Do not breathe vapors.
Wear Protective gloves.
Do not eat, drink or smoke when using this product.
Wash hands thoroughly after handling.
Dispose of in accordance with local, regional, national, international regulations as specified.

In Case of Fire: use dry chemical (BC) or Carbon dioxide (CO_2) fire extinguisher to extinguish.

First Aid
If exposed call Poison Center.
If on skin (on hair): Take off immediately any contaminated clothing. Rinse skin with water.

HAZARD PICTOGRAMS

SIGNAL WORD
Danger

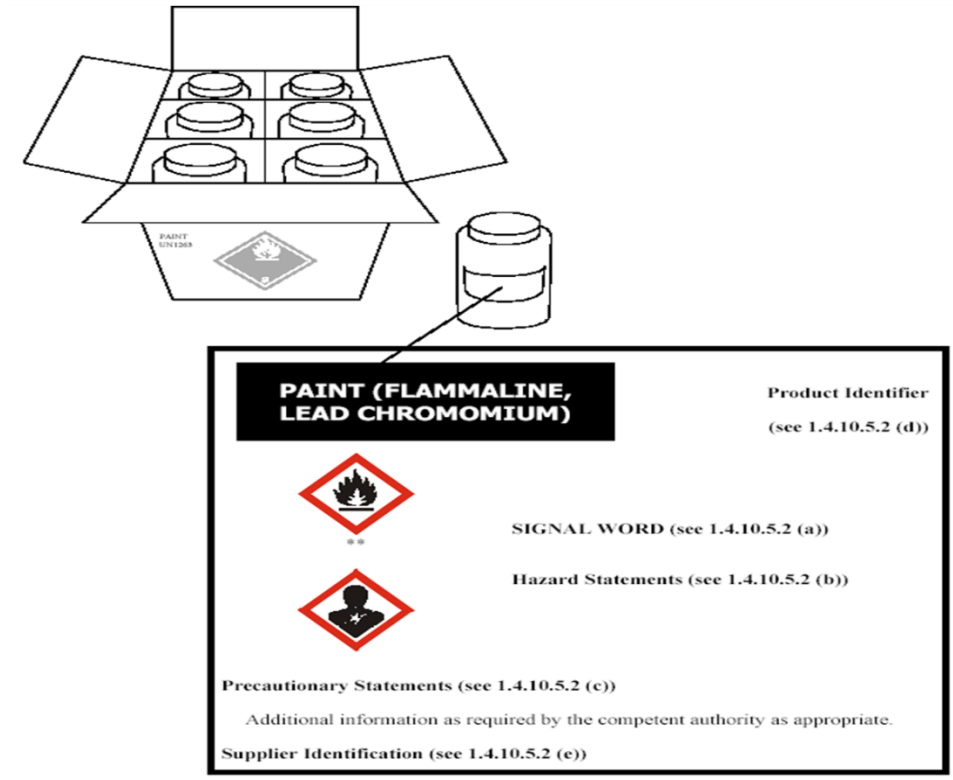
HAZARD STATEMENT

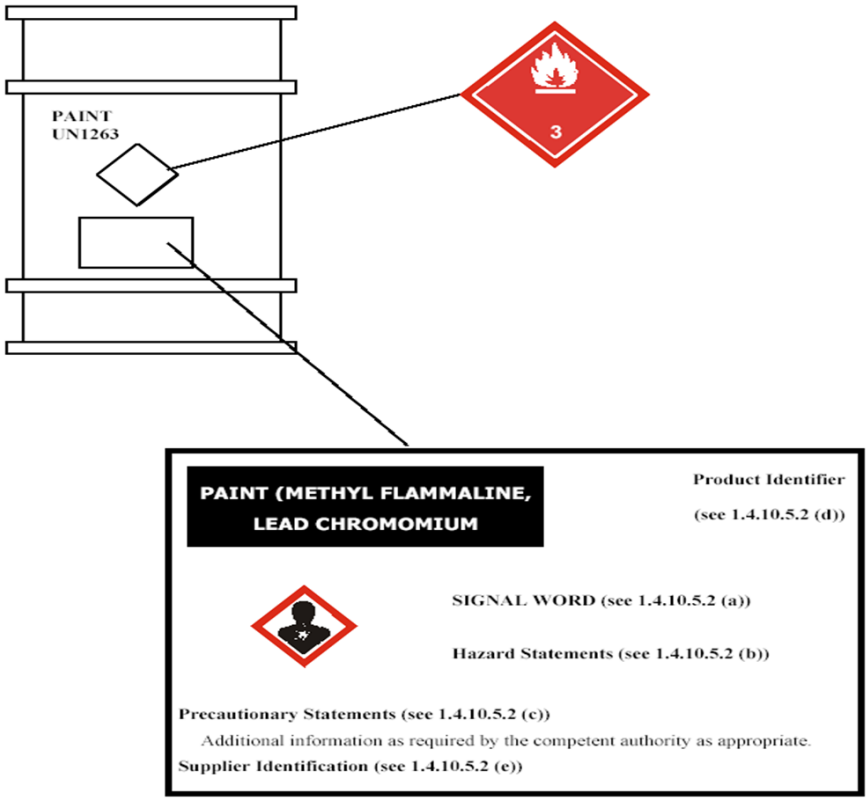
Highly flammable liquid and vapor.
May cause liver and kidney damage.

SUPPLEMENTAL INFORMATION

Directions for use
_____
_____
_____

Fill weight: _____ Lot Number _____
Gross weight: _____ Fill Date: _____
Expiration Date: _____


PAINT (FLAMMALINE, LEAD CHROMOMIUM)
Product Identifier
(see 1.4.10.5.2 (d))
**
SIGNAL WORD (see 1.4.10.5.2 (a))
Hazard Statements (see 1.4.10.5.2 (b))
Precautionary Statements (see 1.4.10.5.2 (c))
Additional information as required by the competent authority as appropriate.
Supplier Identification (see 1.4.10.5.2 (e))


PAINT
UN1263
3
PAINT (METHYL FLAMMALINE, LEAD CHROMOMIUM
Product Identifier
(see 1.4.10.5.2 (d))
SIGNAL WORD (see 1.4.10.5.2 (a))
Hazard Statements (see 1.4.10.5.2 (b))
Precautionary Statements (see 1.4.10.5.2 (c))
Additional information as required by the competent authority as appropriate.
Supplier Identification (see 1.4.10.5.2 (e))

Section Three: Job Hazard Analysis

- Safety Process
  - Assess
  - Plan and Control (hierarchy of controls)
  - Train
  - Implement
  - Monitor
  - Re-Assess
- Routes of Entry (Exposure)
  - Absorption
  - Ingestion
  - Inhalation
  - Injection
  - (The front door into your home)

Routes of exposure

How can chemicals enter the body?

Exposure normally occurs through inhalation, skin or eye contact, and ingestion.

Inhalation The most common type of exposure occurs when you breathe a substance into the lungs. The lungs consist of branching airways (called bronchi) with clusters of tiny air sacs (called alveoli) at the ends of the airways. The alveoli absorb oxygen and other chemicals into the bloodstream.

Some chemicals are irritants and cause nose or throat irritation. They may also cause discomfort, coughing, or chest pain when they are inhaled and come into contact with the bronchi (chemical bronchitis). Other chemicals may be inhaled without causing such warning symptoms, but they still can be dangerous.

Sometimes a chemical is present in the air as small particles (dust or mist). Some of these particles, depending on their size, may be deposited in the bronchi and/or alveoli. Many of them may be coughed out, but others may stay in the lungs and may cause lung damage. Some particles may dissolve and be absorbed into the blood stream, and have effects elsewhere in the body.

Skin Contact The skin is a protective barrier that helps keep foreign chemicals out of the body. However, some chemicals can easily pass through the skin and enter the bloodstream. If the skin is cut or cracked, chemicals can penetrate through the skin more easily. Also, some caustic substances, like strong acids and alkalis, can chemically burn the skin. Others can irritate the skin. Many chemicals, particularly organic solvents, dissolve the oils in the skin, leaving it dry, cracked, and susceptible to infection and absorption of other chemicals.

