

Annual OSHA / EPA Hazardous Waste Operator 8-Hour Refresher



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Introduction:

Workers are required to receive proper training if they work with, work near or have the potential to encounter chemical hazards in the workplace, whether in the normal course of business or in the event of an accidental spill and/or chemical release.

Occupational Safety and Health Act (OSHA) requires employees to be trained about the hazardous chemicals stored, processed, and used on-site. In some conditions, this training requires the OSHA Hazardous Waste Operations and Emergency Response HAZWOPER (Hazardous Waste Operations and Emergency Response) training. (29 CFR 1910.120)
http://www.osha-slc.gov/OshStd_toc/OSHA_Std_toc_1910.html

All facilities required to file reports under the Emergency Planning and Community Right-to-Know Act (EPCRA) are governed by the HAZWOPER rule, as well as hazardous waste sites; hazardous waste transfer, storage, recycling and disposal (TSRD) facilities; and Superfund Sites. The reasoning being – hazardous substances located at a facility might spill or leak. Once these hazardous substances are “released”, it must be quickly and safely controlled and cleaned up by trained personnel. Since these chemicals can be dangerous, employees need training on how to respond to and mitigate the spill and to manage the hazardous waste ... all the while doing protecting themselves. Training is a legal requirement.

Historically HAZWOPER operations and training involved at least three Federal regulatory agencies (EPA, OSHA, and DOT). The regulation cover the work conditions of several industries, including but not limited to science, technology, engineering, medicine, toxicology, law, psychology, organizational management, loss prevention, QA/QC, construction, waste management, etc... Today, there is a fourth agency which has a less visible presence, but does have an impact on facilities and operations – this being the Homeland Security agency.

Basically, employers within these industries fall under OSHA’s General Duty Clause:

"(a) Each Employer....

1. Shall furnish to each of his employees employment a place of employment which are free from recognized hazards that are causing or are likely to cause death or physical harm to his employees:
2. Shall comply with the occupational safety and health standards promulgated under this Act.

Recognizing this, the employer's role in providing a safe workplace includes:

1. Recognizing the hazards
2. Evaluating the hazards.
3. Controlling the hazards.

This concept applies to all workplaces including all workplaces, hazardous waste sites and emergency response.
http://www.osha-slc.gov/OshStd_data/1910_0120.html

To be OSHA HAZWOP certified, one must take the initial 40 hour class with an annual eight hour refresher. The 40-hour class can only be taught by a qualified instructor and must be paid for by the employer. The HAZWOP class gives employees the basic knowledge they need to safely work in a chemical environment. This class is not optional, but mandatory for employees who work with chemicals or have to respond to potential chemical emergencies.

Recently there have been, and will most likely continue to be changes to the “old” HAZWOPER rules... such as:

- Emergency Response has been separated out to its own 24-hour training
- Homeland Security will continue to impose security issues in the security of storage of hazardous materials.
- By 2014, the old MSDS will be phased out with a new product, the SDS and the “old” employee training programs will be needed to be updated to reflect the new Global Harmonization System (GHS).

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Objective:

The objective of this course is to ensure that employees operate in the safest possible manner in situations where contact with potentially hazardous materials is likely. This document is a companion to an eight hour lecture and provides additional background to what was presented. This document may also include materials not covered during the lecture.

This document in coordination with the eight hour lecture will provide:

- Understanding on how to recognize, identify and respond to health and environmental hazards
- Examples of the importance of awareness and protecting oneself
- Knowledge of what to do in case of site emergencies
- How to select and use appropriate safety methods and work practices
- Skills to recognize signs and labels that are used to alert personnel of danger involving hazardous material

OSHA

The Occupational Safety and Health Administration (OSHA) is a federal agency with the US Department of Labor. OSHA was created by the Occupational Safety and Health Act of 1970. Basically the Act was passed to assure safe working conditions for workers ... more specific, the workers that are employees. The Act does not cover:

- Owner/Operator of the business
- Family run farms, or commercial fishing boats
- Employees that work in industries that are regulated by another federal agency (i.e. nuclear energy and weapons)
- And in some instances, state and local public employees

In some instances OSHA rules do not cover state and local government workers. States can develop and operate their own version of OSHA. However, state programs must, at least meet the OSHA standards and must be preapproved and monitored by OSHA. In the case of Washington State, there is a state program that covers all employees in the state, with the exception of federal and tribal employees.

Hazardous Waste Operations and Emergency Response rules (29 CFR 1910.120), developed by OSHA, assures the health and safety of workers at hazardous waste sites, as well as those workers that respond to incidents involving hazardous materials. The provision of this rule addresses everything from the initial response planning to site characterization and all the way to the declassification of the site from a hazardous to non-hazardous site.

Workers in, or on "unknown sites," and are potentially exposed to hazardous materials, based on historical or anecdotal information are most likely covered under the HAZWOPER rules as well.

OSHA Hazard Communication -

Another program instituted by OSHA is the Hazard Communication Standard (HCS). This program requires chemical manufacturers and importers to research the chemicals they produce, import and sell. If a substance presents any of the physical and health hazards, as specified in the HCS, then the manufacturer or importer must communicate the hazards and cautions to their employees as well as to "downstream" employers who purchase the hazardous chemical. The goal behind the HCS is a safer workplace for workers, who informed of the hazards they encounter on the job, can create a safer work environment.

Most OSHA citations involve the employer's failure to comply with the Hazard Communication Standard. 50% of OSHA's citations relate to a failure to implement the Hazard Communication Standard.

Protection under OSHA's Hazard Communication Standard (HCS) includes all workers exposed to hazardous chemicals in all industrial sectors. Employees have both a need and a right to know about the identities and the hazards of the chemicals they are exposed to in the workplace. Employees also need to know what protective measures are available to prevent adverse effects from occurring. More than 30 million workers are potentially exposed to one or more chemical hazards. There are an estimated 650,000 existing hazardous chemical products, and hundreds of new ones are being introduced annually. The (HCS) covers both physical hazards (such as flammability or the potential for explosions), and health hazards (including both acute and chronic effects). By making information available to employers and employees about these hazards, and recommended precautions for safe use, proper implementation of the HCS will result in a reduction of illnesses and injuries caused by chemicals. Using HCS, employers will have the information they need to design an appropriate protective program for their employees. Employees will be better able to participate in these programs effectively when they understand the hazards involved, and how and what steps to take to protect themselves. Together, these employer and employee actions will help prevent the occurrence of adverse effects caused by the use of chemicals in the workplace.

The HCS established uniform requirements to make sure that the hazards of all chemicals imported into, produced, or used in U.S. workplaces are evaluated and that this hazard information is transmitted to affected employers and exposed employees.

Chemical manufacturers and importers must convey the hazard information they learn from their evaluations to downstream employers by means of labels on containers and Material Safety Data Sheets (MSDS's). In addition, all covered employers must have a hazard communication program to get this information to their employees through labels on containers, MSDS's, and employee training.

This hazard communication program ensures that all employers receive the information they need to inform and train their employees properly, and to design and put in place employee protection programs. It also provides necessary hazard information to employees so they can participate in and support the protective measures in use at their workplaces. Employees are often the best source of suggestions about how to reduce workplace hazards and chemical exposures, which can also translate into cost cutting and savings.

All employers, in addition to those in manufacturing and importing, are responsible for informing and training workers about the hazards in their workplaces, retaining warning labels, and making available MSDS's with hazardous chemicals.

Some employees deal with chemicals in sealed containers under normal conditions of use (such as in the retail trades, warehousing, truck and marine cargo handling). Employers of these employees must assure that labels affixed to incoming containers of hazardous chemicals are kept in place. They must maintain and provide access to MSDS's received, or obtain MSDS's if requested by an employee. And they must train workers on what to do in the event of a spill or leak. However, written hazard communication programs will not be required for this type of operation.

All workplaces where employees are exposed to hazardous chemicals must have a written plan which describes how the standard will be implemented in that facility. The only work operations that do not have to comply with the written plan requirements are laboratories and work operations where employees only handle chemicals in sealed containers. However, workers must still be trained about what to do in the event of a spill or leak.

The written program must reflect what employees are doing in a particular workplace. For example: the written program must list the chemicals present at the site, indicate who is responsible for the various aspects of the program in that facility, and where written materials (MSDSs) will be made available to employees.

The HCS mandates the following:

- **Hazard Assessment** – employers will conduct a hazard assessment for each chemical used in the workplace.
- **Inventory of Chemicals** – list of chemicals used in the workplace is available to the employees.
- **Material Safety Data Sheet (MSDS)** – a MSDS is available for each chemical in the workplace.
- **Labeling** – employers adopts a labeling program for each chemical used in the workplace including waste containers.
- **Training** – employers can demonstrate that all employees are trained on the HCS including the knowledge and understanding of the MSDS(s) in use at the workplace.
- **Written Program** – each employer is to provide a written program describing this HCS. The written program is to be made available to all employees.

Health

Permissible Exposure Limits (PEL):

OSHA:

The Occupational Safety and Health Administration (OSHA) is responsible for issuing standards and rules for safe and healthful working conditions, tools, equipment, facilities, and processes. Employers have the general duty of providing their workers a place of employment that is free from recognized hazards to safety and health, a place of employment which must comply with OSHA standards. OSHA sets chemical exposure limits called Permissible Exposure Limits (PEL). But these OSHA PELs have been known to be wrong before. For example, Methylene Chloride once had an OSHA PEL of 500 parts per million (PPM), and now, over a period of ten years, that PEL has been revised downward to 25 PPM. 1, 3 Butadiene once had an OSHA PEL of 1,000 PPM, and this has now been reduced to 1 PPM.

OSHA PELs are based on the concept that the worker is exposed to chemicals for no more than eight hours at a time. The worker has "downtime," or time away from the chemicals and workplace, allowing the body time to remove or lower the amount of chemicals in the system. Continuous exposure with no downtime does not allow for the body to cleanse itself, therefore continuous exposure limits can cause the body to accumulate the chemical at a greater rate than it can expel it, a potentially dangerous situation. OSHA PELs do not apply to continuous exposure. Firefighters responding to a chemical spill or release should determine the OSHA PEL for the chemical spilled and consider the "safe" zone for the public to be at 1/100th or 1/1,000th the OSHA PEL. There may be quite a problem in determining exactly what chemical has been spilled, so this task for firefighters is not easy. Often, there will be many chemicals in the workplace, and the interactions of these make assessing the hazard very difficult for firefighters and emergency responders, especially if a fire is involved, which can create new substances and chemical combinations.

The firefighters responding to a chemical spill or release often consider or use another standard, the **IDLH**, or **I**mmediately **D**angerous to **L**ife or **H**ealth. What the IDLH level is also helps emergency responders determine whether to use a respirator, or what types of respirator, to use in a response. Obviously, knowing what these different standards are, what they mean, and how to interpret them is something to be done long before any accident occurs. This is another reason why chemical emergency preparedness depends on real-time, valid facility chemical inventory information.

NIOSH & ACGIH:

To further complicate matters, the OSHA PEL may not be an entirely correct figure. The National Institute of Occupational Safety and Health (NIOSH) have created standards for exposure to chemicals with Recommended Exposure Limits (REL) that are usually below OSHA PEL standards. And the American Conference of Governmental Industrial Hygienists (ACGIH) has created standards named Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs) that are also generally below OSHA PEL levels.

NIOSH Recommended Exposure Limits (REL) are developed under the authority of the Occupational Safety and Health Act of 1970 (29 USC Chapter 15) and the Federal Mine Safety and Health Act of 1977 (30 USC Chapter 22). NIOSH develops and periodically revises recommended exposure limits (RELs) for hazardous substances or conditions in the workplace. NIOSH also recommends appropriate preventive measures to reduce or eliminate the adverse health and safety effects of these hazards. To formulate these recommendations, NIOSH evaluates all known and available medical, biological, engineering, chemical, trade, and other information relevant to the hazard. These recommendations are then published and transmitted to OSHA and Mine Safety and Health Administration (MSHA) for use in promulgating (creating) legal standards. The operative word here is "recommend." NIOSH is purely an advisory body and has no legal authority of its own. OSHA is the only agency who has the legal authority to set exposure standards. The main difference between OSHA and NIOSH is that OSHA uses an eight hour time-weighted average while NIOSH uses a 10 hour time-weighted exposure limit. [Time-weighted average means averaged over a period of time, so higher and lower exposure levels can occur.] [\[http://www.cdc.gov/niosh/pubs.html\]](http://www.cdc.gov/niosh/pubs.html)

NIOSH also sets "ceilings" for which exposure levels cannot be exceeded at any time. OSHA rarely sets any "ceiling" exposure levels. OSHA is not always successful in implementing NIOSH's recommendations: In July 1992, the 11th Circuit Court of Appeals in its decision in *AFL-CIO v. OSHA*, 965 F.2d 962 (11th Cir., 1992) vacated more protective PELs set by OSHA in 1989 for 212 substances, moving them back to PELs established in 1971. <http://www.cdc.gov/niosh/npg/npg.html>

American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. These exposure levels are based on animal studies. With these and with all such exposure standards, there is uncertainty, and not a guarantee that adverse health will not result from exposure to these levels of chemicals in the air.

There are other related terms and abbreviations that may be encountered. STELs, which are Short-Term Exposure Levels (15 minutes), are based on the theory that a short-term exposure to certain levels of certain chemicals may be allowed. For the vast majority of chemicals, there is simply not enough toxicological data to warrant or establish a STEL. TWA stands for Time-Weighted Average, which is based on the idea that exposure to levels of chemicals above the Threshold Limit Values are allowed so long as the employee is subjected to periods of time when the exposure to levels of chemicals is below the Threshold Limit Values during the workday. Biological Exposure Indices (BEIs) are reference values intended as guidelines for the evaluation of potential health hazards in the practice of industrial hygiene. BEIs represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with some inhalation exposure to the TLV.

