Most workplaces use or store chemicals of one kind or another. Chemicals can cause a number of health effects if not properly controlled.

How Do Chemicals Get Into the Body?

In order to cause health problems, chemicals must enter your body. There are three main “routes of exposure,” or ways a chemical can get into your body.

- **Breathing (Inhalation):** Breathing in chemical gases, mists, or dusts that are in the air.
- **Skin or Eye Contact:** Getting chemicals on the skin, or in the eyes. They can damage the skin, or be absorbed through the skin into the bloodstream.
- **Swallowing (Ingestion):** This can happen when chemicals have spilled or settled onto food, beverages, cigarettes, beards, or hands.

Once chemicals have entered your body, some can move into your bloodstream and reach internal “target” organs, such as the lungs, liver, kidneys, or nervous system.

What Forms Do Chemicals Take?

Chemical substances can take a variety of forms. They can be in the form of solids, liquids, dusts, vapors, gases, fibers, mists and fumes. The form a substance is in has a lot to do with how it gets into your body and what harm it can cause. A chemical can also change forms. For example, liquid solvents can evaporate and give off vapors that you can inhale. Sometimes chemicals are in a form that can’t be seen or smelled, so they can’t be detected.

Detecting some forms of chemicals can be difficult. Solids and liquids are easier to recognize since they can be seen. Dusts and mists may or may not be visible, depending upon their size and concentration. Fumes, vapors, and gases are usually invisible.
What Health Effects Can Chemicals Cause?

The effects of a toxic chemical on your body may be either acute or chronic.

**Acute** (short-term) effects show up immediately or soon after exposure to the chemical. They may be minor, like nose or throat irritation, or they could be serious, like eye damage or passing out from chemical vapors. What all these effects have in common is that they happen right away.

**Chronic** (long-term) effects may take years to show up. They are usually caused by regular exposure to a harmful substance over a long period of time. These effects are usually permanent.

Some chemicals cause both acute and chronic effects. For example, breathing solvent vapors might make you dizzy right away (an acute effect). But breathing the same vapors all the time for many years might eventually cause liver damage (a chronic effect).
## What Symptoms May be Caused by Chemicals at Work?

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>COMMON CAUSES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Head</strong></td>
<td></td>
</tr>
<tr>
<td>Dizziness, headache</td>
<td>Solvents, paint, ozone, smoke (including tobacco)</td>
</tr>
<tr>
<td><strong>Eyes</strong></td>
<td></td>
</tr>
<tr>
<td>Red, watery, irritated, grainy feeling</td>
<td>Smoke, gases, various dusts, vapors from paint and cleaners</td>
</tr>
<tr>
<td><strong>Nose and Throat</strong></td>
<td></td>
</tr>
<tr>
<td>Sneezing, coughing, sore throat</td>
<td>Smoke, ozone, solvents, various dusts, vapors and fumes from paint and cleaners</td>
</tr>
<tr>
<td><strong>Chest and Lungs</strong></td>
<td></td>
</tr>
<tr>
<td>Wheezing, coughing, shortness of breath, lung cancer</td>
<td>Metal fumes, various dusts, smoke, solvents, vapors from paint and cleaners</td>
</tr>
<tr>
<td><strong>Stomach</strong></td>
<td></td>
</tr>
<tr>
<td>Nausea, vomiting, stomach ache, diarrhea</td>
<td>Some metal fumes, solvents, paint vapors, long-term lead exposure</td>
</tr>
<tr>
<td><strong>Skin</strong></td>
<td></td>
</tr>
<tr>
<td>Redness, dryness, rash, itching, skin cancer</td>
<td>Solvents, chromium, nickel, detergents and cleaners, paint on skin</td>
</tr>
<tr>
<td><strong>Nervous System</strong></td>
<td></td>
</tr>
<tr>
<td>Nervousness, irritability, sleeplessness, tremors, loss of balance or coordination</td>
<td>Long-term solvent exposure, long-term lead exposure</td>
</tr>
<tr>
<td><strong>Reproductive System</strong></td>
<td></td>
</tr>
<tr>
<td>For men: low sperm count, damage to sperm</td>
<td>Lead, toluene, some other solvents, ethylene oxide gas</td>
</tr>
<tr>
<td>For women: irregularities in menstruation, miscarriage, damage to egg or fetus</td>
<td></td>
</tr>
</tbody>
</table>
What Factors Affect Your Risk?