Eye Contact Some chemicals may burn or irritate the eye. Occasionally they may be absorbed through the eye and enter the bloodstream. The eyes are easily harmed by chemicals, so any eye contact with chemicals should be taken as a serious incident.

I**ngestion** The least common source of exposure in the workplace is swallowing chemicals. Chemicals can be ingested if they are left on hands, clothing or beard, or accidentally contaminate food, drinks or cigarettes. Chemicals present in the workplace as dust, for example, metal dusts such as lead or cadmium, are easily ingested.

Remember: Your front door could be a *Route of Entry* for bringing contaminants home from work and exposing family members

Hierarchy of Controls (Eliminate, Prevent, Protect)

- Eliminate
- Substitution
- Prefabrication
- Isolation
- Ventilation
- Work Practice Controls
- Leak Detection Programs
- Storage and Handling Procedures
- Training
- Modifying the Work
- Job Rotation
- Personal Protection Equipment

Section Four: Nature of Chemical Hazards

It is long standing principle that knowing the nature of a hazard allows greater prevention, protection and avoidance. Unlike other workplace hazards, chemical hazards are often difficult to sense since we cannot readily see at a molecular level. However a basic understanding starts with a few assumptions; first what we don't understand can harm us and second chemicals contain energy. Dr. William Haddon Jr. a physician with degrees from the Massachusetts Institute of Technology, Harvard Medical School and Harvard School of Public Health and the first director of the National Highway Traffic Safety Administration, proposed a general idea that accidents and injuries involve the transfer of energy. His theory is known as the Energy Release Theory, it poses that objects, events, or environments interaction with people cause harm. Many sources of energy are obvious to us such as the moving parts of a machine, motor vehicles, projectiles, gravity, or even wind and weather systems yet we

often overlook the tremendous energy found in chemicals simply because we cannot see the energy.

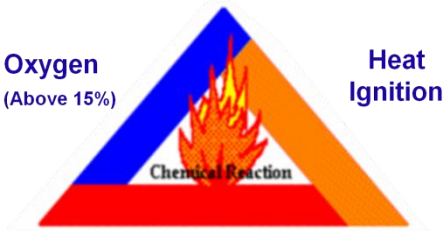
Various concepts such as those that surround permissible exposure limits, flammability, reactivity, oxygen, heat, pressure, specific gravity, relative vapor density, caustics and corrosives, toxins, carcinogens, mutagens and Teratogens will be explained in easy to understand pedagogy and connected to various chemicals and states of matter.

The Nature of Chemical Hazards

- The Nature of Flammables
- The Nature of Reactive agents
- Corrosives and Caustics
- The Nature and Effects of oxygen
- The Nature and Effects of temperature pressure
- Specific gravity and relative vapor density
- Toxins, Carcinogens, Mutagens and Teratogens