Occupational Standards

OSHA Permissible Exposure Limits:

PEL-TWA	Eight hour time-weighted average concentration
PEL-STEL	15 minute time-weighted average concentration
PEL-C	Ceiling concentration - not to be exceeded

NIOSH Recommended Exposure Limits:

REL-TWA	Eight hour time-weighted average concentration
REL-STEL	15 minute time-weighted average concentration
REL-C	Ceiling concentration - not to be exceeded
IDLH	30 minute concentration that is Immediately Dangerous to Life and Health

ACGIH recommended Threshold Limit Values:

TLV-TWA	Eight hour time-weighted average concentration
TLV-STEL	15 minute time-weighted average concentration
TLV-C	Ceiling concentration - not to be exceeded

IDLH - Immediately Dangerous to Life or Health

The maximum level from which a worker could escape without any irreversible health effects within a 30 minute time-frame.

Keep in mind; OSHA PELs have been known to be wrong before. For example, Methylene Chloride once had an OSHA PEL of 500 parts per million (ppm), and now, over a period of ten years, that PEL has been revised downward to 25 ppm. 1, 3 Butadiene once had an OSHA PEL of 1,000 ppm, and this has now been reduced to 1ppm.

Hazard Awareness

Toxicity

Hazardous materials can pose both short-term and possibly long-term toxicological threats to human life and health.

Routes of Entry -

Chemicals - solids, liquids, or gases/vapors can affect humans by primary routes of entry such as:

- Inhalation - the process by which irritants or toxins enter the body through the lungs as a result of the respiratory process.
- Ingestion - the process of consuming contaminated food or water or otherwise permitting oral intake of irritants or toxins.
- Direct contact with skin - the process by which hazardous materials cause injury to bodily tissues via direct contact or cause poisoning via absorption through the skin, or other external tissues. Also included in this category is the passage of toxic materials into the body via puncture wounds or other breaks in the skin.
- Eyes - chemicals can enter through the eye and can injure the eye.

Inhalation exposures may result from breathing gases, vapors, aerosols, or particulates.

Ingestion (i.e., oral) exposures may follow from poor hygiene practices after handling of contaminated materials or from ingestion of contaminated food or water. Ingestion may also occur following inhalation of insoluble particles that become trapped in mucous membranes and swallowed after being cleared from the respiratory tract. (Workers may even "taste" chemicals after inhaling them.)

Direct skin contact may result from exposures to hazardous gases, liquids or solids in the environment, either on land, in the air, or in water. Effects may be local and involve irritation or burns of the skin or eyes or involve poisoning via absorption through external bodily tissues. The worker may not be aware of this exposure for some time.

There are various specific gases, liquids, and even solid materials which have the capability of passing through the skin or tissues of the eyes at various rates upon contact. Those that are highly toxic and which penetrate the body rapidly are the most hazardous. Those that penetrate slowly or which are of relatively low toxicity may require long term contact with large parts of the body to cause significant effects. Although some materials may give some warning that contact has occurred by causing some sort of burning sensation, others may give little or no warning to the victim.

Chemicals considered highly toxic means that relatively small quantities may cause significant health effects upon inhalation, ingestion, and/or direct contact. Chemicals considered to be of low toxicity generally require larger amounts to be inhaled, ingested, or contacted for an equally significant adverse health effect.

It is therefore prudent to always remember that a large quantity of a low toxicity material may present the same or greater toxic hazard to a person than a much smaller quantity of a highly toxic material. It is also necessary to understand that the toxicity of a material is only one of several factors to be considered in determining the toxic hazard posed by the material.

Types of Toxic Effects -

Most toxic substances can be classified as irritants, anesthetics and narcotics, systemic poisons, sensitizers, carcinogens, mutagens, and/or teratogenic substances. Systemic poisons may be further segregated into the categories of hepatotoxic agents, nephrotoxic agents, neurotoxic agents, agents which act on the blood or hematopoietic system, and agents which damage the lung.

Irritants-

Irritants are substances with the ability to cause inflammation or chemical burns of the eyes, skin, nose, throat, lungs, and other tissues of the body in which they may come in contact. Some substances such as strong acids (e.g., sulfuric acid, hydrochloric acid, hydrofluoric acid, or nitric acid) may be irritating to the point of being corrosive when concentrated, and may quickly cause second and third degree chemical burns upon contact with the skin or eyes. If inhaled as a gas, vapor, fume, mist, or dust, they may cause severe lung injury, and if ingested, can seriously damage the mouth, throat, stomach, and/or intestinal tract. Yet other irritants may have milder effects and may only cause reddening of the skin or eyes after contact.

Some of the most common irritants are organic or hydrocarbon fuels which can dissolve natural oils in the skin and cause dermatitis. After repeated or prolonged contact, these will dry the skin to the point that it may become cracked, inflamed and possibly infected. These same materials often cause irritation of the eyes and possibly loss of vision upon contact of the epithelium, a clear thin membrane that covers the surface of the cornea.

Entry into the lungs of many hydrocarbons and some organic liquids that are irritants may cause chemical pneumonia or pneumonitis together with pulmonary edema (filling of the lungs with fluid), hemorrhage (bleeding), and tissue necrosis (death of living tissue). Since entry of liquids into the lungs usually involves aspiration when a victim who has accidentally ingested the substance vomits, the first aid instructions for such substances typically recommend against intentionally inducing vomiting. They also are likely to mention that the effects of aspiration into the lungs may not appear for several hours or even days after the exposure has taken place.

Asphyxiant -

Simple asphyxiants are typically non-toxic gases that may cause injury by inhalation only if they are present in air in such high concentrations that they displace and exclude the oxygen needed to maintain consciousness and life. A good example is nitrogen, a gas that makes up about 78% of the air we breathe and which is perfectly harmless at this level as a component of air. If additional nitrogen or another such simple asphyxiant were added to the air to the point that the normal oxygen concentration of approximately 21 percent by volume was significantly reduced, the situation could become life-threatening. Another example: A tank of Argon, an inert gas, ruptures in an enclosed building. The gas released from the tank displaces the air (oxygen) around it causing anyone in the affected area to become unable to breathe because of lack of oxygen. Methane, a common decomposition chemical, can accumulate in confined spaces or low-lying areas (gulleys), causing those to walk there to asphyxiate.

Chemical asphyxiants are substances that in one way or another prevent the body from using the oxygen it takes in and are often highly toxic substances. One common, classic example is carbon monoxide which combines with and ties up the component of blood (hemoglobin) that transports oxygen from our lungs to other organs. If too much of the hemoglobin becomes unavailable for carrying oxygen, a person may pass out and eventually die.

Four Stages of Asphyxiation -

1st Stage: 20.9 - 19.5 % oxygen by volume, increase pulse and breathing rate with disturbed muscular coordination.

2nd Stage: 12 - 19.5 % oxygen by volume, faulty judgment, rapid fatigue, and insensitivity to pain.

3rd Stage: 10 - 6 % oxygen by volume, nausea and vomiting, collapse, and permanent brain damage.

4th Stage: Less than 6 % by volume, convulsion, breathing stopped, and death.

Anesthetics and Narcotics -

Numerous hydrocarbon and organic compounds classifies as hazardous materials, including some alcohols, act on the body by depressing the central nervous system (CNS). Early symptoms of exposure to these substances include dizziness, drowsiness, weakness, fatigue, and lack of coordination. Severe exposures may lead to unconsciousness, paralysis of the respiratory system, and possibly death.

Sensitizers -

A few hazardous materials are sensitizers and cause sensitization. What this means is that some people who are exposed to one of these materials may not be abnormally affected the first time but may experience significant and possibly dangerous effects even in the presence of very low levels of the contaminant if ever exposed again. Victims become extremely allergic to the material and possibly others of a similar nature.

Other Types of Toxic Agents:

- Hepatotoxic agents - materials that cause liver damage.
- Nephrotoxic agents - materials that cause kidney damage.
- Neurotoxic agents - substances that in one way or another impact the nervous system and possibly cause neurological damage.
- Carcinogens - substances that may incite or produce cancer within some part of the body.
- Mutagens - can produce changes in the genetic materials of cells.
- Teratogenic - materials may have adverse effects on sperm, eggs, and/or fetal tissue.
- Hematopoietic system (blood) - Some chemicals can affect the blood and the blood forming tissues.

Health Effects:

Acute effect –

Adverse health effects caused after an exposure of short duration (minutes, hours, days). An adverse effect on a human or animal body resulting from a single exposure with symptoms developing almost immediately or shortly after exposure occurs.

When a major accident or other rare event causes a significant spill or discharge of a toxic material into the environment, the general public or nearby workers may be exposed to relatively high levels of one or more toxic contaminants until such time as they escape, are rescued from contaminated locations, or the contaminant itself becomes diluted below hazardous levels.

These short-term exposures with long periods of time between repeated exposures (if they reoccur at all) are referred to as acute exposures. Not all acute exposures, of course, need involve high concentrations of toxic materials. A small spill or discharge may produce low levels of contamination yet still be of an acute nature.

Chronic effects –

While many chemicals do not persist for long periods of time in the environment, others may remain present for weeks, months, or years. Effects that occur after a longer period of time (months, years) resulting from repeated low level exposure, with symptoms that develop slowly over a long period of time or that reoccur frequently.

There is controversy over what constitutes a "safe level" especially for non-work related exposures such as in a residential area, where exposure is not limited to eight hours per day and continues on through weekends. Nor has it been proven that these "safe levels" are appropriate for populations that have been previously and acutely exposed and sensitized from previous exposure. Employers have a duty to protect the health of their workers, but this duty does not apply to nearby residents and passersby.

There is also some uncertainty as to whether multiple chemical exposures and any possible synergistic reactions have an appropriate "safe level." OSHA PELs have been known to be wrong. For example, Methylene Chloride once had an OSHA PEL of 500 parts per million (ppm), and now, over a period of ten years, that PEL has been revised downward to 25 ppm. 1, 3 Butadiene once had an OSHA PEL of 1,000 ppm, and this has now been reduced to 1 ppm.

Chemicals which are relatively inert or do not degrade, react, vaporize, or dissolve freely may pose health hazards for extended periods of time within a localized environment. In this situation additional planning to address long-term chronic exposure hazards to the public need to be addressed. Examples include heavy metals (lead, cadmium, chromium) and various chlorinated hydrocarbons such as DDT, trichloroethylene, and PCBs.

Exposure Level -

In considering the effects of toxic exposures, it is necessary to understand that the duration of an exposure can be as important as the level of exposure in determining the outcome. The body has a capacity to cope with the intake of many contaminants as a certain rate. Below a certain threshold rate of intake or absorption, the body has an ability to excrete or somehow convert the contaminant to a harmless substance, so toxic effects may be minimal or nonexistent. For example, arsenic is commonly found in all human bodies at low levels. It is only when the level exceeds the safe threshold due to excessive intake that symptoms of toxicity become apparent.

The rate at which a contaminant enters the body by inhalation is a function of the concentration of the contaminant in the air, and the specific properties of the contaminant. Higher concentrations in air obviously lead to higher rates of intake or absorption into bodily tissues.

The potential for toxic effects via skin absorption is a function of the amount of toxic material that contacts the body, the properties of the material, and the length of time it is permitted to remain in contact.

Toxic effects via ingestion can also be a function of the amount or rate of intake over a period of time. Small doses of certain poisons ingested hours or days apart may not be harmful, but taken the total amount all at once may be deadly. Other poisons may accumulate in the body such that small doses taken over time may buildup to a fatal dose.

The reason that chronic exposure to low levels of toxic materials commonly found in the environment does not often cause widespread health problems is likely that the rate of intake is below the threshold at which health effects become apparent.

Major spills or releases of toxic materials may pose a significant threat to public health because the resulting contaminant concentrations in the local area may be so high that only a moment or two of exposure is sufficient to produce severe health problems due to an excessive body burden of contamination. This is particularly true where large amounts of toxic gases or vapors are released into the air. Most at risk in such situations are emergency response personnel who enter contaminated areas without adequate personnel protective clothing and respiratory devices in attempts to contain or otherwise mitigate the impacts of the spill.

Dose-Response Relationship for Chemicals -

Toxicology is based on the dose-response relationship. This relates the amount of a substance (the dose) given to a test animal to the effect shown by the animal (the response).

The simplest study relates the percentage of test animals which die (mortality) to the dose given. The dose is usually expressed in mg/kg (for ingestion or inoculation), in mg/m³ (for skin exposure), or in parts-per-million (ppm). The response is expressed in percent of animals which have died.

The LD50 is the lethal dose of a substance that caused the death of 50% of a group of laboratory animals used in experiments. The important thing to remember for hazard awareness is that the smaller an LD50 is, the more toxic the chemical is likely to be. Also bear in mind that many of the laboratory animals died at various levels of exposure to the chemical before the point was reached where half had died. Some people will get ill at levels below the LD50.

More Health Effects Information -

For more information about health effects of chemicals, check out the following government-sponsored websites:

Health Finder – Department of Health and Human Services' gateway to medical journals, news, databases, libraries, state agencies, educational sites, organizations, and support groups www.healthfinder.gov

National Institutes of Health – Federal health information resources, clinical-trial databases, consumer health publications, and an index of health conditions being investigated by the government. www.nih.gov

National Library of Medicine features MedLine – a free database of citations and abstracts from 3,900 medical journals www.nlm.nih.gov

Biological

1. Biological hazards are those caused by living organisms – mold, bacteria, viruses, parasites, etc.
2. Examples of how one becomes infected are:
 - Handling hospital waste and contracting AIDS or Hepatitis.
 - Working in areas with mice droppings can expose you to Hanta virus.
 - While working on a site, a raccoon bites you and you contract rabies.
3. Since these hazards are hard to visually identify, they are hard to control.

Radiological

1. Radiation is basically energy being given off in the form of heat, light, radio and radioactivity. The radiations of most concern are:
 - Ionizing – which is a high-energy form, capable of breaking chemical bonds?
 - Non-Ionizing – is electromagnetic energy, a lower energy level that does not generally effect atomic structures, but rather it usually creates injuries due to heat.
2. There are three types of Ionizing Radiation:
 - Alpha – heavy, very short-range particle
 - Beta – light, short-range particle
 - Gamma – highly penetrating electromagnetic radiation

Chemical Reactions

1. Exothermic Reactions –

When one substance is brought together or mixed with another and the resulting interaction evolves or generates heat, the process is referred to as an exothermic reaction. An exothermic (exo- is a prefix meaning "out of") reaction is one where the energy flows out of the system into the environment. Combustion reactions are exothermic. Some exothermic reactions may require heating just to get started, and will then proceed on their own.

Exothermic reactions pose special hazards whether occurring in the open environment or within a closed container. In the open, the heat evolved will raise the temperature of the reactants, of any products of the reaction, and of surrounding materials. Since several properties of all substances are a function of temperature, such as pressure, the resulting higher temperatures may affect how the materials involved behave in the environment.

Heat will increase the vapor pressures of hazardous materials and the rate at which they vaporize. If very high temperatures are achieved, nearby combustible materials may ignite. Explosive materials, whether they are the reactants of the reaction or just nearby, may explode upon ignition or excessive heating.

Similar hazards are associated with exothermic reactions taking place in closed containers. In this case, however, increasing internal temperatures as well as the evolution of gases from the reaction may increase internal pressures to the point that the tank or container ruptures violently in an over-pressurization explosion, thus suddenly releasing large amounts of possibly flammable and/or toxic gases or vapors into the atmosphere. Such gases or vapors may also be released through ruptured pipes, opened relief valves or devices, or any other paths to the external environment.

2. Reactions with Water or Air –

Some of the most basic types of exothermic reactions occur when certain materials are dissolved in water.

Such substances have what is called a positive heat of solution. They do not transform to a different material, but simply generate heat while mixing. Some examples are sodium hydroxide (also called caustic soda) and sulfuric acid, which generates considerable heat to the point of causing some degree of "violence" when concentrated or pure materials are spilled into water. Other materials may ignite, evolve flammable gases, or otherwise react violently when in contact with water.

Knowledge of the reactivity of any substance with water is especially important when water is present in the spill area or a fire takes place and firefighters do not wish to make the situation worse by applying water to the flames or chemicals.

Several of the strong acids and related substances in this category of materials may evolve large amounts of fumes when in contact with water or moisture in the air. These fumes, which may consist of a mixture of fine droplets of acid in air and acid vapors, are usually highly irritating, corrosive, and heavier than air.

Many substances referred to as being pyrophoric will react violently or exothermically with air and are likely to ignite in a spontaneous fashion. Such substances (such as phosphorus) are commonly transported or stored in a manner that prevents exposure to air, often submerged in water or some type of compatible oil. Note: The fact that a substance can be safely stored under water in no way suggests that it may also be safely submerged in oil.

3. Reaction with Combustible Organic Materials –

Certain chemicals are known as strong oxidizing agents or oxidizers. They have the common characteristic of being able to decompose or oxidize organic materials and react with a variety of inorganic materials while generating heat, oxygen, flammable gases, and possibly toxic gases. If the heat generated is sufficient to ignite a combustible or flammable material, a fire or explosion may occur.

Another group of chemicals are referred to as strong reducing agents. These substances may evolve (produce, create) hydrogen upon reaction with many other chemicals, may evolve other flammable or toxic gases, and like oxidizing agents, may generate heat.

A fire or explosion may result if sufficient heat is generated to ignite a combustible or flammable substance.

Strong reducing agents and oxidizing agents should never be allowed to make contact without appropriate safeguards since they represent opposite extremes of chemical reactivity.

4. Exothermic Polymerization Reactions –

A few of the more common plastics in use on a widespread basis are polyethylene, polypropylene, polystyrene, and polyvinyl chloride (PVC). Although all are manufactured from liquids or gases, they are typically solids in their final form. They are respectively manufactured from ethylene, propylene, styrene, and vinyl chloride by means of a polymerization reaction in which molecules of these materials are linked together into long chains of molecules. As the chains become longer and begin connecting to each other, increasing the molecular weight of individual molecules, a solid plastic is formed.

Some chemicals capable of being polymerized have strong tendency to do so even under normal ambient conditions and are especially prone to polymerize if heated above a certain temperature or if contaminated by a catalyst or polymerization initiator, which in some cases might be a rather common substance such as water or rust.

Once polymerization starts, an exothermic chain reaction may occur that develops high temperatures and pressures within containers and which can lead to possible explosion or violent rupture of the container and/or discharge of flammable and/or toxic gases if safety and control systems malfunction are lacking.

The incident in Bhopal, India partially involved this type of reaction when a container of methyl isocyanate contaminated with water and chloroform began polymerizing. The reaction caused a large portion of isocyanate to vaporize into the air through a pressure relief system before it had a chance to polymerize.

Substances with the above tendency to self-polymerize or to undergo autocatalytic polymerization are transported or stored only while containing an amount of a substance called an inhibitor. Inhibitors act to inhibit, slow, or interfere with the chemical processes that can lead to a runaway uncontrolled polymerization reaction under normal conditions of transportation or storage. Inadvertent contamination or excessive heat, however, may overpower the inhibitor and allow the reaction to proceed.

5. Exothermic Decomposition Reactions -

While some chemical molecules can join together to form larger molecules via exothermic polymerization, others are unstable and can break apart in a runaway exothermic reaction once the process is initiated. Inhibitors may be used to slow the process down or to prevent its occurrence. Various contaminants or heat may overcome the inhibitors or otherwise start an uncontrolled reaction.

Decomposition and polymerization reactions are hazardous only if they somehow become uncontrolled and start a chain reaction that cannot be stopped with available equipment, materials, or safety systems. They are widely and safely conducted in chemical and other manufacturing plants across the nation on a daily bases without incident. It is only when control or safety systems break down or people make mistakes that problems develop.

It is extremely important to know and understand the Acute and Chronic effects of the chemicals you will most likely be exposed to!

- Strong acids include hydrochloric acid (HCL), hydrofluoric acid (HF), nitric acid (HNO₃), and sulfuric acid (H₂SO₄).
- Strong bases include sodium hydroxide (NaOH) and potassium hydroxide (KOH)

6. Other Hazardous Results or Products of Reactions –

The combination of various chemicals may produce new chemicals with hazards quite different and possibly more hazardous than those associated with the original materials. Some combinations may result in spontaneous fires; spontaneous explosions; generation of toxic gases, liquids or solids; or generation of flammable gases, liquids or solids. It is necessary to look at hazardous materials on a fairly specific case-by-case basis to determine their reactivity hazards.

7. Reactivity –

The reactivity chart illustrated below is based on the National Fire Protection Association (NFPA) 704 System which now defines reactivity as instability while the Hazardous Materials Identification System (HMIS) developed by the National Paint & Coatings Association still defines reactivity as reactivity. [\[LINK http://www.nfpa.org/\]](http://www.nfpa.org/)

8. Reactivity / Instability Hazard Rating Chart

Code No.	Hazard	Definition
1	Minimal	Normally stable even in fire conditions.
2	Moderate	Normally unstable if heated; may react with water.
3	Severe	Materials capable of detonation or explosion but require a strong initiating source or which may react explosively with water.
4	Extreme	Materials readily capable of explosive decomposition or detonation at normal temperature and pressure.

Corrosives:

The process by which a chemical gradually erodes or dissolves another material is often referred to as corrosion. The word corrosive is also used descriptively to indicate that a substance may cause chemical burns of the skin, eyes, or other bodily tissues upon contact.

In evaluating whether one material is corrosive to another via reference to material safety data sheets, chemical company product bulletins, hazardous material data bases, or other reference sources, it is often important to place the time frame and rate of corrosion into the proper context.

Acids and Bases (Corrosivity) -

Corrosive materials are either acidic or basic. The relative degree of corrosivity is determined by the material's ability to dissociate or form ions in solution. Those that form the number of hydrogen ions [H⁺] are the strongest acids, while those that form hydroxide ions [OH⁻] are the strongest bases. The pH scale ranges from 0 to 14 and is logarithmic, meaning that each numerical increase on the pH scale represents a tenfold increase in acids and base concentration relative to pure water measured at 7.0 pH. A 6.0 pH is 10 times more acidic than 7.0 pH; a 5.0 is 100 times more acidic than 7.0 pH. The term "weak" when applied to acids and bases means that only a small portion of the substance in solution has formed ions. Dilute means that only a small amount of the substance is in solution and is not the same as "weak." A dilute solution of a strong acid may have a higher pH (less acidic) than a concentrated solution of a weak acid.

The following table lists pH values for some of the more common solutions:

SOLUTION	pH
Hydrochloric Acid (4%)	0
Gastric juices	1.6 to 1.8
Lemon juice	2.3
Vinegar	3
Coke	4
Milk	6.5
Water	7
Isopropyl Alcohol	7
Milk of magnesia	10.5
Sodium hydroxide (4%)	13

A buffer is a solution that resists changes in pH when either an acid or base is added. Buffer solutions are critical to the human organism. A pH imbalance in the blood can cause acidosis (low pH) which in extreme cases can cause shock, coma, and even death; or alkalosis (high pH) which in severe cases can lead to convulsions or death. A buffer solution contains two components in relatively large concentrations: a weak acid and a salt of that acid. Citric acid and sodium citrate form a buffer combination often found in commercial food products.

It is important to note that different acids can have different health effects on the human body. For example: If splashed with a hydrochloric acid solution on 25 square inches of skin, an immediate sensation of burning will take place and the tissue that was exposed will burn and decomposed until the acid is flushed away or neutralized. While the exposed tissues will be damaged, there is no danger of the exposure going "systemic" and killing the person. (Later, infection could be a problem though.) Systemic means "body-wide," where the poison causes damage beyond the initial exposed area. This could be something that contaminates the blood, or targets one or more vital organs. If splashed with a 2% solution of Hydrofluoric Acid on 25 square inches of skin (5 inches by 5 inches), the skin will not burn away like other acids, but the chemical will move to the bone to decompose the bone. The effect will be systemic as the acid lowers the body's calcium level. Besides the extreme pain of the bone being eaten away, without immediate medical attention, the victim will die. The lowering of calcium levels in the blood by the Hydrofluoric Acid will also cause confusion, dizziness, and fainting.

Behavior of Spilled Chemicals

In order to understand how the impacts of chemical spills can be predicted, some science and chemistry concepts must be examined.

Vapor Pressure –

Vapor pressure is the measurement of a particular liquid chemical's tendency to vaporize. All liquids will evaporate, even thick liquids. Everyone is familiar with the evaporation of liquids like water, gasoline, and the solvents used in paints. When the paint dries, its solvents have all evaporated away, leaving the dry finish. These individual chemicals all evaporate at different rates, and they all have different vapor pressures.

And the vapor pressure for each increase, as the temperature goes up. When water is heated closer to its boiling point of 212 F, it evaporates at a faster rate than water at room temperature. The vapor pressure for the water increases as the water gets hotter. Those same paint solvents will dry faster if the paint is warmer. It takes longer for paint to dry in a cold house than a warm house.

Responders should beware of liquids with substantial (large) vapor pressures, which is the primary measure of a chemical's tendency to vaporize. Some chemicals evaporate faster than others.

Vapor pressure is also the measurement of the pressure exerted on the walls of a container which is partially full of the liquid chemical and free of any other vapor or gas. Higher temperatures cause increases in the vapor pressure. Lower temperatures cause a decrease, and there is a direct relationship between the temperature of any given substance and its vapor pressure. The warmer a liquid is, the more it tends to evaporate.

Vapor pressure is most often expressed in units of millimeters of mercury (mm Hg).

As a rule of thumb, the higher the vapor pressure, the further the distance the vapor will disperse. There is a direct relationship between the vapor pressure of an evaporating substance and the maximum concentration that its vapor or gas may achieve when mixed with air in the open environment. In other words, the concentration of the vapors of a spilled chemical will only be so much in the air, and this concentration depends on the vapor pressure of the chemical.

Higher vapor pressures above the surface of a substance require that more molecules of the substance be physically present. Thus, if the vapor pressure of the substance is known, the approximate maximum airborne contaminant concentration it may attain can be calculated. Such concentrations are most commonly expressed in units of percent in air by volume, parts per million parts of air (ppm) by volume, or in milligrams of chemical per cubic meter (mg/m³) of air.

No matter what the vapor pressure of a spilled chemical, it can only evaporate into the air if it is exposed to the air. So limiting the surface of a spilled liquid is a common strategy in responding to a spill of a liquid that is evaporating. Firefighters will dike (push dirt up to form a pool) the area around a tank that is leaking liquid to limit the surface area of the growing pool of liquid. The amount of surface area of a diked pool of liquid is much less than an uncontained spill.

To illustrate this, look at a filled glass of water, and note the small portion of the water that is in direct contact with the air. It is just a fraction of the total amount of the water in the glass that is exposed. If the glass of water is spilled, almost all of the water is exposed to the air, and the water spreads out into a much larger pool. And obviously, it would take longer for the water in the glass to evaporate than the spilled water, because more of the water molecules are exposed to the air.

Boiling Point –

Any liquid will boil at the temperature at which its vapor pressure equals the pressure being exerted by the environment onto the surface of the liquid. This is why water boils at a lower temperature in high elevations. So boiling points are related to the pressure exerted on the chemical.

Liquids in sealed containers (barrels, tanks) will remain as liquids when heated above their normal boiling points although their vapor pressures may become very dangerously high. If heating continues and the pressure is not adequately relieved by a safety device, the pressure and temperature within the tank may eventually rise to the point that some part or the entire container may burst or rupture. Water will boil when heated to the boiling point in an open pan on a stove, but if water is sealed inside a container and heated to its boiling point, the water will cause the container to burst.