The Nature of Flammables

The Fire Triangle



All 3 things must be present

Fire Classifications

Fires are classified according to the type of fuel that is burning

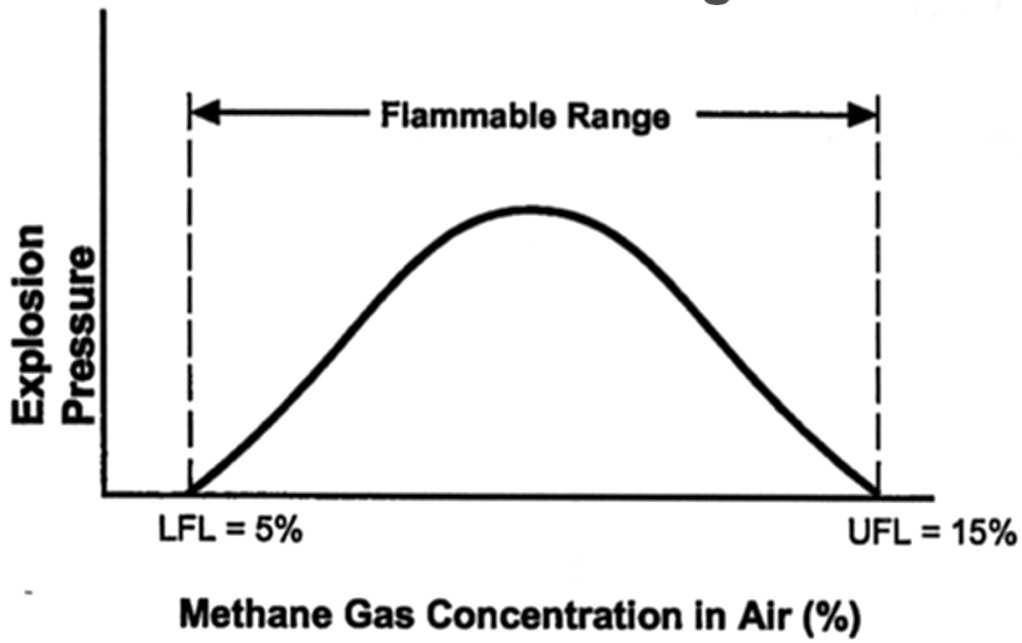
Class A - ordinary combustibles 

Class B - flammable liquids 

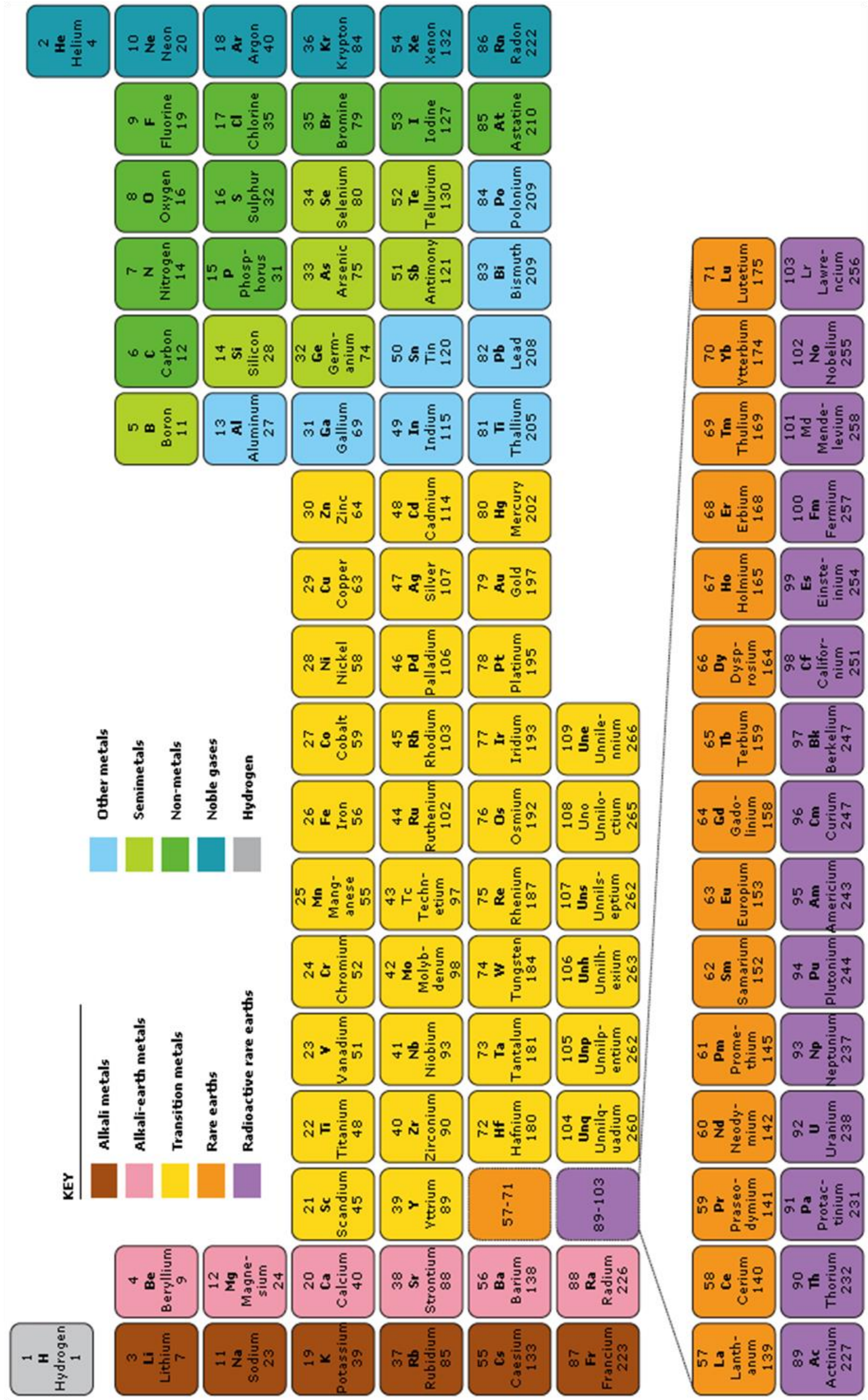
Class C - electrical fires 

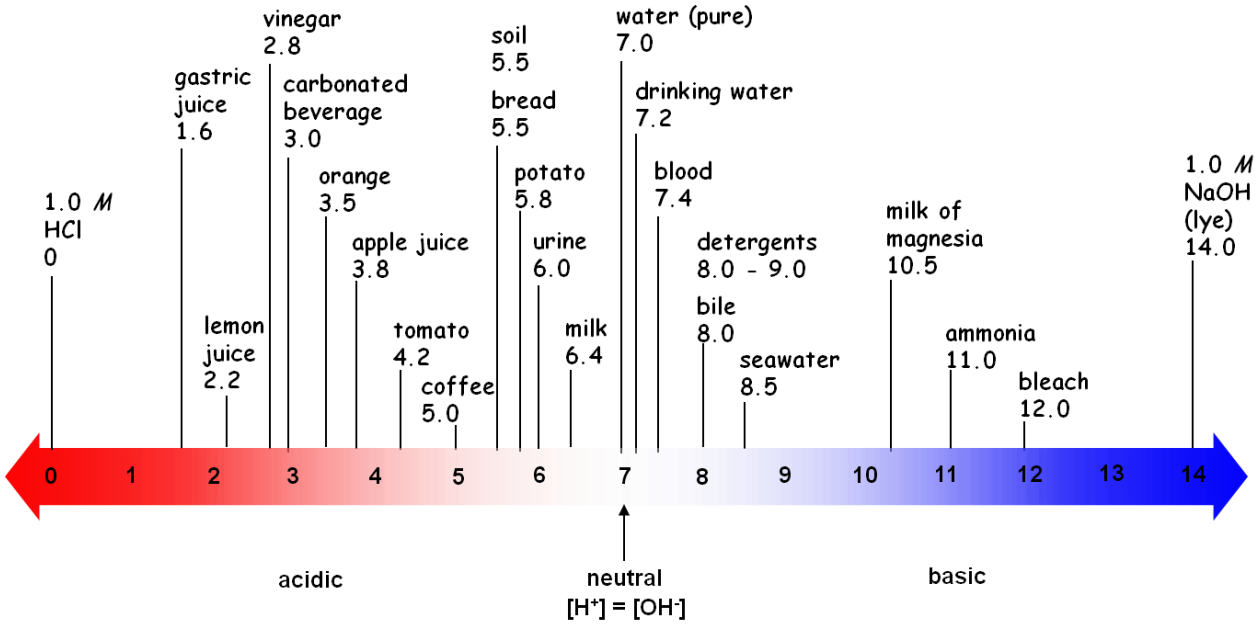
Class D - metals fires 

The LFL and UFL and The Flammable Range



The Nature of Reactive agents **Periodic Table**


KEY
Alkali metals
Alkali-earth metals
Transition metals
Rare earths
Radioactive rare earths
Other metals
Semimetals
Non-metals
Noble gases
Hydrogen
1 H Hydrogen 1
2 He Helium 4
3 Li Lithium 7
4 Be Beryllium 9
5 B Boron 11
6 C Carbon 12
7 N Nitrogen 14
8 O Oxygen 16
9 F Fluorine 19
10 Ne Neon 20
11 Na Sodium 23
12 Mg Magne-sium 24
13 Al Aluminum 27
14 Si Silicon 28
15 P Phosp-horus 31
16 S Sulphur 32
17 Cl Chlorine 35
18 Ar Argon 40
19 K Potassium 39
20 Ca Calcium 40
21 Sc Scandium 45
22 Ti Titanium 48
23 V Vanadium 51
24 Cr Chromium 52
25 Mn Mang-anese 55
26 Fe Iron 56
27 Co Cobalt 59
28 Ni Nickel 58
29 Cu Copper 63
30 Zn Zinc 64
31 Ga Gallium 69
32 Ge Germ-anium 74
33 As Arsenic 75
34 Se Selenium 80
35 Br Bromine 79
36 Kr Krypton 84
37 Rb Rubidium 85
38 Sr Strontium 88
39 Y Yttrium 89
40 Zr Zirconium 90
41 Nb Niobium 93
42 Mo Molyb-denum 98
43 Tc Techn-etium 97
44 Ru Ruthenium 102
45 Rh Rhodium 103
46 Pd Palladium 106
47 Ag Silver 107
48 Cd Cadmium 114
49 In Indium 115
50 Sn Tin 120
51 Sb Antimony 121
52 Te Tellurium 130
53 I Iodine 127
54 Xe Xenon 132
55 Cs Caesium 133
56 Ba Barium 138
57-71
72 Hf Hafnium 180
73 Ta Tantalum 181
74 W Tungsten 184
75 Re Rhenium 187
76 Os Osmium 192
77 Ir Iridium 193
78 Pt Platinum 195
79 Au Gold 197
80 Hg Mercury 202
81 Tl Thallium 205
82 Pb Lead 208
83 Bi Bismuth 209
84 Po Polonium 209
85 At Astatine 210
86 Rn Radon 222
87 Fr Francium 223
88 Ra Radium 226
89-103
104 Unq Unnilq-uadium 260
105 Unp Unnilp-entium 262
106 Unh Unnilh-exium 263
107 Uns Unnils-eptium 262
108 Uno Unnilo-ctium 265
109 Une Unnile-nnium 266
57 La Lanth-anum 139
58 Ce Cerium 140
59 Pr Praseo-dymium 141
60 Nd Neody-mium 142
61 Pm Prome-thium 145
62 Sm Samarium 152
63 Eu Europium 153
64 Gd Gado-linium 158
65 Tb Terbium 159
66 Dy Dysp-rosium 164
67 Ho Holmium 165
68 Er Erbium 168
69 Tm Thulium 169
70 Yb Ytterbium 174
71 Lu Lutetium 175
89 Ac Actinium 227
90 Th Thorium 232
91 Pa Protac-tinium 231
92 U Uranium 238
93 Np Neptunium 237
94 Pu Plutonium 244
95 Am Americium 243
96 Cm Curium 247
97 Bk Berkelium 247
98 Cf Califor-nium 251
99 Es Einste-inium 254
100 Fm Fermium 257
101 Md Mende-levium 258
102 No Nobelium 255
103 Lr Lawre-ncium 256


1.0 M HCl 0
gastric juice 1.6
lemon juice 2.2
vinegar 2.8
carbonated beverage 3.0
orange 3.5
apple juice 3.8
tomato 4.2
coffee 5.0
soil 5.5
bread 5.5
potato 5.8
urine 6.0
milk 6.4
water (pure) 7.0
drinking water 7.2
blood 7.4
bile 8.0
detergents 8.0 - 9.0
seawater 8.5
milk of magnesia 10.5
ammonia 11.0
bleach 12.0
1.0 M NaOH (lye) 14.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
acidic
neutral
[H+] = [OH-]
basic

The Nature and Effects of oxygen

- Oxygen is essential to life. Its normal concentration in the air we breathe is approximately 21 % (20.9%)
- OSHA 19.5 % to 23.5 %
- We can breathe in a 50-60% oxygen enriched atmosphere for several hours under medical care (oxygen therapy)
- Oxygen is not flammable but supports combustion.
- Most materials burn fiercely sometimes explosively in oxygen.
- As the oxygen concentration in air increases, the potential fire risk increases. Oxygen enrichment cannot be detected by the human senses
- At concentrations above 23.5 % in air, the situation becomes dangerous due to the increased fire hazard.
- Oxygen is colourless, tasteless and has no odour.
- Oxygen is heavier than air, oxygen can accumulate in low lying areas. such as pits or underground rooms especially in cases of liquid spillage.
- 3 Means of losing oxygen
  - Displacement
  - Consomption
  - Reaction