This is why firefighters will take steps to cool a tank near a fire--to prevent a violent tank failure. When a tank bursts under this scenario, the liquid tends to vaporize almost instantly, and if flammable, burn almost instantly. One of the dangers associated with a tanker of propane is a BLEVE, Boiling Liquid Expanding Vapor Explosion. A BLEVE is a catastrophic explosion of a flammable fuel.

If a spilled liquid is in an environment above its boiling point, it will rapidly boil and expand, sometimes explosively. An example of this is Ammonia. Ammonia boils at -28.17 degrees Fahrenheit. If Ammonia spills, there may be a second phase reaction, which can cause a cloud of Ammonia to expand and move

very quickly. Ammonia is lighter than air, and once it warms up, it tends to move up and way into the atmosphere.

Often, the available data about a chemical will indicate its boiling point, but, just like water, a chemical in liquid form will evaporate at temperatures far below the boiling point.

Atmospheric Pressure –

The weight of the air is on everything, and the atmospheric pressure at sea level is more than at the top of a mountain. The weight of the air at sea level has been measured. The atmospheric pressure at sea level is 14.7 pounds per square inch, expressed as psi. This means that for every square inch of surface an object has, there are 14.7 pounds of pressure pushing down.

This sea level pressure is also expressed as one atmosphere. In the United States, the most common relative scale of measurement is in terms of gauge pressure, where a reading of zero matches an absolute pressure of one standard atmosphere. In this system, an absolute pressure of 15.7 psi would be expressed as 1.0 pound per square inch - gauge, or 1.0 psig for short. $[15.7 - 14.7 = 1.0]$ The pressure inside a tank of chemical will be usually expressed in these terms.

Any gas or vapor entering the atmosphere will quickly adjust its volume to achieve a total pressure of the atmosphere it is released in. The vapors from a spill of a chemical in a higher elevation will travel further than one at sea level, all other factors being the same.

A tank of a liquefied gas, when opened to the atmosphere, will spew out many times the original volume of the tank. Unless the tank is sealed, the liquefied gas will escape as a gas until the pressure of the atmosphere outside the tank is the same as inside the tank. A tank of propane, when emptied directly into the air, will still contain propane, but the pressure of the remaining propane will be at the same atmospheric pressure as the outside air.

To illustrate how gases behave when they escape from opened containers, open a bottle of a carbonated beverage. When one is opened, bubbles of carbon dioxide are seen forming and rising to the surface. Before opening the bottle, the carbon dioxide was dissolved into the liquid under pressure. When the bottle is opened, the pressure is released, and the carbon dioxide is seen escaping. If a person shook the bottle before opening, the carbon dioxide will escape more rapidly, spraying the liquid quite a distance. There is no way to look at the bottle of carbonated beverage and tell if it has been shook up or not. When modeling what a plume from a tank of chemicals might be, these same uncertainties are present.

When a tank of liquids vents gases into the outside atmosphere, the tank of liquids itself is cooled. This lowers the vapor pressure of the liquid in the tank, and may significantly slow the release of the gases from the tank. It also creates a special hazard because the leak may be more difficult to detect.

Vapor Density –

Chemicals have different molecular formulas and makeup. Vapor density is the ratio of the density of a pure gas or vapor to the density of air. Vapors or gases with a vapor density less than air tend to float above the air, moving up and away from the spilled chemical and the ground. This is just like oil floating on water because oil is less dense than water. Vapors or gases with a vapor density higher than air tend to sink and move along the ground. When the vapor density is close to that of air, the behavior can be more unpredictable, but is treated as if the gas is heavier than air.

Molecular Weight –

The molecular weight of a chemical depends on what elements make up its chemical formula. The molecular weight will vastly influence the behavior of a spilled chemical, including vapor pressure. The heavier the molecule of a chemical that is evaporating, the slower it will be to evaporate and float away. The heavier the molecules, the more likely they will be to move along the ground rather than upwards.

Special Chemical Reactions Software -

When working at a facility, a facility making chemical process changes, or even a facility that is merely rearranging chemicals stored at the facility, the facility workers should be aware of, and consider the compatibility of, the various chemicals that may be stored next to each other at the facility. This is important because the inadvertent mixing of incompatible chemicals can cause fires, explosions, poison gases to form, and other unexpected outcomes. It is important to consider what possible mixing of chemicals might occur in the event of a spill, fire, or hazardous materials incident.

To help understand potential reactions where more than one chemical may be involved in a spill scenario, the Chemical Reactivity Worksheet has been developed. It can be found on the web at:

<http://response.restoration.noaa.gov/chemaids.html>, or at

<http://response.restoration.noaa.gov/chemaids/react.html>.

This can be downloaded from the Internet. It includes a database of reactivity information for more than 4,000 common hazardous chemicals. The database includes information about the special hazards of each chemical and about whether a chemical reacts with air, water, or other materials. It also includes a way to virtually "mix" chemicals to find out what dangers could arise from accidental mixing.

Material Safety Data Sheets (MSDS)

The Material Safety Data Sheet (MSDS) provides detailed information prepared by the manufacturer of a chemical that includes; the physical and chemical properties; physical and health hazards; routes of exposure; precautions for safe handling and use; emergency and first-aid procedures, and control measures. The MSDS can also aid in the selection of appropriate PPE when handling the chemical, and guides employers and employees to respond effectively to daily exposure situations as well as to emergency situations.

While there is not a specific format required by OSHA for MSDS sheets, many manufacturers do follow a common format. OSHA provides guidance for the subjects that must be covered. What are consistent about MSDSs are the types of information required to be included on each form.

Distributors of chemicals shall ensure that Material Safety Data Sheets, and updated information, are provided to other distributors and employers with their initial shipment and with the first shipment after a Material Safety Data Sheet is updated.

The distributor shall either provide Material Safety Data Sheets with the shipped containers, or send them to the other distributor or employer prior to or at the time of the shipment.

But there are problems with MSDSs. Not all of the information is presented the same way because there is not one specific format. There is often disagreement on the data on the different MSDSs. A review of several different MSDSs for the same chemical can show different information. There is nothing that requires a detailed accounting of all information on an MSDS. Some are "bare-bones," others have more information. There can be disagreement about what constitutes safe levels of exposure or the proper instructions for medical attention.

The MSDS information that the OSHA guidance requires first examines if the chemical is a single substance or a mixture. If it is a single substance, the chemical and common name(s) of the chemical are required.

If the hazardous chemical is a mixture which has been tested *as a whole to determine its hazards*, the chemical and common name(s) of the ingredients which contribute to these known hazards, and the common name(s) of the mixture itself must be provided.

If the hazardous chemical is a mixture which has not been tested as a whole, the MSDS must provide:

1. The chemical and common name(s) of all ingredients which have been determined to be health hazards, and which comprise 1% or greater of the composition, except that chemicals identified by OSHA regulations as carcinogens (cancer-causing agent) shall be listed if the concentrations are 0.1% or greater; and,
2. The chemical and common name(s) of all ingredients which have been determined to be health hazards, and which comprise less than 1% (0.1% for carcinogens) of the mixture, if there is evidence that the ingredient(s) could be released from the mixture in concentrations which would exceed an established OSHA permissible exposure limit** (OSHA PEL) or ACGIH (American Conference of Governmental Industrial Hygienists) Threshold Limit Value, or could present a health risk to employees; and,
3. The chemical and common name(s) of all ingredients which have been determined to present a physical hazard when present in the mixture;
4. The physical and chemical characteristics of the hazardous chemical (such as vapor pressure, flash point);
5. The physical hazards of the hazardous chemical, including the potential for fire, explosion, and reactivity;
6. The health hazards of the hazardous chemical, including signs and symptoms of exposure, and any medical conditions which are generally recognized as being aggravated by exposure to the chemical;
7. The primary route(s) of entry;
8. The OSHA permissible exposure limit, ACGIH Threshold Limit Value, and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the Material Safety Data Sheet, where available;
9. Whether the hazardous chemical is listed in the National Toxicology Program (NTP) Annual Report on Carcinogens (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) Monographs (latest editions), or by OSHA;
10. Any generally applicable precautions for safe handling and use which are known to the chemical manufacturer, importer or employer preparing the material safety data sheet, including appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for clean-up of spills and leaks;
11. Any generally applicable control measures which are known to the chemical manufacturer, importer or employer preparing the Material Safety Data Sheet, such as appropriate engineering controls, work practices, or personal protective equipment;
12. Emergency and first aid procedures;
13. The date of preparation of the Material Safety Data Sheet or the last change to it; and,
14. The name, address and telephone number of the chemical manufacturer, importer, employer or other responsible party preparing or distributing the Material Safety Data Sheet, who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

What is the GHS?

The GHS is a short acronym for *The Globally Harmonized System of Classification and Labeling of Chemicals*. The GHS is a system for standardizing and harmonizing the classification and labeling of chemicals. It is a logical and comprehensive approach to:

- Defining health, physical and environmental hazards of chemicals;
- Creating classification processes that use available data on chemicals for comparison with the defined hazard criteria; and
- Communicating hazard information, as well as protective measures, on labels and Safety Data Sheets (SDS).

GHS is a system that defines and classifies the hazards of chemical products, and communicates health and safety information on labels and material safety data sheets (called Safety Data Sheets, or SDSs, in GHS). The goal is that the same set of rules for classifying hazards, and the same format and content for labels and safety data sheets (SDS) will be adopted and used around the world. An international team of hazard communication experts developed GHS.

Why GHS?

In the past, many different countries had different systems for classification and labeling of chemical products. In addition, several different systems could exist even within the same country (see example below). This situation has been expensive for governments to regulate and enforce, costly for companies who have to comply with many different systems, and confusing for workers who need to understand the hazards of a chemical in order to work safely.

GHS promises to deliver several distinct benefits. Among them are:

- promoting regulatory efficiency
- facilitating trade
- easing compliance
- reducing costs
- providing improved, consistent hazard information
- encouraging the safe transport, handling and use of chemicals
- promoting better emergency response to chemical incidents, and
- reducing the need for animal testing

Example of difference –

Agency	Flammable	Combustible
OSHA	0 – 100	100 – 200
NFPA	0 – 100	100 – 200+
DOT	0 – 140	140 – 200
GHS	0 – 140	140 – 200

Two major elements in GHS

The two major elements of GHS are:

1. Classification of the hazards of chemicals according to the GHS rules:
 - i. GHS provides guidance on classifying pure chemicals and mixtures according to its criteria or rules.
2. Communication of the hazards and precautionary information using Safety Data Sheets and labels:
 - i. *Labels* – With the GHS system, certain information will appear on the label. For example, the chemical identity may be required. Standardized hazard statements, signal words and symbols will appear on the label according to the classification of that chemical or mixture. Precautionary statements may also be required, if adopted by your regulatory authority.

- ii. *Safety Data Sheets (SDS)* – The GHS SDS has 16 sections in a set order, and information requirements are prescribed.

Key terms in the GHS Vocabulary

1. *SDS* – Safety Data Sheet. SDS is the term used by GHS for Material Safety Data Sheet's (MSDS) replacement.
2. *Hazard group* – While not given a formal definition, GHS divides hazards into three major groups - Health, Physical and Environmental.
3. *Class* – Class is the term used to describe the different hazards. For example, "Gases under Pressure" is an example of a Class in the Physical Hazards Group.
4. *Category* – Category is the name used to describe the sub-sections of classes. For example, Self-Reactive Chemicals have 7 categories. Each category has rules or criteria to determine what chemicals are assigned to that category.
5. *Hazard Statement* – For each category of a class, a standardized statement is used to describe the hazard. For example, the hazard statement for chemicals which meet the criteria for the class Self-heating substances and mixtures, Category 1 is "Self-heating; may catch fire". This hazard statement would appear both on the label and on the SDS.
6. *Signal word* – There are two signal words in the GHS system - Danger and Warning. **Note: the word "Caution" is no longer a signal word.** These signal words are used to communicate the level of hazard on both the label and the SDS. The appropriate signal word to use is set out by the classification system. For example, the signal word for Self-heating substances and mixtures, Category 1 is "Danger" while "Warning" is used for the less serious Category 2. There are categories where no signal word is used.
7. *Pictogram* – Pictogram refers to the GHS symbol on the label and SDS. Not all categories have a symbol associated with them.

Classes within the Health Hazard Group

Criteria for classifying chemicals have been developed for the following health hazard classes:

- acute toxicity
- skin corrosion/irritation
- serious eye damage/eye irritation
- respiratory or skin sensitization
- germ cell mutagenicity
- carcinogenicity
- reproductive toxicity
- specific target organ toxicity - single exposure
- specific target organ toxicity - repeated exposure
- aspiration hazard

In addition, there are specific classification rules for chemical mixtures for each health hazard class.

Classes within the Physical Hazard Group

Criteria for classifying chemicals have been developed for the following physical hazard classes:

- explosives
- flammable gases
- flammable aerosols
- oxidizing gases
- gases under pressure
- flammable liquids
- flammable solids
- self-reactive substances and mixtures
- pyrophoric liquids
- pyrophoric solids
- self-heating substances and mixtures
- substances and mixtures which, in contact with water, emit flammable gases
- oxidizing liquids
- oxidizing solids
- organic peroxides
- corrosive to metals

Classes within the Environmental Hazard Group

Criteria for classifying chemicals have been developed for the following environmental hazard class:

- hazardous to the aquatic environment (acute and chronic)
- hazardous to the ozone layer

In addition, there are specific classification rules for chemical mixtures for each environmental hazard class.