Oxidizing Agents

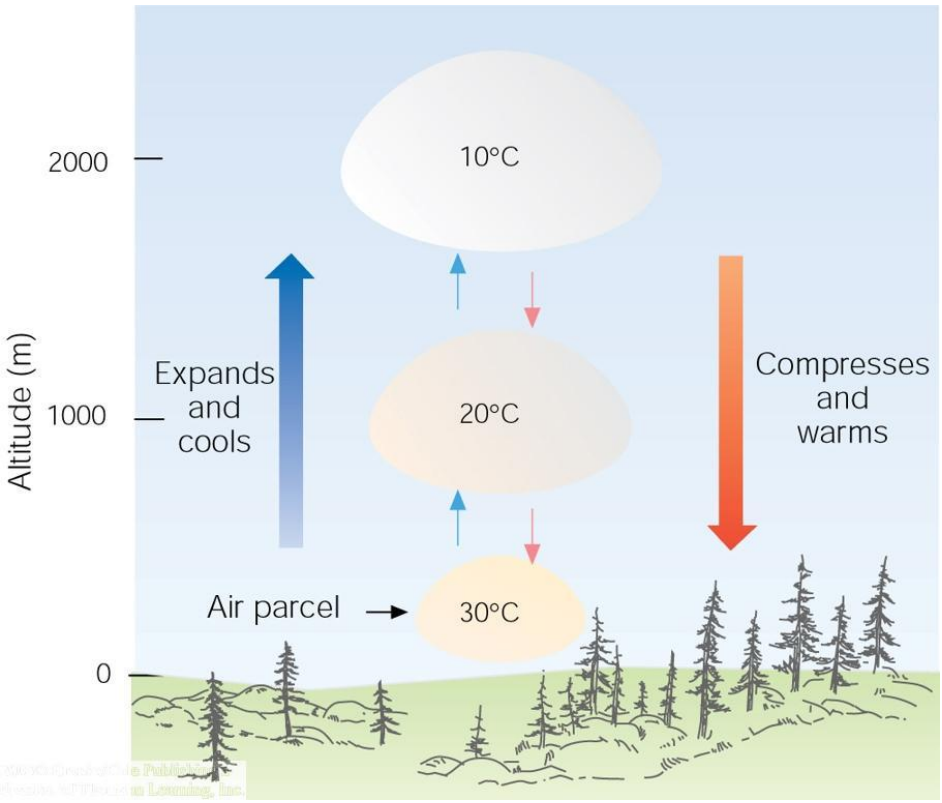
An oxidizing agent is a chemical substance that reacts with another chemical called the reactant and results in the removal electrons. This reaction is referred to as a redox chemical reaction and can in some oxidizers release a great deal of chemical energy, which has the potential to cause injury, illness and damage.

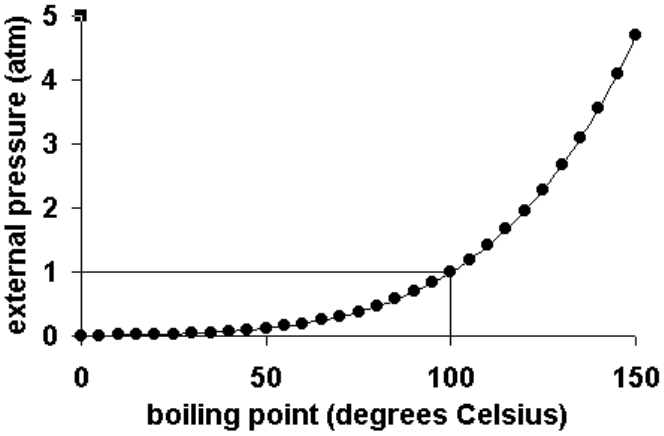
Common Oxidizing Agents

- Oxygen (O_2)
- Ozone (O_3)
- Hydrogen peroxide (H_2O_2) and other inorganic peroxides
- Fluorine (F_2), chlorine (Cl_2), and other halogens
- Hexavalent chromium compounds such as chromic and dichromic acids and chromium trioxide, pyridinium chlorochromate (PCC), and chromate/dichromate compounds
- Permanganate compounds such as $KMnO_4$
- Sodium perborate
- Nitric acid (HNO_3) and nitrate compounds
- Sulfuric acid (H_2SO_4)
- Peroxydisulfuric acid ($H_2S_2O_8$)
- Peroxymonosulfuric acid (H_2SO_5)
- Chlorite, chlorate, perchlorate, and other analogous halogen compounds
- Hypochlorite and other hypohalite compounds, including household bleach (NaClO)
- Nitrous oxide (N_2O)
- Silver oxide (Ag_2O)
- Osmium tetroxide (OsO_4)

The Nature and Effects of Temperature and Pressure

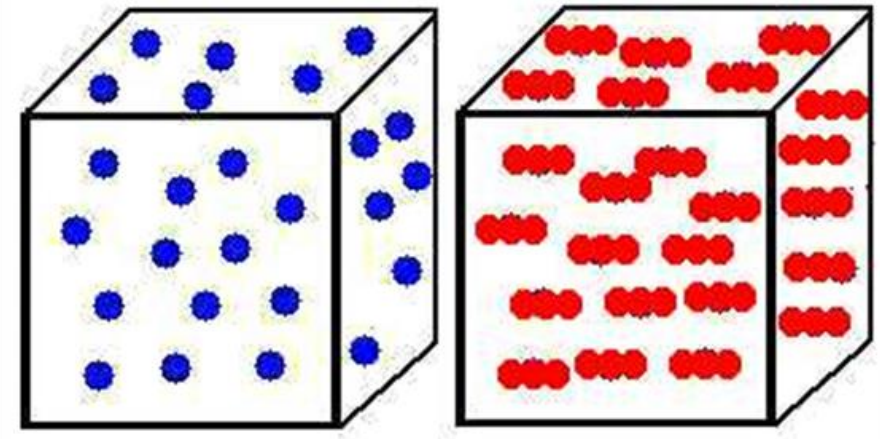
Boiling Points: As a liquid is heated, its vapor pressure increases until the vapor pressure equals the pressure of the gas above I The temperature of a boiling liquid remains constant, even when more heat is added yet the liquid change state into a vapor. Pressure (altitude) and temperature can affect the states of matter.





Specific gravity and relative vapor density

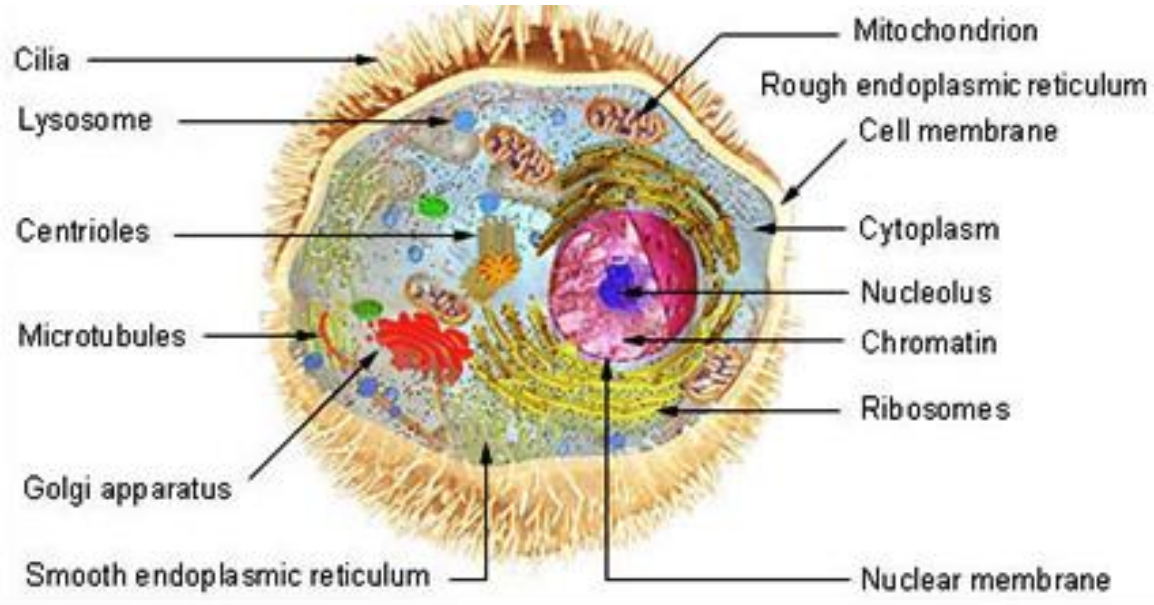
Specific gravity and vapor density comparative measurements based on the respective relative weight of a liquid and a gas or vapor compared to water or air. This “weight” of water or air is an arbitrary value of one (1). If a gas has a vapor density of less than one it will generally rise in air. If the vapor density is greater than one the gas will generally sink in air. Propane for example has a vapor density of 1.554, so it will sink in air, the vapor density of helium is 0.145 so it is significantly lighter than air so it will rise. Acetone is twice as heavy as air so its vapor density is 2. Mercury vapor is nearly seven times heavier the air. As you would imagine, the density of a chemical has great safety and health implications for example storage of chemicals especially flammables, oxidizers or other highly reactive chemicals that can displace air, possibly presenting hazard to employees.



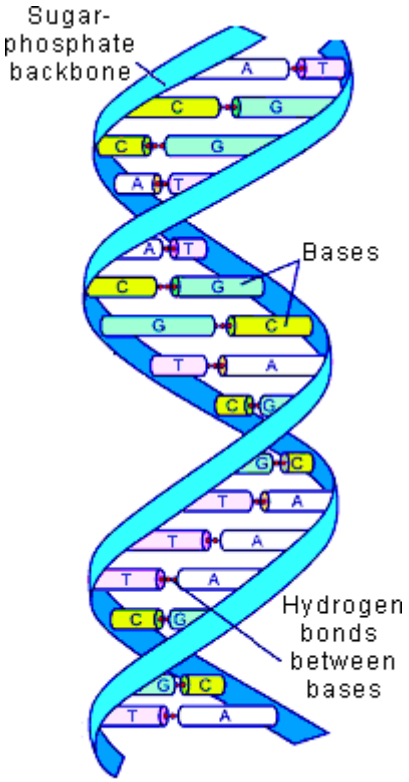
Helium **Carbon Dioxide**

Molecular Weight 4g **Molecular Weight 44g**

Toxins Carcinogens, Mutagens and Teratogens



Structure of Eukaryotic Cell



Structure of Deoxyribonucleic DNA

Section Five: Summary and Debriefing

Notes:

Appendix A: Abbreviations

Abbreviations

ANSI	American National Standards Institute
ATE	Acute toxicity estimate (ATE)
CIH	Certified Industrial Hygienist (See http://www.abih.org for more information)
CDZ	Controlled Decking Zones
CSP	Certified Safety Professional (See http://www.bcsp.org for more information)
HASP	Health & Safety Plan
JHA	Job Hazard Analysis
JSA	Job Safety Analysis

MOC	Management of Change
OPHP	Office of Public Health Practice
OSHA	Occupational Safety & Health Act or Administration
PFAS	Personal Fall Arrest System
PPE	Personal Protective Equipment
SPH	School of Public Health
UMDNJ	University of Medicine & Dentistry of New Jersey
VPP	Voluntary Protection Program

Appendix B: Definitions & Desk Reference

ACGIH American Conference of Governmental Industrial Hygienists, which develops and publishes recommended occupational exposure limits for hundreds of chemical substances and physical agents. See TLV.

Acid Any chemical with a low pH that in water solution can burn the skin or eyes. Acids turn litmus paper red and have pH values of 0 to 6.

Action level Term used by OSHA and NIOSH to express the level of toxicant which requires medical surveillance, usually one half of the PEL.

Activated charcoal Charcoal is an amorphous form of carbon formed by burning wood, nutshells, animal bones, and other carbonaceous materials. Charcoal becomes activated by heating it with steam to 800-900^{o}C. During this treatment, a porous, submicroscopic internal structure is formed which gives it an extensive internal surface area. Activated charcoal is commonly used as a gas or vapor adsorbent in air-purifying respirators and as a solid sorbent in air-sampling.

Acute Effect Adverse effect on a human or animal which has severe symptoms developing rapidly and coming quickly to a crisis. Also see "chronic effect."

Acute toxicity refers to those adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours

Adverse effects on sexual function and fertility means any effect of chemicals that interferes with reproductive ability or sexual capacity. This includes, but is not limited to, alterations to the female and male reproductive system, adverse effects on onset of puberty, gamete production and transport, reproductive cycle normality, sexual behaviour, fertility, parturition, pregnancy outcomes, premature reproductive senescence, or modifications in other functions that are dependent on the integrity of the reproductive systems.

Adverse effects on development of the offspring means any effect of chemicals which interferes with normal development of the conceptus either before or after birth, which is induced during pregnancy or results from parental exposure. These effects can be manifested at any point in the life span of the organism. The major manifestations of developmental toxicity include death of the developing organism, structural abnormality, altered growth and functional deficiency.

Adsorption is the condensation of gases, liquids, or dissolved substances on the surfaces of solids.

AIHA American Industrial Hygiene Association.

Air. The mixture of gases that surrounds the earth; its major components are as follows: 78.08% nitrogen, 20.95% oxygen, 0.03% carbon dioxide, and 0.93% argon. Water vapor (humidity) varies.

Air-line respirator. A respirator that is connected to a compressed breathing air source by a hose of small inside diameter. The air is delivered continuously or intermittently in a sufficient volume to meet the wearer's breathing requirements.

Air-purifying respirator. A respirator that uses chemicals to remove specific gases and vapors form the air or that uses a mechanical filter to remove particulate matter. An air-purifying respirator must only be used when there is sufficient oxygen to sustain life and the air contaminant level is below the concentration limits of the device.

Aldehydes consist of any class of highly reactive organic compounds brought about by oxidation of certain alcohols and containing carbon, hydrogen and oxygen (CHO).
Alkali. Any chemical with a high pH that in water solution is irritating or caustic to the skin. Strong alkalies in solution are corrosive to the skin and mucous membranes. Example: sodium hydroxide, referred to as caustic soda or lye. Alkalis turn litmus paper blue and have pH values from 8 to 14. Another term for alkali is base.

Allergy. An abnormal response of a hypersensitive person to chemical and physical stimuli. Allergic manifestations of major importance occur in about 10 percent of the population.

ANSI. The American National Standards Institute is a voluntary membership organization (run with private funding) that develops consensus standards nationally for a wide variety of devices and procedures.

Aerosol means any non-refillable receptacle containing a gas compressed, liquefied or dissolved under pressure, and fitted with a release device allowing the contents to be ejected as particles in suspension in a gas, or as a foam, paste, powder, liquid or gas.

Article means a manufactured item other than a fluid or particle: (i) which is formed to a specific shape or design during manufacture; (ii) which has end use function(s) dependent in whole or in part upon its shape or design during end use; and (iii) which under normal conditions of use does not release more than very small quantities, *e.g.*,

minute or trace amounts of a hazardous chemical (as determined under paragraph (d) of this section), and does not pose a physical hazard or health risk to employees

Aspiration means the entry of a liquid or solid chemical directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system. Aspiration toxicity includes severe acute effects such as chemical pneumonia, varying degrees of pulmonary injury or death. Aspiration is initiated at the moment of inspiration, in the time required to take one breath, as the causative material lodges at the crossroad of the upper respiratory and digestive tracts in the laryngopharyngeal region.

ASTM. American Society for Testing and Materials.

Atmosphere-supplying respirator. A respirator that provides breathing air from a source independent of the surrounding atmosphere. There are two types: air-line and self-contained breathing apparatus.