GHS Label Format

The GHS includes directions for application of the hazard communication elements on the label. In particular, it specifies for each hazard, and for each class within the hazard, what signal word, pictogram, and hazard statement should be used. The GHS hazard pictograms - signal words and hazard statements - should be located together on the label. The actual label format or layout is not specified in the GHS. National authorities may choose to specify where information should appear on the label or allow supplier discretion. There has been discussion about the size of GHS pictograms and that a GHS pictogram might be confused with a transport pictogram or "diamond". Transport pictograms are different in appearance than the GHS pictograms. Annex 7 of the Purple Book explains how the GHS pictograms are expected to be proportional to the size of the label text. So that generally the GHS pictograms would be smaller than the transport pictograms.

GHS Label Elements



One of the new symbols/pictograms

The standardized label elements included in the GHS are:

- **Symbols** (hazard pictograms): Convey health, physical and environmental hazard information, assigned to a GHS hazard class and category. Pictograms include the harmonized hazard symbols plus other graphic elements, such as borders, background patterns or colors that are intended to convey specific information. The symbols are similar to current EU symbols, with a few exceptions. A new hazard symbol featuring a white sprawling mass within a bust of a human is introduced. It is used for carcinogens, mutagens, reproductive toxicity, aspiration hazards, respiratory sensitizers and substances which have target organ toxicity. Also, harmful chemicals and irritants are marked with an exclamation mark, replacing the European saltire (a diagonal cross). Pictograms will have a black symbol on a white background with a red diamond frame. For transport, pictograms will have the background, symbol and colors currently used in the UN Recommendations on the Transport of Dangerous Goods. Where a transport pictogram appears, the GHS pictogram for the same hazard should not appear. Examples of all the pictograms and downloadable files can be accessed on the UN website for the GHS at <http://www.unece.org/trans/danger/publi/ghs/pictograms.html>
- **Signal Words:** "Danger" or "Warning" will be used to emphasize hazards and indicate the relative level of severity of the hazard, assigned to a GHS hazard class and category. Some lower level hazard categories do not use signal words. Only one signal word corresponding to the class of the most severe hazard should be used on a label.
- **Hazard Statements:** Standard phrases assigned to a hazard class and category that describe the nature of the hazard. An appropriate statement for each GHS hazard should be included on the label for products possessing more than one hazard.

The additional label elements included in the GHS are:

- **Precautionary Statements:** Measures to minimize or prevent adverse effects. There are four types of precautionary statements covering: prevention, response in cases of accidental spillage or exposure, storage, and disposal. The precautionary statements have been linked to each GHS hazard statement and type of hazard.
- **Product Identifier** (ingredient disclosure): Name or number used for a hazardous product on a label or in the MSDS. The GHS label for a substance should include the chemical identity of the substance. For mixtures, the label should include the chemical identities of all ingredients that contribute to acute toxicity, skin corrosion or serious eye damage, germ cell mutagenicity, carcinogenicity, reproductive toxicity, skin or respiratory sensitization, or Target Organ Systemic Toxicity (TOST), when these hazards appear on the label.
- **Supplier identification:** The name, address and telephone number should be provided on the label.
- **Supplemental information:** Non-harmonized information on the container of a hazardous product that is not required or specified under the GHS. Supplemental information may be used to provide further detail that does not contradict or cast doubt on the validity of the standardized hazard information.

Data Sheet or Safety Data Sheet

The GHS Safety Data Sheet (SDS) is specifically aimed at use in the workplace. It is very similar to the MSDS, however, the SDS has additional comprehensive information about the chemical products that allows employers and workers to obtain concise, relevant and accurate information that can be put in perspective with regard to the hazards, uses and risk management the chemical product in the workplace.

The SDS contains 16 required sections – the current MSDS requires only eight sections. While there were some differences in existing industry recommendations, there was widespread agreement on a 16 section SDS – the sections includes the following headings in the order specified:

1. Identification
2. Hazard(s) identification
3. Composition/ information on ingredients
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure control/ personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information.

The primary difference between the GHS requirements in terms of headings and sections and the international industry recommendations is that sections 2 and 3 have been reversed in order. The GHS SDS headings, sequence and content are similar to the ISO, EU and ANSI MSDS/SDS requirements.

Identification of Hazardous Materials

Different regulatory agencies use different ways to describe hazardous materials.






- The United States Department of Transportation (DOT) defines a "hazardous material" as a substance or material capable of posing an unreasonable risk to health, safety, and property when transported.
- The United States Environmental Protection Agency (EPA) uses the term "hazardous substance", and provides lists of such hazardous substances in various regulations.
- The Occupational Safety and Health Administration (OSHA) define "hazardous and toxic substances" as those chemicals present in the workplace which are capable of causing harm.
- The National Fire Protection Association (NFPA) defines "hazardous material" as a substance (solid, liquid or gas) that when released is capable of creating harm to people, the environment, and property.
- Internationally, the term "dangerous goods" is used to describe articles or substances which are capable of posing a risk to health, safety, property or the environment.

All these different descriptions for a hazardous material can be summed up to; when a material escapes its container and has the potential to hurt or harm someone, or damage something.

Thousands of substances in use and in transport every day exhibit one or more characteristics of flammability, radioactivity, corrosiveness, toxicity, or other properties which classify them as hazardous.

In both international and domestic transportation, there are nine classes of hazardous materials/dangerous goods. Some of these classes are further divided into divisions, based on their hazard characteristics. Each of these classes have specific shipping placard and package labeling requirements. Placards are used to represent the hazard classes of materials contained within freight containers, motor vehicles or train cars. Labels communicate the same hazards for smaller containers and packages offered for transport. Examples of the placards and labels used for the various hazard classes follow.

Hazard Classes / Placards

	<p>Class 1: Explosives</p> <p>Division 1.1 Explosives with a mass explosion hazard (Examples: dynamite, TNT, and black powder)</p> <p>Division 1.2 Explosives with a projection hazard (Examples: certain rockets, projectiles, Igniters, aerial flares and fireworks)</p> <p>Division 1.3 Explosives with predominantly a fire hazard (Examples: rocket motors and smokeless powder)</p> <p>Division 1.4 Explosives with no significant blast hazard (Examples: flexible detonating cord and small arms ammunition)</p> <p>Division 1.5 Very insensitive explosives with a mass explosion hazard (Example: ammonium nitrate and fuel oil)</p> <p>Division 1.6 Extremely insensitive detonating articles</p>
  	<p>Class 2: Gases</p> <p>Division 2.1 Flammable gases (Examples: hydrogen, acetylene, propane and vinyl chloride)</p> <p>Division 2.2 Nonflammable, nontoxic* gases (Examples: carbon dioxide and oxygen)</p> <p>Division 2.3 Toxic* gases (Example: chlorine)</p> <p>*The words "poison" or "poisonous" are synonymous with the word "toxic"</p> <p>Other examples of Toxic Gas Placards</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div>



Class 3: Flammable liquids

Liquids with a flash point below 141 degrees F. Examples: gasoline, toluene and ethyl alcohol), ... and

Combustible liquids

Liquids with a flash point above 141 degrees F. and below 200 degrees F. Example: diesel fuel)



Class 4: Flammable solids; Spontaneously combustible materials; and Dangerous when wet materials/Water-reactive substances

Division 4.1 Flammable Solids (wetted explosives that when dry are Explosives of Class 1, are self reactive materials that are thermally unstable and that can undergo a strongly exothermal decomposition even without participation of oxygen, or solids which may cause a fire through friction. Examples: magnesium, matches)

Division 4.2 Spontaneously Combustible Materials (A pyrophoric liquid or solid that can ignite within 5 minutes after contact with air without an external ignition source. Examples: white phosphorus and alkyl bromide)

Division 4.3 Water-Reactive substances - Dangerous when Wet Materials (a material that by contact with water may become spontaneously flammable or give off flammable or toxic gas. Examples: metallic sodium and calcium carbide)



Class 5: Oxidizers and Organic peroxides

Division 5.1 Oxidizers (solid or liquid material that may, generally by yielding oxygen, cause or enhance the combustion of other materials. Examples: calcium hypochlorate, ammonium nitrate and hydrogen peroxide)

Division 5.2 Organic peroxides [any organic compound containing oxygen in the bivalent structure (an O-O bond which easily breaks) and which may be considered a derivative of hydrogen peroxide. Most organic peroxides are highly flammable, explosive, powerful, volatile, and strong bleaching agents. Examples: methyl ethyl ketone peroxide, benzoyl peroxide.]



Class 6: Toxic* substances and Infectious substances

Division 6.1 Toxic* substances (poisonous material, other than a gas, which is known or presumed to be toxic to humans. (Examples: tetraethyl lead, hydrogen or sodium cyanide, parathion, and biological toxins)

Division 6.2 Infectious substances (Example: Staphylococcus aureus, HIV)

* The words "poison" or "poisonous" are synonymous with the word "toxic"








Class 7: Radioactive materials

Any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in the table in [49 CFR 173.436](#).



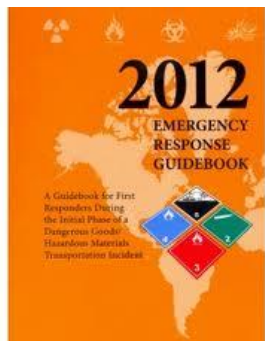
Class 8: Corrosive substances

A material, liquid or solid, that causes visible destruction or irreversible alteration to human skin or a liquid that has a severe corrosion rate on steel or aluminum (Examples: acids - sulfuric acid, acetic acid, hydrochloric acid; bases - sodium hydroxide, potassium hydroxide and alkali battery fluid)

	<p>Class 9: Miscellaneous</p> <p>A material which presents a hazard during transport, but which is not included in any other hazard class. (Examples: molten sulfur, dry ice, and PCBs)</p>
   	<p>ORM-D: Other regulated material and markings</p> <p>A material which, although otherwise subjected to regulations, presents a limited hazard during transportation due to its form, quantity and packaging (Examples: spray paint and hair spray)</p> <p>Markings are additional identifiers (other than hazard labels & placards) that further describe the package.</p>

Emergency Response Guidebook

Once the material involved is identified, initial actions may be determined from the guidelines outlined in the DOT *Emergency Response Guidebook* (ERG). This guidebook is distributed free of charge to Public Safety Organizations.



The ERG is used by first responders, firefighters, police officers, and ambulance personnel when responding to a transportation emergency involving hazardous materials. It was first issued by the US Department of Transportation in 1973 and was most recently reissued in 2012 as a joint publication of the US, Canada, Mexico & Argentina. It is issued every 4 years.

The ERG is primarily a guide to aid first responders in quickly identifying the specific or generic hazards of the material(s) involved in the incident, and protecting themselves and the general public during the initial response phase of the incident.

This guidebook will assist responders in making initial decisions upon arriving at the scene of a dangerous goods incident. The guide is intended only to be used for the **first thirty minutes** of an emergency. The ERG **does not** address all possible circumstances that may be associated with a dangerous goods incident. It is primarily designed for use at a dangerous goods incident occurring on a highway or railroad. Be mindful that there may be limited value in its application at fixed facility locations.

The ERG is divided into four color-coded sections.

White Section

The White Section appears at both the front and back of the guidebook. The front section contains information on how to use the guidebook, safety precautions, who to call for assistance, hazard classifications, and a placard guide.

Yellow Section

The Yellow Section references the material in order of its assigned UN (United Nations) number which is often placarded with the other hazardous materials placards. This gives a guide number which refers the user to the Orange Section.

Blue Section

The Blue Section references the material in alphabetical order of its name. It then, like the yellow section, gives the guide number (and the UN number) to reference to the Orange Section. In both the Yellow and Blue Sections, a highlighted entry means an evacuation area needs to be established and the user should first refer to the Green Section.

Orange Section

The Orange Section gives directions on how to proceed during the first thirty minutes. It gives health and fire/explosion hazard information, listing the most dangerous of the two first. For example, "the material gives off irritating vapors, easily ignited by heat, reactive with water," etc.

After this, information for responders on appropriate protective clothing and possible evacuation information for either spill or fire is given. It also gives information on fighting fires (example, do not apply water to sodium), warnings for spills or leaks, and special directions for first aid (example, not to give mouth-to-mouth respiration if the materials are toxic).

Green Section

The Green Section suggests initial evacuation or shelter-in-place distances (protective action distances) for spills of materials that are toxic by inhalation (TIH). These distances vary based on the size of the spill and whether the incident has occurred during the day or the night. Only chemicals that are highlighted in the Yellow and Blue Sections are included in the Green Section.

Weapons of Mass Destruction

Beginning with the 2004 edition, a small section within the white pages (page 368 in the 2012 edition) at the back of the book gives information specifically for hazardous materials being used for terrorism.

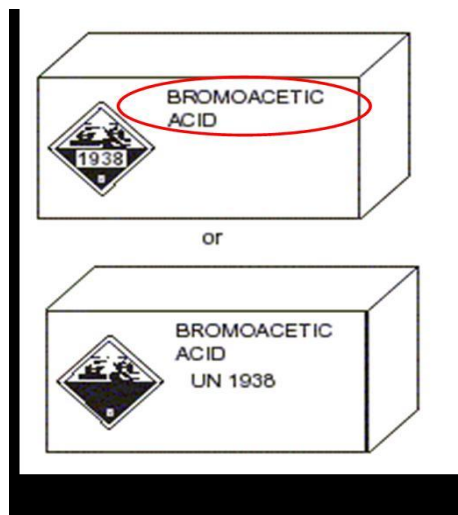
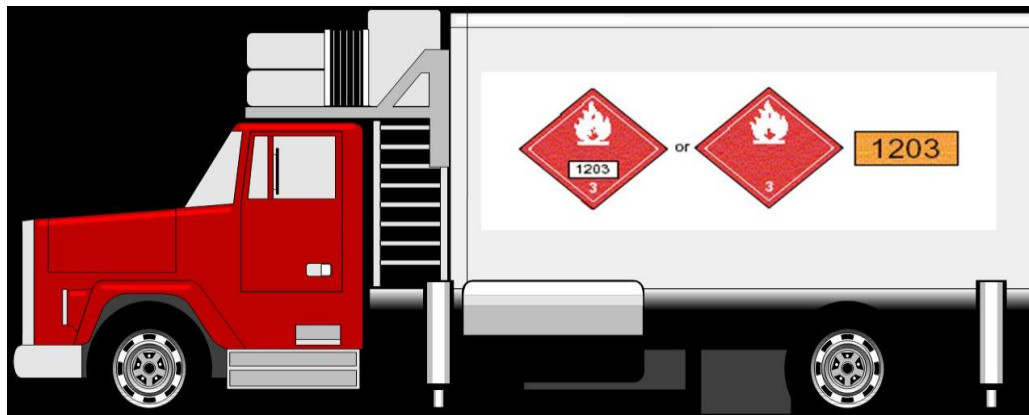
Unplacarded Vehicles

In the event of an unknown material, a special guide (#111) is assigned. If the material is unknown and the UN number is not posted, but a placard is displayed (such as radioactive, or corrosive), special guides are also referenced, as are special guides for certain types of containers.