Atmospheric pressure. The pressure exerted in all directions by the atmosphere. At sea level, mean atmospheric pressure is 29.92 inches Hg, 14.7 psi, or 407 inches w.g.

Base. A compound that reacts with an acid to form a salt. It is another term for alkali.

Benign. Not malignant. A benign tumor is one which does not metastasize or invade tissue. Benign tumors may still be lethal, due to pressure on vital organs.

Biohazard. A combination of the words biological hazard. Organisms or products of organisms that present a risk to humans.

Boiling point. The temperature at which the vapor pressure of a liquid equals atmospheric pressure.

Carbon monoxide. A colorless, odorless toxic gas produced by any process that involves the incomplete combustion of carbon-containing substances. It is emitted through the exhaust of gasoline powered vehicles.

Carcinogen means a substance or a mixture of substances which induce cancer or increase its incidence. Substances and mixtures which have induced benign and malignant tumors in well-performed experimental studies on animals are considered also to be presumed or suspected human carcinogens unless there is strong evidence that the mechanism of tumor formation is not relevant for humans.

CAS. Chemical Abstracts Service is an organization under the American Chemical Society. CAS abstracts and indexes chemical literature from all over the world in "Chemical Abstracts." "CAS Numbers" are used to identify specific chemicals or mixtures.

Ceiling limit (C). An airborne concentration of a toxic substance in the work environment, which should never be exceeded.

CERCLA. Comprehensive Environmental Response, Compensation and Liability Act of 1980. Commonly known as "Superfund." (US EPA)

Chemical means any substance, or mixture of substances.

Chemical cartridge respirator. A respirator that uses various chemical substances to purify inhaled air of certain gases and vapors. This type respirator is effective for concentrations no more than ten times the TLV of the contaminant, if the contaminant has warning properties (odor or irritation) below the TLV.

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

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

Classification means to identify the relevant data regarding the hazards of a chemical; review those data to ascertain the hazards associated with the chemical; and decide whether the chemical will be classified as hazardous according to the definition of hazardous chemical in this section. In addition, classification for health and physical hazards includes the determination of the degree of hazard, where appropriate, by comparing the data with the criteria for health and physical hazards.

Chronic effect. An adverse effect on a human or animal body, with symptoms which develop slowly over a long period of time or which recur frequently. Also see "acute."

Commercial account means an arrangement whereby a retail distributor sells hazardous chemicals to an employer, generally in large quantities over time and/or at costs that are below the regular retail price.

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

Container means any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purposes of this section, pipes or piping systems, and engines, fuel tanks, or other operating systems in

a vehicle, are not considered to be containers. **Chemical cartridge respirator.** A respirator that uses various chemical substances to purify inhaled air of certain gases and vapors. This type respirator is effective for concentrations no more than ten times the TLV of the contaminant, if the contaminant has warning properties (odor or irritation) below the TLV

Chronic effect. An adverse effect on a human or animal body, with symptoms which develop slowly over a long period of time or which recur frequently. Also see "acute.

Concentration. The amount of a given substance in a stated unit of measure. Common methods of stating concentration are percent by weight or by volume, weight per unit volume, normality, etc.

Corrosive. A substance that causes visible destruction or permanent changes in human skin tissue at the site of contact.

CORROSIVE TO METALS A *chemical which is corrosive to metals* means a chemical which by chemical action will materially damage, or even destroy, metals.

CFR. Code of Federal Regulations. A collection of the regulations that have been promulgated under United States Law.

Cutaneous. Pertaining to or affecting the skin.

Degrees Celsius (Centigrade). The temperature on a scale in which the freezing point of water is 0^{o}C and the boiling point is 100^{o}C. To convert to Degrees Fahrenheit, use the following formula: $^{o}F = (^{o}C \times 1.8) + 32$.

Degrees Fahrenheit. The temperature on a scale in which the boiling point of water is 212^{o}F and the freezing point is 32^{o}F.

Density. The mass per unit volume of a substance. For example, lead is much more dense than aluminum.

Dermatitis. Inflammation of the skin from any cause.

Dermatosis. A broader term than dermatitis; it includes any cutaneous abnormality, thus encompassing folliculitis, acne, pigmentary changes, and nodules and tumors.

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

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

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

Dose-response relationship. Correlation between the amount of exposure to an agent or toxic chemical and the resulting effect on the body.

DOL. US Department of Labor. OSHA and MSHA are part of the DOL.

DOT. US Department of Transportation.

Dusts. Solid particles generated by handling, crushing, grinding, rapid impact, detonation, and decrepitation of organic or inorganic materials, such as rock, ore, metal, coal, wood and grain. Dusts do not tend to flocculate, except under electrostatic forces; they do not diffuse in air but settle under the influence of gravity.

Dyspnea. Shortness of breath, difficult or labored breathing.

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

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

EPA. US Environmental Protection Agency.

Evaporation. The process by which a liquid is changed into the vapor state.

Evaporation rate. The ratio of the time required to evaporate a measured volume of a liquid to the time required to evaporate the same volume of a reference liquid (butyl acetate, ethyl ether) under ideal test conditions. The higher the ratio, the slower the evaporation rate. The evaporation rate can be useful in evaluating the health and fire hazards of a material.

Exposure or exposed means that an employee is subjected in the course of employment to a chemical that is a physical or health hazard, and includes potential (*e.g.* accidental or possible) exposure. "Subjected" in terms of health hazards includes any route of entry (*e.g.* inhalation, ingestion, skin contact or absorption.)

Federal Register. Publication of US government documents officially promulgated under the law, documents whose validity depends upon such publication. It is published on each day following a government working day. It is, in effect, the daily supplement to the Code of Federal Regulations, CFR.

Fire point. The lowest temperature at which a material can evolve vapors fast enough to support continuous combustion.

First Aid. Emergency measures to be taken when a person is suffering from overexposure to a hazardous material, before regular medical help can be obtained.

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

Flammable limits. Flammables have a minimum concentration below which propagation of flame does not occur on contact with a source of ignition. This is known as the lower flammable explosive limit (LEL). There is also a maximum concentration of vapor or gas in air above which propagation of flame does not occur. This is known as the upper flammable explosive limit (UEL). These units are expressed in percent of gas or vapor in air by volume.

Flammable gas means a gas having a flammable range with air at 20°C (68°F) and a standard pressure of 101.3 kPa (14.7 psi

Flammable liquid. Any liquid having a flash point below 37.8^{o}C (100^{o}F), except any mixture having components with flashpoints of 100^{o}F or higher, the total of which make up 99 percent or more of the total volume of the mixture.

Flammable liquid means a liquid having a flash point of not more than 93°C (199.4°F).

Flash point means the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid

Flammable range. The difference between the lower and upper flammable limits,

expressed in terms of percentage of vapor or gas in air by volume, and is also often referred to as the "explosive range."

TABLE B.6.1—CRITERIA FOR FLAMMABLE LIQUIDS (From CFR 29 1910.1200)

Category	Criteria
1	Flash point < 23°C (73.4°F) and initial boiling point ≤ 35°C (95°F)
2	Flash point < 23°C (73.4°F) and initial boiling point > 35°C (95°F)
3	Flash point ≥ 23°C (73.4°F) and ≤ 60°C (140°F)
4	Flash point > 60°C (140°F) and ≤ 93°C (199.4°F)

Additional classification considerations

The flash point shall be determined in accordance with ASTM D56-05, ASTM D3278, ASTM D3828, ASTM D93-08 (incorporated by reference), or any other method specified in GHS Revision 3, Chapter 2.6 The initial boiling point shall be determined in accordance with ASTM D86-07a or ASTM D1078 (incorporated by reference).

Flammable solid is a solid which is a readily combustible solid, or which may cause or contribute to fire through friction.

Flash point is the minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. Two tests are used - open cup and closed cup.

Fume is the airborne particulate formed by the evaporation of solid materials, e.g. metal fume emitted during welding usually less than one micron in diameter.

Gage pressure is the pressure measured with respect to atmospheric pressure.