To use the ERG:

STEP ONE: *Identify the material.* Use any of the following:

- Identification Number (4-Digit ID) from a placard, orange panel, shipping paper or package (after UN/NA)



- NAME OF THE MATERIAL from a shipping document or package

STEP TWO: Identify the 3-Digit Guide Number in the ERG

- If you know the ID NUMBER, go to the ID NUMBER INDEX in the yellow-bordered pages

ID No.	Guide No.	Name of Material	ID No.	Guide No.	Name of Material
1063	115	Refrigerant gas R-40	1077	115	Propylene
1064	117	Methyl mercaptan	1078	126	Dispersant gas, n.o.s.
1065	121	Neon	1078	126	Refrigerant gas, n.o.s.
1065	121	Neon, compressed	1079	125	Sulfur dioxide
1066	121	Nitrogen	1079	125	Sulphur dioxide
1066	121	Nitrogen, compressed	1080	126	Sulfur hexafluoride
1067	124	Dinitrogen tetroxide	1080	126	Sulphur hexafluoride
1067	124	Nitrogen dioxide	1081	116P	Tetrafluoroethylene, stabilized
1069	125	Nitrosyl chloride	1082	119P	Trifluorochloroethylene, stabilized
1070	122	Nitrous oxide	1083	118	Trimethylamine, anhydrous
1070	122	Nitrous oxide, compressed	1085	116P	Vinyl bromide, stabilized
1071	119	Oil gas	1086	116P	Vinyl chloride, stabilized
1071	119	Oil gas, compressed	1087	116P	Vinyl methyl ether, stabilized
1072	122	Oxygen	1088	127	Acetal
1072	122	Oxygen, compressed	1089	129	Acetaldehyde
1073	122	Oxygen, refrigerated liquid (cryogenic liquid)	1090	127	Acetone
1075	115	Butane	1091	127	Acetone oils
1075	115	Butane mixture	1092	131P	Acrolein, stabilized
1075	115	Butylene	1093	131P	Acrylonitrile, stabilized
1075	115	Isobutane	1098	131	Allyl alcohol
1075	115	Isobutane mixture	1099	131	Allyl bromide
1075	115	Isobutylene	1100	131	Allyl chloride
1075	115	Liquefied petroleum gas	1104	129	Amyl acetates
1075	115	LPG	1105	129	Amyl alcohols
1075	115	Petroleum gases, liquefied	1105	129	Pentanol
1075	115	Propane	1106	132	Amylamines
1075	115	Propane mixture	1107	129	Amyl chloride
1075	115	Propylene	1108	128	n-Amylene
1076	125	CG	1108	128	1-Pentene
1076	125	Diphosgene	1109	129	Amyl formates
1076	125	DP	1110	127	n-Amyl methyl ketone
1076	125	Phosgene	1110	127	Amyl methyl ketone

- If you know the NAME OF THE MATERIAL, go to the NAME OF MATERIAL INDEX in the Blue Section

Name of Material	Guide No.	ID No.	Name of Material	Guide No.	ID No.
Bisulfates, aqueous solution	154	2837	Boron trifluoride propionic acid complex, solid	157	3420
Bisulfites, aqueous solution, n.o.s.	154	2693	Bromates, inorganic, aqueous solution, n.o.s.	140	3213
Bisulfites, inorganic, aqueous solution, n.o.s.	154	2693	Bromates, inorganic, n.o.s.	141	1450
Bisulphates, aqueous solution	154	2837	Bromine	154	1744
Bisulphites, aqueous solution, n.o.s.	154	2693	Bromine, solution	154	1744
Bisulphites, inorganic, aqueous solution, n.o.s.	154	2693	Bromine, solution (Inhalation Hazard Zone A)	154	1744
Blasting agent, n.o.s.	112	—	Bromine, solution (Inhalation Hazard Zone B)	154	1744
Bleaching powder	140	2208	Bromine chloride	124	2901
Blue asbestos	171	2212	Bromine pentafluoride	144	1745
Bombs, smoke, non-explosive, with corrosive liquid, without initiating device	153	2028	Bromine trifluoride	144	1746
Borate and Chlorate mixtures	140	1458	Bromoacetic acid	156	1938
Borneol	133	1312	Bromoacetic acid, solid	156	3425
Boron tribromide	157	2692	Bromoacetic acid, solution	156	1938
Boron trichloride	125	1741	Bromoacetone	131	1569
Boron trifluoride	125	1008	Bromoacetyl bromide	156	2513
Boron trifluoride, compressed	125	1008	Bromobenzene	130	2514
Boron trifluoride, dihydrate	157	2851	Bromobenzyl cyanides	159	1694
Boron trifluoride acetic acid complex	157	1742	Bromobenzyl cyanides, liquid	159	1694
Boron trifluoride acetic acid complex, liquid	157	1742	Bromobenzyl cyanides, solid	159	1694
Boron trifluoride acetic acid complex, solid	157	3419	Bromobenzyl cyanides, solid	159	3449
Boron trifluoride diethyl etherate	132	2604	1-Bromobutane	130	1126
Boron trifluoride dimethyl etherate	139	2965	2-Bromobutane	130	2339
Boron trifluoride propionic acid complex	157	1743	Bromochlorodifluoromethane	126	1974
Boron trifluoride propionic acid complex, liquid	157	1743	Bromochloromethane	160	1887
			1-Bromo-3-chloropropane	159	2688
			2-Bromoethyl ethyl ether	130	2340
			Bromoform	159	2515
			1-Bromo-3-methylbutane	130	2341
			Bromomethylpropanes	130	2342
			2-Bromo-2-nitropropane-1,3-diol	133	3241

- If you don't know either, pages 6 and 7 (2012 edition) of the ERG depict the different placards used in the transport of dangerous goods. Each set of placards has a 3-digit guide number next to them.

TABLE OF PLACARDS AND INITIAL USE THIS TABLE ONLY IF MATERIALS CANNOT BE SPECIFICALLY IDENTIFIED BY			RESPONSE GUIDE TO USE ON-SCENE USING THE SHIPPING DOCUMENT, NUMBERED PLACARD, OR ORANGE PANEL NUMBER		

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- Finally, pages 8 and 9 (2012 edition) depicts the general shapes of railcars and road trailers used in the transportation of dangerous goods. Each shape is associated to a 3-digit guide number.

RAIL CAR IDENTIFICATION CHART*

Pressure Tank Car Compressed Liquefied Gases (117)

Low Pressure Tank Car Liquids (131)

REPORTING MARKS & CAR NUMBER
LOAD LIMIT (POUNDS OR KG)
EMPTY WEIGHT OF CAR
PLACARD HOLDER
TANK TEST & SAFETY VALVE TEST INFORMATION
CAR SPECIFICATION
COMMODITY NAME*
TC PERMIT NUMBER

REPORTING MARKS & CAR NUMBER
CAPACITY IN GALLONS OR LITERS
PLACARD HOLDER*

CAUTION: Emergency response personnel must be aware that rail tank cars vary widely in construction, fittings and purpose. Tank cars could transport products that may be solids, liquids or gases. The products may be under pressure. It is essential that products be identified by consulting shipping documents or train consist or contacting dispatch centers before emergency response is initiated.

The information stenciled on the sides or ends of tank cars, as illustrated above, may be used to identify the product utilizing:

- the commodity name shown; or
- the other information shown, especially reporting marks and car number which, when supplied to a dispatch center, will facilitate the identification of the product.

* The recommended guides should be considered as last resort if the material cannot be identified by any other means.

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ROAD TRAILER IDENTIFICATION CHART*

DOT406, TC406, SCT-306 Non-pressure Liquid Tank (MC306, TC306) (131)

MC338, TC338, SCT-338 Cryogenic Liquid Tank (TC341, CGA341) (117)

DOT407, TC407, SCT-307 Low Pressure Chemical Tank (MC307, TC307) (137)

DOT412, TC412, SCT-312 Corrosive Liquid Tank (MC312, TC312) (137)

MC331, TC331, SCT-331 High Pressure Tank (117)

DOT407, TC407, DOT412, TC412 Vacuum Loaded Tank (TC350) (137)

Intermodal Tank (117)

CAUTION: This chart depicts only the most general shapes of road trailers. Emergency response personnel must be aware that there are many variations of road trailers, not illustrated above, that are used for shipping chemical products. The suggested guides are for the most hazardous products that may be transported in these trailer types.

* The recommended guides should be considered as last resort if the material cannot be identified by any other means.

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- Use Guide 112 for all explosives except EXPLOSIVES 1.4 (EXPLOSIVES C) where Guide 114 is to be consulted.

Notes:

- Guide numbers supplemented with the letter "P" indicates that the material may undergo violent polymerization if subjected to heat or contamination.
- Index entries highlighted in green are TIH (Toxic Inhalation Hazard) material, a chemical warfare agent or a Dangerous Water Reactive Material (produces toxic gas upon contact with water). Go straight to the green section and find the ID number and name of the material. If necessary, begin protective actions immediately.

STEP THREE: Once the 3-Digit Guide Number is identified, turn to that Guide Number in the Orange Section. For example, if you look up "Gasoline" in the Blue Section, it gives you the 3-Digit Guide Number of 128. Guide 128 in the Orange Section is shown here.

GUIDE 128	FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE)	ERG2008	ERG2008	FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE)	GUIDE 128
POTENTIAL HAZARDS			EMERGENCY RESPONSE		
FIRE OR EXPLOSION <ul style="list-style-type: none"> • HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames. • Vapors may form explosive mixtures with air. • Vapors may travel to source of ignition and flash back. • Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). • Vapor explosion hazard indoors, outdoors or in sewers. • Those substances designated with a "P" may polymerize explosively when heated or involved in a fire. • Runoff to sewer may create fire or explosion hazard. • Containers may explode when heated. • Many liquids are lighter than water. • Substance may be transported hot. • If molten aluminum is involved, refer to GUIDE 169. 			FIRE CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient. CAUTION: For mixtures containing alcohol or polar solvent, alcohol-resistant foam may be more effective. Small Fire <ul style="list-style-type: none"> • Dry chemical, CO₂, water spray or regular foam. Large Fire <ul style="list-style-type: none"> • Water spray, fog or regular foam. • Use water spray or fog; do not use straight streams. • Move containers from fire area if you can do it without risk. Fire Involving Tanks or Car/Trailer Loads <ul style="list-style-type: none"> • Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. • Cool containers with flooding quantities of water until well after fire is out. • Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. • ALWAYS stay away from tanks engulfed in fire. • For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. 		
HEALTH <ul style="list-style-type: none"> • Inhalation or contact with material may irritate or burn skin and eyes. • Fire may produce irritating, corrosive and/or toxic gases. • Vapors may cause dizziness or suffocation. • Runoff from fire control or dilution water may cause pollution. 			SPILL OR LEAK <ul style="list-style-type: none"> • ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). • All equipment used when handling the product must be grounded. • Do not touch or walk through spilled material. • Stop leak if you can do it without risk. • Prevent entry into waterways, sewers, basements or confined areas. • A vapor suppressing foam may be used to reduce vapors. • Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. • Use clean non-sparking tools to collect absorbed material. Large Spill <ul style="list-style-type: none"> • Dike far ahead of liquid spill for later disposal. • Water spray may reduce vapor; but may not prevent ignition in closed spaces. 		
PUBLIC SAFETY			FIRST AID		
<ul style="list-style-type: none"> • CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover. • As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions. • Keep unauthorized personnel away. • Stay upwind. • Keep out of low areas. • Ventilate closed spaces before entering. 			<ul style="list-style-type: none"> • Move victim to fresh air. • Call 911 or emergency medical service. • Give artificial respiration if victim is not breathing. • Administer oxygen if breathing is difficult. • Remove and isolate contaminated clothing and shoes. • In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. • Wash skin with soap and water. • In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin. • Keep victim warm and quiet. • Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. 		
PROTECTIVE CLOTHING <ul style="list-style-type: none"> • Wear positive pressure self-contained breathing apparatus (SCBA). • Structural firefighters' protective clothing will only provide limited protection. 					
EVACUATION Large Spill <ul style="list-style-type: none"> • Consider initial downwind evacuation for at least 300 meters (1000 feet). Fire <ul style="list-style-type: none"> • If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions. 					

If a shipping document is available, call the emergency response telephone number listed. If a shipping document or emergency response telephone is not available, IMMEDIATELY CALL the appropriate emergency response agency listed in the back of this guidebook. Provide as much information as possible, such as the name of the carrier (trucking company or railroad) and vehicle number.

If a reference to a Guide cannot be found and the incident is believed to involve dangerous goods, turn to guide 111 and use it until additional information becomes available.

The Orange Section contains:

- Under **Public Safety:**
 - A suggested isolation area, as an immediate precautionary measure, irrespectively of the quantity involved.
- Under **Evacuation:**
 - A suggested evacuation perimeter for spill and fire situations AND/OR
 - The reference to Table 1 - Initial Isolation and Protective Action Distances (Green Section)

If the Yellow or Blue Sections are not highlighted in green, isolate the area in all directions as an immediate precautionary measure to the minimum distance suggested under **Public Safety** in the Orange Section, increase the zone if needed, and consider the evacuation distances suggested.

If the Yellow or Blue Sections are highlighted in green, for small and large spills use the "Initial Isolation and Protective Action Distances" suggested in the Green Section (Table 1), and in case of fire, use the distances provided in the Guide in the Orange Section, under **Evacuation - Fire**.

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TABLE 1 - INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES													
ID No.	NAME OF MATERIAL	SMALL SPILLS (From a small package or small leak from a large package)				LARGE SPILLS (From a large package or from many small packages)							
		First ISOLATE in all Directions		Then PROTECT		First ISOLATE in all Directions		Then PROTECT					
				persons Downwind during-				persons Downwind during-					
		Meters	(Feet)	DAY Kilometers (Miles)	NIGHT Kilometers (Miles)	Meters	(Feet)	DAY Kilometers (Miles)	NIGHT Kilometers (Miles)				
1005	Ammonia, anhydrous	30 m	(100 ft)	0.1 km	(0.1 mi)	0.2 km	(0.1 mi)	150 m	(500 ft)	0.8 km	(0.5 mi)	2.3 km	(1.4 mi)
1005	Anhydrous ammonia												
1008	Boron trifluoride	30 m	(100 ft)	0.1 km	(0.1 mi)	0.6 km	(0.4 mi)	300 m	(1000 ft)	1.9 km	(1.2 mi)	4.8 km	(3.0 mi)
1008	Boron trifluoride, compressed												
1016	Carbon monoxide	30 m	(100 ft)	0.1 km	(0.1 mi)	0.1 km	(0.1 mi)	150 m	(500 ft)	0.7 km	(0.5 mi)	2.7 km	(1.7 mi)
1016	Carbon monoxide, compressed												
1017	Chlorine	60 m	(200 ft)	0.4 km	(0.3 mi)	1.6 km	(1.0 mi)	600 m	(2000 ft)	3.5 km	(2.2 mi)	8.0 km	(5.0 mi)
1023	Coal gas	30 m	(100 ft)	0.1 km	(0.1 mi)	0.1 km	(0.1 mi)	60 m	(200 ft)	0.3 km	(0.2 mi)	0.4 km	(0.3 mi)
1023	Coal gas, compressed												
1026	Cyanogen	30 m	(100 ft)	0.2 km	(0.1 mi)	0.9 km	(0.5 mi)	150 m	(500 ft)	1.0 km	(0.7 mi)	3.5 km	(2.2 mi)
1026	Cyanogen gas												
1040	Ethylene oxide	30 m	(100 ft)	0.1 km	(0.1 mi)	0.2 km	(0.1 mi)	150 m	(500 ft)	0.8 km	(0.5 mi)	2.5 km	(1.6 mi)
1040	Ethylene oxide with Nitrogen												
1045	Fluorine	30 m	(100 ft)	0.1 km	(0.1 mi)	0.3 km	(0.2 mi)	150 m	(500 ft)	0.8 km	(0.5 mi)	3.1 km	(1.9 mi)
1045	Fluorine, compressed												
1048	Hydrogen bromide, anhydrous	30 m	(100 ft)	0.1 km	(0.1 mi)	0.4 km	(0.3 mi)	300 m	(1000 ft)	1.5 km	(1.0 mi)	4.5 km	(2.8 mi)
1050	Hydrogen chloride, anhydrous	30 m	(100 ft)	0.1 km	(0.1 mi)	0.4 km	(0.2 mi)	60 m	(200 ft)	0.3 km	(0.2 mi)	1.4 km	(0.9 mi)
1051	AC (when used as a weapon)	100 m	(300 ft)	0.3 km	(0.2 mi)	1.1 km	(0.7 mi)	1000 m	(3000 ft)	3.8 km	(2.4 mi)	7.2 km	(4.5 mi)
1051	Hydrocyanic acid, aqueous solutions, with more than 20% Hydrogen cyanide	60 m	(200 ft)	0.2 km	(0.1 mi)	0.6 km	(0.4 mi)	400 m	(1250 ft)	1.6 km	(1.0 mi)	4.1 km	(2.5 mi)
1051	Hydrogen cyanide, anhydrous, stabilized												
1051	Hydrogen cyanide, stabilized												
1052	Hydrogen fluoride, anhydrous	30 m	(100 ft)	0.1 km	(0.1 mi)	0.5 km	(0.3 mi)	300 m	(1000 ft)	1.7 km	(1.1 mi)	3.6 km	(2.2 mi)

Please remember the purpose and limitations of the ERG:

- It is designed to assist responders in making initial (within 30 minutes) decisions upon arriving at a hazardous materials emergency.
- Personnel using this Guidebook must be properly trained to use and interpret the information provided.
- It is mainly designed for use during transportation emergencies (highway and rail).
- It may have limited value for use in fixed facility incidents.
- The guide instructions are based upon single chemical involvement and do not take into consideration simultaneous release of multiple chemicals. It does not address all possible circumstances that may be associated with a hazardous materials incident.

Brief Overview of HAZWOP Instruments

Various instruments are used to measure chemical air contamination, as well as oxygen content and flammability levels. The results of these readings will determine the level of protection needed to work safely in that environment. The two most important instruments to use when entering an area with unknown chemicals or unknown quantities of chemicals are the Oxygen Meter and the LEL Meter (Lower Explosive Limit).

When entering an area with unknown chemicals or unknown quantities of chemicals, Level A protection should be used if possible, but nothing less than Level B protection shall be used until initial environmental hazards are fully recognized and quantified. The Oxygen Meter will determine if there is enough oxygen (19.5% to 25%) to support life or whether there is too much oxygen whereby creating a fire/explosion hazard (over 25%). The LEL Meter (Lower Explosive Limit) will measure the concentration of combustible materials in the atmosphere. If the concentration is too high (greater than 25% for the LEL outside, or greater than 10% of the LEL in a confined area) then there exists a fire/explosion hazard.

Direct Reading Instruments –

Measures the level of a specific chemical(s) in the air. Direct Reading Instruments can be designed for one particular contaminant or multiple contaminants; however, with multiple reading instruments the probability of them being out-of-service because of calibration or other problems is greater. If the contaminant is at levels above the Permissible Exposure Limit (PEL) then appropriate measures of Personal Protective Equipment (Level A, B, C) shall be utilized. This type of instrumentation is available for about 100 chemicals and generally has a cost in the thousands of dollars.

Colorimetric tubes (aka Drager Tubes) –

An inexpensive device (\$10 average) when exposed to a particular chemical shows a chemical reaction (color change). Different tubes have different reaction and color scales. If the contaminant is at levels above the Permissible Exposure Limit (PEL) then appropriate measures of Personal Protective Equipment (Level A, B, C) shall be utilized (see appendix 3). Colorimetric tubes are available for approximately 300 chemicals.

Photo Ionization Detector/Flame Ionization Detectors –

Detectors that can detect a large range of unspecified chemicals are often used when the chemical contaminant is unknown. High humidity can create false/positive readings with these detectors.

Personal Protective Equipment

Personal protective equipment, or PPE, is designed to protect employees from serious workplace injuries or illnesses resulting from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Besides face shields, safety glasses, hard hats, and safety shoes, PPE includes a variety of devices and garments such as goggles, coveralls, gloves, vests, earplugs, and respirators.

OSHA's general PPE requirements mandate that employers conduct a hazard assessment of their workplaces to determine what hazards are present that require the use of PPE, provide workers with appropriate PPE, and require them to use and maintain it in sanitary and reliable condition.

Using PPE is often essential, but it is generally the last line of defense after engineering controls, work practices, and administrative controls.

Engineering controls involve physically changing a machine or work environment. Administrative controls involve changing how or when employees do their jobs, such as scheduling work and rotating employees to reduce exposures.

Work practices involve training workers how to perform tasks in ways that reduce their exposure to workplace hazards.

When engineering controls are not feasible, workers must use appropriate respirators to protect against adverse health effects caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors. Respirators generally cover the nose and mouth or the entire face or head and help prevent illness and injury. A proper fit is essential, however, for respirators to be effective.

All employees that are required to wear respirators must first undergo medical evaluation.

Level of Protection



PPE's to be worn when the highest level of respiratory, skin, eye and mucous membrane protection is needed.

Personal Protective Equipment

- Positive pressure (pressure demand), self contained breathing apparatus (NIOSH approved), or positive-pressure supplied air respirator with escape SCBA.
- Fully encapsulating chemical protective suit.
- Gloves, inner, chemical resistant.
- Gloves, outer, chemical resistant.
- Boots, chemical resistant, steel toe and shank; (depending on suit boot construction, worn over or under suit boot.)
- Underwear, cotton, long-john type.*
- Hardhat (under suit).*
- Coveralls (under suit).*
- Two-way radio communications (intrinsically safe/non-sparking).*



PPE's to be worn when the highest level of respiratory protection is needed, but a lesser level of skin and eye protection. Level B protection is the minimum level recommended on initial site entries until the hazards have been further identified and defined by monitoring, sampling, and other reliable methods of analysis, and equipment corresponding with those findings utilized.

Personal Protective Equipment

- Positive-pressure (pressure-demand), self-contained breathing apparatus (NIOSH approved), or positive-pressure supplied air respirator with escape SCBA.
- Chemical resistant clothing (overalls and long-sleeved jacket, coveralls, hooded two-piece chemical splash suit, disposable chemical resistant coveralls.)
- Coveralls (under splash suit).*
- Gloves, outer, chemical resistant.
- Gloves, inner, chemical resistant.
- Boots, outer, chemical resistant, steel toe and shank.
- Boot-covers, chemical resistant (disposable).*

- Two-way radio communications (intrinsically safe).*
- Hardhat.*
- Faceshield.*



PPE's to be worn when the type of airborne substance is known, concentration measured, criteria for using air-purifying respirators met, and skin and eye exposure is unlikely. Periodic monitoring of the air must be performed.

Personal Protective Equipment

- Full-face or half-mask, air-purifying respirator (NIOSH approved).
- Chemical resistant clothing (one piece coverall, hooded two piece chemical splash suit, chemical resistant hood and apron, disposable chemical resistant coveralls.)
- Gloves, outer, chemical resistant.
- Gloves, inner, chemical resistant.
- Boots, steel toe and shank, chemical resistant.
- Boot-covers, chemical resistant.*
- Cloth coveralls (inside chemical protective clothing).*
- Two-way radio communications (intrinsically safe).*
- Hardhat.*
- Escape mask.*
- Faceshield.*

* **Optional**



Basically, this level is primarily a work uniform and is used for nuisance contamination only. The type of environment and the overall level of protection should be reevaluated periodically as the amount of information about the site increases and as workers are required to perform different tasks ... It should not be worn on any site where respiratory or skin hazards exist.

Personal Protective Equipment

- It requires only coveralls and safety shoes/boots. Other PPE is based upon the situation (types of gloves, etc.).

Reasons to upgrade to a higher level (D is lowest, A is highest)

- Known or suspected presence of dermal hazards
- Occurrence or likely occurrence of gas or vapor emission
- Change in work task that will increase contact or potential contact with hazardous materials
- Request of the individual performing the task

Reasons to downgrade:

- New information indicating that the situation is less hazardous than was originally thought
- Change in site conditions that decreases the hazard
- Change in work task that will reduce contact with hazardous materials



Respirator

Respirators are used to protect employees from inhaling hazardous chemicals in the air. These chemicals can be in the form of gases, vapors, mists or dust. If a respirator is provided, a written respiratory protection program is also required. The written program must spell out how you do the following at your workplace:

- How the proper respirators for the particular hazards are selected and issued (include a list of respirators used),
- When and how respirators will be used in routine work activities, infrequent activities, and foreseeable emergencies such as spill response, rescue or escape situations,
- How medical evaluations of respirator wearers is provided,
- How respirator fit-testing is done,
- How respirators in use are cleaned, stored, inspected and repaired or discarded,
- How sufficient high purity air is provided for air-supplied respirators (if you use them),
- How employees are trained about respiratory hazards at your workplace,
- How employees are trained on the proper use of the respirators used at your workplace,
- How you evaluate the effectiveness of your respiratory program.

The type and brands of respirators vary widely ranging from simple dust masks to supplied air respirators like the kind firemen wear. Following is description of the main types of respirators.

Dust Masks (filtering facepieces)

These simple, two-strap disposable dust masks are designed only for dusts. They are not as protective as other respirators, but do an adequate job in many cases, unless the dust is really toxic or copious.

Don't confuse the *two-strap* masks with the less protective *one-strap* dust mask designed only for pollen or other large airborne particles. So in some jurisdictions, the one strap masks are not considered acceptable to use for duties involving fine dust particles (sanding painted surfaces, sand blasting, & etc.)



Half-Face Air-Purifying Respirator

These respirators are sometimes called “half-face” or “half-mask” respirators since they cover just the nose and mouth. They have removable cartridges that filter out either dust, chemicals or both. Selecting the correct cartridges is essential since they are designed for particular types of chemicals or dust. A reputable respirator vendor can assist you in selecting the correct cartridges. These cartridges are typically removable and sometimes interchangeable. Cartridges are available for solvents, ammonia, chlorine, acids and other chemicals. The cartridges must be changed out or replaced periodically, especially for chemicals, since they can absorb only so much contaminant before breakthrough occurs. A few cartridges are equipped with end-of-service indicators that show when a cartridge should be replaced. Most cartridges don't have this indicator and you must develop a change-out schedule to prevent breakthrough. The change-out schedule is based on the chemical concentration, physical work effort, temperature and humidity. Many respirator manufacturers have cartridge change schedule calculators available on the Internet.