Gas is the state of matter in which the material has very low density and viscosity; can expand and contract greatly in response to changes in temperature and pressure; easily diffuses into other gases; readily and uniformly distributes itself throughout any container. A gas can be changed to the liquid or solid state only by the combined effect of increased pressure and decreased temperature. Examples include sulfur dioxide, ozone, and carbon monoxide.

Genotoxic and genotoxicity are terms applying to agents or processes which alter the structure, information, content, or segregation of DNA, including those which cause DNA damage by interfering with normal replication processes, or which in a non-physiological manner (temporarily) alter its replication. Genotoxicity test results are usually taken as indicators for mutagenic effects.

Gram (g) is a metric unit of weight. One ounce equals 28.4 grams.

Hazard category is the division of criteria within each hazard class, e.g., oral acute toxicity and flammable liquids include four hazard categories. These categories compare hazard severity within a hazard class and should not be taken as a comparison of hazard categories more generally.

Hazard class is the nature of the physical or health hazards, e.g., flammable solid, carcinogen, oral acute toxicity.

Hazard not otherwise classified (HNOC) is an adverse physical or health effect identified through evaluation of scientific evidence during the classification process that does not meet the specified criteria for the physical and health hazard classes addressed in this section. This does not extend coverage to adverse physical and health effects for which there is a hazard class addressed in this section, but the effect either falls below the cut-off value/concentration limit of the hazard class or is under a GHS hazard category that has not been adopted by OSHA (e.g., acute toxicity Category

5).

Hazard statement is a statement assigned to a hazard class and category that describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard.

Hazardous chemical is any chemical which is classified as a physical hazard or a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas, or hazard not otherwise classified.

Health hazard means a chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in Appendix A to §1910.1200—Health Hazard Criteria.

High Efficiency Particulate Air (HEPA) filter is a disposable, extended medium, dry type filter with a particle removal efficiency of no less than 99.97 percent for 0.3m particles.

IARC International Agency for Research on Cancer

IDLH (Immediately Dangerous to Life and Health) is an atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere.

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

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

Ignition source is anything that provides heat, spark or flame sufficient to cause combustion/explosion.

Ignition temperature is the minimum temperature to initiate or cause self-sustained combustion in the absence of any source of ignition.

Impervious. A material that does not allow another substance to pass through or penetrate it. Frequently used to describe gloves.

Inches of mercury column is a unit used in measuring pressure. One inch of mercury column equals a pressure of 1.66 kPa (0.491 psi).

Inches of water column is a unit used in measuring pressures. One inch of water column equals a pressure of 0.25 kPa (0.036 psi).

Incompatible. **Materials which could cause dangerous reactions from direct contact with one another.**

Ingestion is taking in by the mouth.

Inhalation is the breathing of a substance in the form of a gas, vapor, fume, mist, or dust.

Insoluble is being Incapable of being dissolved in a liquid.

Irritant is a chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.

Label means an appropriate group of written, printed or graphic information elements concerning a hazardous chemical that is affixed to, printed on, or attached to the immediate container of a hazardous chemical, or to the outside packaging.

Label elements is the specified pictogram, hazard statement, signal word and precautionary statement for each hazard class and category.
Latent period. The time that elapses between exposure and the first manifestation of damage.

LC_{50} is the lethal concentration that will kill 50 percent of the test animals within a specified time. See LD_{50}.

LD_{50}. is the dose required to produce the death in 50 percent of the exposed species within a specified time.

Liter (L) is a measure of capacity - one quart equals 0.9L.

Lower explosive limit (LEL) The lower limit of flammability of a gas or vapor at ordinary ambient temperatures expressed in percent of the gas or vapor in air by volume. This limit is assumed constant for temperatures up to $120^{o}C$ ($250^{o}F$). Above this, it should be decreased by a factor of 0.7 because explosibility increases with higher temperatures.

Malignant. As applied to a tumor. Cancerous and capable of undergoing metastasis, or invasion of surrounding tissue.

Metastasis is the transfer of the causal agent (cell or microorganism) of a disease from a primary focus to a distant one through the blood or lymphatic vessels. Also, spread of malignancy from site of primary cancer to secondary sites.

Meter is a metric unit of length, equal to about 39 inches.

Micron (micrometer, m) is a unit of length equal to one millionth of a meter, approximately 1/25,000 of an inch.

Milligram (mg) is a unit of weight in the metric system. One thousand milligrams equals one gram.

Milligrams per cubic meter (mg/m^3) is a unit used to measure air concentrations of dusts, gases, mists, and fumes.

Milliliter (mL) is a metric unit used to measure volume. One milliliter equals one cubic centimeter.

Millimeter of mercury (mmHg) is the unit of pressure equal to the pressure exerted by a column of liquid mercury one millimeter high at a standard temperature.

Mists are Suspended liquid droplets generated by condensation from the gaseous to the liquid state or by breaking up a liquid into a dispersed state, such as by splashing, foaming, or atomizing. Mist is formed when a finely divided liquid is suspended in air.

Mixture means a combination or a solution composed of two or more substances in which they do not react.

MSDS Material Safety Data Sheet (formerly used replaced by Safety Data Sheet).

MSHA Mine Safety and Health Administration, US Department of Labor.

Mucous membranes is the lining of the hollow organs of the body, notably the nose, mouth, stomach, intestines, bronchial tubes, and urinary tract.

NFPA National Fire Protection Association (NFPA) is a voluntary membership organization whose aim is to promote and improve fire protection and prevention. The NFPA publishes 16 volumes of codes known as the National Fire Codes.

NIOSH National Institute for Occupational Safety and Health (NIOSH) is a federal agency. It conducts research on health and safety concerns, tests and certifies respirators, and trains occupational health and safety professionals.

NTP National Toxicology Program (NTP) publishes an Annual Report on carcinogens.

Nuisance dusts have a long history of little adverse effect on the lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control.

OSHA Occupational Safety and Health Administration (OSHA), United States Department of Labor.

Oxidizer is a substance that gives up oxygen readily. Presence of an oxidizer increases the fire hazard..

Oxygen deficiency is the concentration of oxygen by volume below which atmosphere supplying respiratory protection must be provided. It exists in atmospheres where the percentage of oxygen by volume is less than 19.5 percent oxygen.

Oxidizing gas is any gas which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does

Oxidizing liquid is a liquid which, while in itself not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other material.

Oxidizing solid is a solid which, while in itself is not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other material.

Oxygen-enriched atmosphere is an atmosphere containing more than 23.5 percent oxygen by volume.

Organic peroxide is a liquid or solid organic chemical which contains the bivalent -0-0- structure and as such is considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. The term organic peroxide includes organic peroxide mixtures containing at least one organic peroxide. Organic peroxides are thermally unstable chemicals, which may undergo exothermic self-accelerating decomposition. In addition, they may have one or more of the following properties:

(a) Be liable to explosive decomposition;

(b) Burn rapidly;

(c) Be sensitive to impact or friction;

(d) React dangerously with other substances.

Organic peroxide is regarded as possessing explosive properties when in laboratory testing the formulation is liable to detonate, to deflagrate rapidly or to show a violent effect when heated under confinement.

Particulate matter is a suspension of fine solid or liquid particles in air, such as dust,

fog, fume, mist, smoke or sprays. Particulate matter suspended in air is commonly known as an aerosol.

PEL Permissible Exposure Limits (PEL) are exposure limit that are published and enforced by OSHA as a legal standard.

Personal protective equipment (PPE) are devices worn by the worker to protect against hazards in the environment. Respirators, gloves, and hearing protectors are examples.

pH is used to express the degree of acidity or alkalinity of a solution with neutrality indicated as seven.

Phenols also known as carbolic acids are caustic molecules containing hydroxbenzene aromatic compounds typically used in resins, pharmaceuticals, antiseptics and disinfectants.

Physical hazard means a chemical that is classified as posing one of the following hazardous effects: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid or gas); self-reactive; pyrophoric (liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; or in contact with water emits flammable gas. See Appendix B to §1910.1200—Physical Hazard Criteria.

Pictogram is a composition that may include a symbol plus other graphic elements, such as a border, background pattern, or color, that is intended to convey specific information about the hazards of a chemical. Eight pictograms are designated under this standard for application to a hazard category.

Polymerization is a chemical reaction in which two or more small molecules (monomers) combine to form larger molecules (polymers) that contain repeating

structural units of the original molecules. A hazardous polymerization is the above reaction, with an uncontrolled release of energy.

ppm Parts Per Million (PPM) of air by volume of vapor or gas or other contaminant are used to measure air concentrations of vapors and gases.

Precautionary statement is a phrase that describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous chemical, or improper storage or handling.

Produce means to manufacture, process, formulate, blend, extract, generate, emit, or repackage.

Product identifier is the name or number used for a hazardous chemical on a label or in the SDS. It provides a unique means by which the user can identify the chemical. The product identifier used shall permit cross-references to be made among the list of hazardous chemicals required in the written hazard communication program, the label and the SDS.

Pyrophoric gas is a chemical in a gaseous state that will ignite spontaneously in air at a temperature of 130 degrees F (54.4 degrees C) or below.

psi. Pounds per square inch (for SDS purposes) is the pressure a material exerts on the walls of a confining vessel or enclosure. For technical accuracy, pressure must be expressed as psig (pounds per square inch gauge) or psia (pounds per square absolute; that is, gauge pressure plus sea level atmospheric pressure, or psig plus approximately 14.7 pounds per square inch).

Pyrophoric liquid is a liquid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.

Pyrophoric solid is a solid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.

Readily combustible solids are powdered, granular, or pasty chemicals which are dangerous if they can be easily ignited by brief contact with an ignition source, such as a burning match, and if the flame spreads rapidly.

RCRA Resource Conservation and Recovery Act of 1976. (US Environmental Protection Agency)

Reactivity (chemical). A substance's susceptibility to undergo a chemical reaction or change that may result in dangerous side effects, such as an explosion, burning, and corrosive or toxic emissions.

Respirable size particulates are particulates in the size range that permits them to penetrate deep into the lungs upon inhalation.

Respirator (approved) is a device which has met the requirements of 30 CFR Part 11 and is designed to protect the wearer from inhalation of harmful atmospheres and has been approved by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA).

Respiratory system consists of (in descending order) - the nose, mouth, nasal passages, nasal pharynx, pharynx, larynx, trachea, bronchi, bronchioles, air sacs (alveoli) of the lungs, and muscles of respiration.

Respiratory sensitizer is a chemical that will lead to hypersensitivity of the airways following inhalation of the chemical..

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

Route of entry is the path by which chemicals can enter the body. There are three main routes of entry: inhalation, ingestion, and skin absorption.

Safety data sheet (SDS) is written or printed material concerning a hazardous chemical that is prepared in accordance with paragraph (g) of this section.

SARA Superfund Amendments and Reauthorization Act of 1986. (US Environmental Protection Agency)

SCBA Self-contained breathing apparatus.

Scientifically validated refers to the process by which the reliability and the relevance of a procedure are established for a particular purpose. Any test that determines hazardous properties, which is conducted according to recognized scientific principles, can be used for purposes of a hazard determination for health hazards. Test conditions need to be standardized so that the results are reproducible with a given substance, and the standardized test yields "valid" data for defining the hazard class of concern.

Sensitizer is a substance which on first exposure causes little or no reaction but which on repeated exposure may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of sensitization in the industrial setting.

Short-term exposure limit (STEL) is the ACGIH-recommended exposure limit. Maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures.

Signal word is a word used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label. The signal words used in this section are

"danger" and "warning." "Danger" is used for the more severe hazards, while "warning" is used for the less severe.

Simple asphyxiant is a substance or mixture that displaces oxygen in the ambient atmosphere, and can thus cause oxygen deprivation in those who are exposed, leading to unconsciousness and death.

Skin sensitizer is a chemical that will lead to an allergic response following skin contact

Solubility in water expresses the percentage of a material (by weight) that will dissolve in water at ambient temperature. Solubility information can be useful in determining spill cleanup methods and re-extinguishing agents and methods for a material.

Solvent is a substance, usually a liquid, in which other substances are dissolved. The most common solvent is water.

Sorbent (1) A material that a removes toxic gases and vapors from air inhaled through a canister or cartridge. (2) Material used to collect gases and vapors during air-sampling.

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

Specific gravity is the ratio of the mass of a unit volume of a substance to the mass of the same volume of a standard substance at a standard temperature. Water at 4^{o}C (39.2^{o}F) is the standard usually referred to for liquids; for gases, dry air (at the same temperature and pressure as the gas) is often taken as the standard substance. See Density

Specific target organ toxicity - single exposure, (STOT-SE) is specific, non-lethal target organ toxicity arising from a single exposure to a chemical. All significant health effects that can impair function, both reversible and irreversible, immediate and/or delayed and not specifically addressed in A.1 to A.7 and A.10 of this Appendix are included. Specific target organ toxicity following repeated exposure is classified in accordance with SPECIFIC TARGET ORGAN TOXICITY – REPEATED EXPOSURE (A.9 of this Appendix) and is therefore not included here.

Specific target organ toxicity - repeated exposure (STOT-RE) is specific target organ toxicity arising from repeated exposure to a substance or mixture. All significant health effects that can impair function, both reversible and irreversible, immediate and/or delayed and not specifically addressed in A.1 to A.7 and A.10 of this Appendix are included. Specific target organ toxicity following a single-event exposure is classified in accordance with SPECIFIC TARGET ORGAN TOXICITY – SINGLE EXPOSURE (A.8 of this Appendix) and is therefore not included here.

Stability Is an expression of the ability of a material to remain unchanged. For SDS purposes, a material is stable if it remains in the same form under expected and reasonable conditions of storage or use. Conditions which may cause instability (dangerous change) are stated. Examples are temperatures above 150^{o}F, shock from dropping.

Substance means chemical elements and their compounds in the natural state or obtained by any production process, including any additive necessary to preserve the stability of the product and any impurities deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition.

Surfactants are compounds that lower the surface tension of a liquid typically increasing the contact between the liquid and other substances. Typical surfactants include soap, detergents and other wetting agents.

Synergism Is the cooperative action of substances whose total effect is greater than the sum of their separate effects.

Systemic Spread throughout the body, affecting all body systems and organs, not localized in one spot or area.

Threshold is the lowest dose or exposure to a chemical at which a specific effect is observed.

Time-weighted average concentration (TWA) Refers to concentrations of airborne toxic materials which have been weighted for a certain time duration, usually 8 hours.

Threshold Limit Value (TLV) time-weighted average concentration under which most people can work consistently for 8 hours a day, day after day, with no harmful effects. A table of these values and accompanying precautions is published annually by the American Conference of Governmental Industrial Hygienists.

Toxicity is a relative property of a chemical agent and refers to a harmful effect on some biologic mechanism and the conditions under which this effect occurs.
Trade secret means any confidential formula, pattern, process, device, information or compilation of information that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it.

Upper explosive limit (UEL) Is the highest concentration (expressed in percent vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present.

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

Use means to package, handle, react, emit, extract, generate as a byproduct, or transfer.

Vapor pressure is pressure (measured in pounds per square inch absolute - psia) exerted by a vapor. If a vapor is kept in confinement over its liquid so that the vapor can accumulate above the liquid (the temperature being held constant), the vapor pressure approaches a fixed limit called the maximum (or saturated) vapor pressure, dependent only on the temperature and the liquid.

Vapors is the gaseous form of substances that are normally in the solid or liquid state (at room temperature and pressure). The vapor can be changed back to the solid or liquid state either by increasing the pressure or decreasing the temperature alone. Vapors also diffuse. Evaporation is the process by which a liquid is changed into the vapor state and mixed with the surrounding air. Solvents with low boiling points will volatilize readily. Examples include benzene, methyl alcohol, mercury, and toluene.

Viscosity is the property of a fluid that resists internal flow by releasing counteracting forces.

Volatility is **t**he tendency or ability of a liquid to vaporize. Such liquids as alcohol and gasoline, because of their well-known tendency to evaporate rapidly, are called volatile liquids.

Water column is the unit used in measuring pressure. See also Inches of water column.

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

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