Full-Face Air-Purifying Respirator

In some situations, you may need, or want, to use full-face respirators. This type of respirator is used when the contaminants in the air can irritate the eyes. They also provide somewhat higher protection to the lungs since they tend to fit tighter and are less prone to leaking. These respirators also have replaceable cartridges that must be changed on a regular basis as described above for half-face respirators.



Powered Air Purifying Respirator (PAPR)

Powered Air Purifying Respirators have a battery pack that draws air through replaceable cartridges and blows into a full facepiece, helmet or hood. These respirators are often more comfortable in hot weather and some can provide more protection, depending on the type. The cartridges must be changed regularly as describe for half-face respirators above.





Air purifying helmets



Supplied Air Respirators and Self-Contained Breathing Apparatus (SCBA)



Airline Respirator



Tank-type respirator (SCBA)

In a few situations, you may need to provide a supplied air respirator to your employees. These situations include large chemical spills or leaks, entering a confined space where there is lack of oxygen or high levels of air contaminants, or working around extremely toxic chemicals. They may also be necessary working at hazardous waste sites, during sandblasting or in some spray painting operations. “Supplied air,” means that clean air is provided by means of an air hose from a compressor or a pressurized air tank.

Supplied air respirators are required when a respiratory hazard is considered “immediately dangerous to life or health” (also called “IDLH”). Respiratory hazards are classified as IDLH as follows:

- There is a lack of oxygen (less than 19.5% oxygen)
- There is too much oxygen (more than 23.5% - a fire hazard)
- You know there are toxic chemicals in the air, but you don’t know how much
- The amount of chemical in the air is known or expected to be above the IDLH level for that chemical. See the [NIOSH Pocket Guide to Chemical Hazards](#) for chemical IDLH levels.

Levels of chemicals above IDLH can occur in confined spaces, or enclosed spaces where there is little or no ventilation.

Emergency Escape Respirators

Emergency escape respirators, as the name implies, can only be used for one thing – to escape or exit from a room or building in an emergency, usually a large chemical release, leak or spill, or when a supplied air respirator fails or runs out of air. An escape respirator is typically a small bottle or tank of air connected to a facepiece that



supplies 5-10 minutes of air. Some supplied air respirators will have an auxiliary bottle of air for escape that connects to the existing facepiece.

How do you decide which type of respirator to select? First, it must be the correct type for the air contaminant. Second, it must fit properly. Third, it must provide adequate protection for the amount of chemical in the air. The more toxic or more concentrated the chemical is in the air, the higher the level of protection the respirator must provide.

Different respirators provide different protection. Depending on the amount of chemical in the air, you may need to use a respirator that provides more protection. Respirators are rated by their “assigned protection factor” (APF), which is a number between 10 and 10,000. The higher the number, the greater the protection. A respirator with a protection factor of 10 will provide adequate protection to levels of the chemical in the air 10 times the safe limit of that chemical. See Table 5 below.

Hazard Controls / Work Zones

Hazard Control Methods

There are three ways to control hazards:

1. Administrative Controls
2. Engineering Controls
3. Personal Protective Equipment

Administrative Controls

As the name implies, these are controls through administrative actions, such as rules, operational standards, work assignments, duty rotations, limited exposures to hazards, and etc.

Engineering Controls

This is modifying the work environment and/or reducing the quantity of contamination exposing the workers and the environment.

Personal Protective Equipment (PPE)

The PPE is used to reduce the workers exposure to the hazards. PPE are used when engineering controls cannot make the work environment safe.

Zones

Hot (Exclusion) Zone –

Is the area immediately surrounding a hazardous materials incident and the involved material itself? The hot zone extends far enough away from the material to prevent further exposure and adverse effects from the materials to personnel outside the zone.

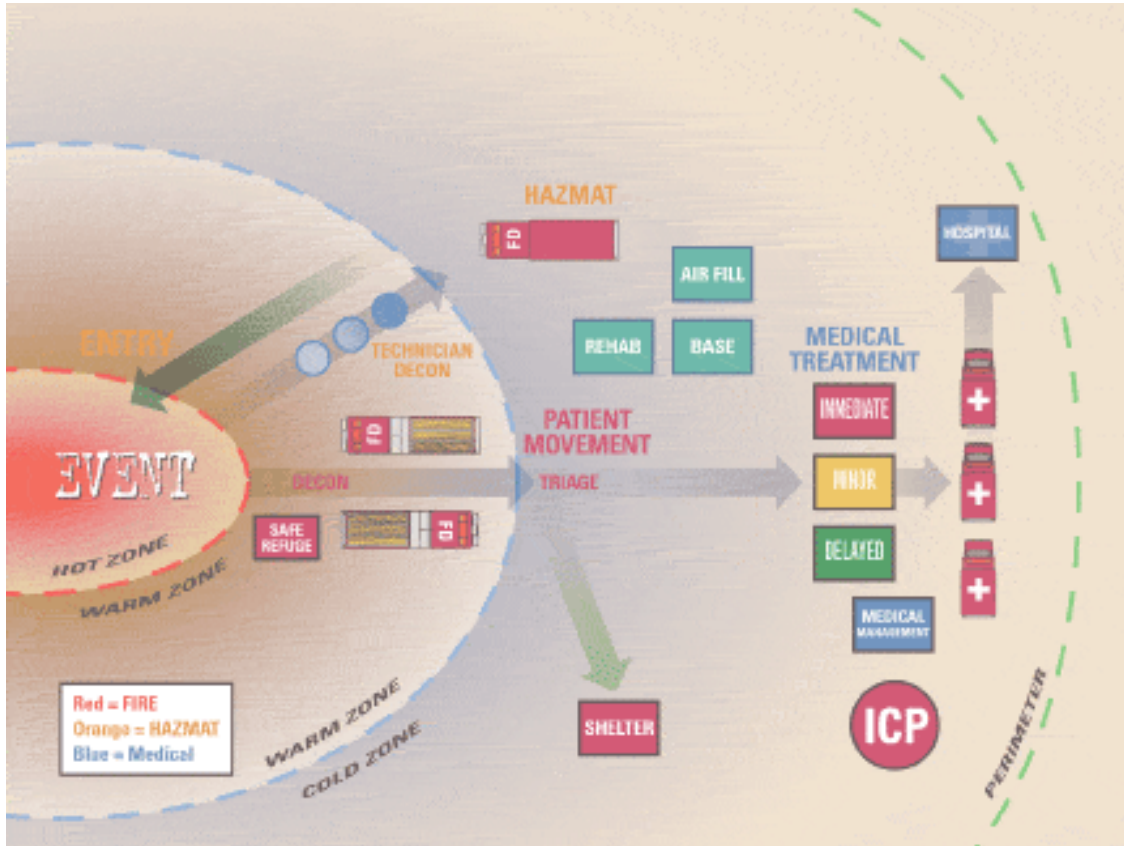
Warm (Contamination Reduction) Zone –

An area immediately surrounding the hot zone; where personnel and equipment decontamination take place. Generally, decontamination involves a simple soap and water rinse preventing the spread of contaminant outside the hot zone. The warm zone also includes control points for access and egress to the hot zone and assists in reducing the further spread of contamination

Cold (Support) Zone –

Begins where the warm zone ends and continues to progress away from the hot and warm zones. The cold zone typically contains the command post, the staging area for resources and other support functions used to control the incident and help to prevent further spread of the material involved.

Specific access points control the movement of workers and equipment. Alternate exit routes and isolation zones also exist for emergency purposes.



Decontamination

It is the physical or chemical process of reducing and preventing the spread of contamination from persons and equipment after working with hazardous materials. Decontamination is carried out within a restricted work area – typically within the Warm Zone. Decontamination is where personnel and equipment cleaned and isolated reduce the spread of contamination. This area is also referred to as the "contamination reduction," "yellow zone," "or" "limited access zone" in other documents.



Practicing decontamination on animals ...





Appendix One – Common Acronyms

ALOHA ... Areal Locations of Hazardous Atmospheres
APR ... Air Purifying Respirator
CAS ... Chemical Abstracts Service
CAMEO ... Computer Aided Management of Emergency Operations
CERCLA ... Comprehensive Environmental Response, Compensation, and Liability Act
CFR ... Code of Federal Regulations
CPC ... Chemical Protective Clothing
CWA ... Clean Water Act
DOT ... Department of Transportation
EPA ... Environmental Protection Agency
EPCRA ... Emergency Planning and Community Right-to-Know Act
FRA ... First Responder Awareness
FRO ... First Responder Operations
GHS ... Global Harmonization System
IDLH ... Immediately Dangerous to Life or Health
LEL ... Lower Explosive Limit
MSDS ... Material Safety Data Sheet
NCP ... National Contingency Plan
NFPA ... National Fire Protection Association
NIOSH ... National Institute for Occupational Safety and Health
NOS ... Not Otherwise Specified
NRC ... National Response Center
NSF ... National Strike Force
OPA 90 ... Oil Pollution Act of 1990
OSHA ... Occupational Safety and Health Administration
PEL ... Permissible Exposure Limit
PPE ... Personal Protective Equipment
RCRA ... Resource Conservation and Recovery Act (1976)
SARA ... Superfund Amendments and Reauthorization Act
SCBA ... Self-Contained Breathing Apparatus
SDS ... Safety Data Sheet (GHS replacement for MSDS)
STEL ... Short Term Exposure Limit
TLV ... Threshold Limit Value
USCG ... U.S. Coast Guard
USDOT ... U.S. Department of Transportation
USEPA ... U.S. Environmental Protection Agency (aka - EPA)
VOC ... Volatile Organic Compound
WMD ... Weapons of Mass Destruction

Appendix Two – Terminology

Those who work with chemicals will need to know the following terms:

Solubility (Sol)	Solubility is usually given in water and is measured in percent by weight. It is a measure of how well something dissolves
Specific Gravity (SG)	The density of a chemical compared to water. Water = a specific gravity of 1. (Water weighs 8.34 pounds/gallon)
Relative Density of Gases (RDG)	The density of gas compared to air.
Vapor Density (VD)	The density of a vapor compare to air.
Vapor Pressure (VP)	The pressure a liquid exerts at 68 degrees F. It is measured in mmHg. The lower the Vapor Pressure, the more rapidly the chemical will volatilize (evaporate) into the air.
Pyrophoric	A substance that burns spontaneously in air at a temperature of 130 degrees F or below.
Autoignition Temperature	The lowest temperature at which a liquid will give off enough flammable vapors and heat energy to ignite spontaneously and maintain combustion.
Upper Explosive Limit (UEL)	The upper explosive limit in air measured by percent by volume at room temperature. The maximum concentration of gas or vapor above which the substance will not burn or explode. Above this concentration, the mixture is too "rich" to ignite or explode. (Like a carburetor that "floods")
Lower Explosive Limit (LEL)	The lower explosive limit in air measured in percent by volume at room temperature. The minimum concentration of gas or vapor in the air below which the substance will not burn or explode. Below this concentration, the mixture is too "lean" to ignite or explode.
Flash Point (FP)	The temperature at which the liquid phase gives off enough vapor to flash when exposed to an external ignition source.
Fire Triangle (FT)	In order to have a fire or explosion the following elements are needed: Fuel, oxygen, ignition. The fuel and oxygen must be blended in the right combination. That is, the concentration of the chemical in the air must be between the LEL and UEL and the oxygen concentration must be at or near 20.9%

When a substance is in the air in a concentration above its LEL and below the UEL, extreme danger of sudden explosion or flash-over is present. Instruments such as Photo-ionization detectors have been developed that will read LEL levels. Generally, any level above 25% of the LEL in the open air is considered a hazardous situation. In a confined space, that safe level drops to 10% of the LEL. Some instruments have alarms that will sound when the concentration of gases or vapors meet the 10-25% of the LEL. Example: Gasoline has an LEL of 1.4%, a UEL of 7.6% and a flash point of -45 degrees F. In a confined area, above -45 degrees F, gasoline fumes that exceeded .14% of the atmosphere would be considered a hazardous situation and all personnel should be immediately removed. If the gasoline fumes are between 1.4% (14,000 ppm) and 7.6% (76,000 ppm) then any sort of ignition source, i.e. spark of some kind, could cause the atmosphere to ignite or explode.

To find out a chemicals physical & health hazards, look up the chemical alphabetically in the National Institute for Occupational Safety and Health (NIOSH)'s "Pocket Guide to Chemical Hazards."
[\[http://www.cdc.gov/niosh/npg/npg.html\]](http://www.cdc.gov/niosh/npg/npg.html)

Appendix Two - Special Caution on Handling Drums and Other Containers of Chemicals

Accidents may occur during handling of drums and other hazardous chemical containers. Hazards include detonations, fires, explosions, vapor generation, and physical injury resulting from moving heavy containers by hand and working around stacked drums, heavy equipment and deteriorated drums. While these hazards are always present, proper work practices such as minimizing handling and using equipment and procedures that isolate workers from hazardous substances can minimize the risks to personnel.

Do Not Handle Drums with Unknown Contents.

Proper labeling of drums is a must to avoid unintended exposure and the mixture of incompatible wastes or chemicals.

Do Not Handle Bulging Drums.

Pressurized drums can be explosive upon opening and should only be opened by trained professionals with the proper equipment, including remote control devices, which provide the necessary shielding. Do not use picks, chisels or firearms to open drums.



Appendix 3 – Personal Protective Equipment Trigger

In general, PPE triggers for unknown contaminants can use the following for guidance:

- 0 - 5 ppm* detected = Level C Personal Protection Equipment (PPE)
 - 5 - 500 ppm* detected = Level B Personal Protection Equipment (PPE)
 - Greater than 500 ppm* detected = Level A Personal Protection Equipment (PPE)
- *Parts Per Million

If the air monitoring shows sufficient oxygen (19.5% to 25%) and any chemical contaminants are below Permissible Exposure Limits (PEL), then the area is considered safe to work in without Personal Protection Equipment (PPE).