<table>
<thead>
<tr>
<th>1. How toxic the chemical is (toxicity).</th>
<th>The more toxic the chemical, the more likely it will cause health problems, even in small amounts. Asbestos and cyanide are considered highly toxic because a very small quantity can cause health effects.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. How the chemical gets into the person’s body (route of exposure).</td>
<td>The way a chemical enters your body affects your risk. Some chemicals, like the pesticide parathion, are very toxic whether they get into the body through the skin, by breathing, or by swallowing. On the other hand, asbestos is only harmful when inhaled or swallowed. A house may have asbestos insulation, but unless the asbestos is disturbed and becomes a dust in the air, it can’t be breathed in, so it won’t cause harm.</td>
</tr>
<tr>
<td>3. The amount of the chemical that you are exposed to (dose).</td>
<td>For some chemicals, the higher the amount, the greater the damage. For example, acetone is an industrial solvent that is also found in nail polish remover. It is more dangerous to the worker who uses large amounts than to the person who uses a little nail polish remover.</td>
</tr>
<tr>
<td>4. How long you are exposed to the chemical (duration).</td>
<td>The longer the exposure, the greater the danger. For example, someone may work with a chemical for half an hour per day, while another person is exposed for eight hours a day. Also, someone may be exposed for one month, while another person may have 20 years of exposure.</td>
</tr>
<tr>
<td>5. Reaction and interaction with other chemicals.</td>
<td>Some chemicals in combination can create a different chemical that is more hazardous than the original ones (reaction). For example, ammonia and bleach used together can produce a highly toxic chemical. Some chemicals, in combination, can increase the likelihood of harm. For example, workers who have been exposed to asbestos increase their likelihood of getting lung cancer if they smoke cigarettes.</td>
</tr>
<tr>
<td>6. Individual differences (like heredity, body size, age, smoking, drinking, allergies, sensitivities, or previous exposures to other toxic chemicals).</td>
<td>Chemicals can be more harmful to some people than to others. Lead is much more harmful to small children than adults because it affects their developing brain and nervous system. If two people work with asbestos and one of them smokes, the smoker is more likely to develop asbestos-related lung cancer than the non-smoker.</td>
</tr>
</tbody>
</table>
Controlling Chemical Hazards

Once chemical hazards are identified, various methods can be used to protect workers from them. These are called hazard controls. Not all controls are equally effective. There is a “hierarchy” of possible solutions. The most effective solutions, at the top of the pyramid, are those that actually remove the hazard. Further down are solutions that only reduce or limit the worker’s exposure.

Often a combination of methods is needed to get the best protection.

Remove the Hazard

The best way to protect workers from hazards is to remove the hazards from the workplace altogether, or at least keep them away from workers. These methods are often called engineering controls. They directly address the hazard and do not depend on workers’ actions to be effective. Workers don’t have to wear special protective gear or take special precautions, because the hazard is gone.

Engineering controls include these methods:

- **Redesign** the process. For example:
  - Replace gasoline motors with electric motors to eliminate exhaust fumes.
  - Use wet methods when grinding, sanding, or using other tools to reduce dust levels.
Remove the Hazard (continued from previous page)

- **Substitute safer products for hazardous ones.** For example, use chemicals that are less toxic or dangerous, such as some water-based cleaners.
- **Isolate the process, or isolate the worker from the process.** For example, use glove boxes when working with dangerous substances like radioactive material.
- **Install ventilation systems.** These remove chemicals from the air that workers breathe. The best systems remove vapors and fumes close to the source (local exhaust ventilation).

Improve Work Policies and Procedures

When the hazard cannot be eliminated altogether, another option is to set rules that will limit workers’ exposure to the danger. These measures are often called **administrative controls**.

**Administrative controls include:**

- **Rotate workers** between a hazardous task and a non-hazardous task so that the length of exposure is reduced.
- **Increase the number of breaks** to reduce the time of exposure.
- **Restrict access** to the work area.
- **Improve personal hygiene facilities and practices.** Provide a way for workers to wash their hands and faces before eating and drinking. Prohibit eating in work areas. Set up facilities for showering after the shift, and leaving contaminated clothes at the workplace.
- **Provide worker training programs.** Increase workers’ ability to recognize and evaluate chemical hazards, and to take action to protect themselves.
Provide Personal Protective Equipment

A third method of reducing hazards is to use personal protective equipment (PPE). PPE is worn on the body and protects you from exposure to chemicals. It includes gloves, goggles, respirators, and coveralls. Wear PPE when other methods of hazard control aren’t possible or don’t give enough protection.

For PPE to be effective, workers must be given the correct PPE and trained in its use, care, and storage. PPE is usually considered less protective than the other methods because:

- It doesn’t get rid of the hazard itself. However, it can reduce the amount of exposure by placing a barrier between the hazard and the worker.
- Workers may not want to wear it because it can be uncomfortable and hot, and may make it hard to communicate.
- It has to fit properly to work. In many cases, it must be cleaned and inspected often.
- It has to be the right type for the particular hazard, such as the right respirator cartridge or glove for the chemical being used.
- Workers must know and remember how to use it properly.
- Some PPE creates its own hazards, such as heat, heavy weight, reduced visibility and reduced hearing, restricted movement, and discomfort.
- PPE depends entirely on human action to be effective.

Use a Combination of Methods

Sometimes you may need a combination of methods to control a chemical hazard. While engineering controls may be the most effective method, you also need to have training programs and good workplace policies to supplement them. There may also be situations where PPE is essential. It’s important to consider as many solutions as possible before settling on a strategy for controlling chemical hazards.
How Do You Find Out About Chemicals at Work?

The Cal/OSHA Hazard Communication standard (Title 8 CCR § 5194), gives you the right to information about the chemicals and other hazardous substances you may be exposed to at work. It requires employers to inventory the chemicals in the workplace; to ensure chemicals are properly labeled; to make sure there are up-to-date Safety Data Sheets (SDSs) on each chemical from the chemical manufacturers; and to train workers about the hazards of working with chemicals.

Chemical Labels

Under the current “Right to Know” law, (California’s Hazard Communication standard), labels from suppliers are only required to contain the following information:

- Product identity, specifically the chemical name.
- Hazard warnings, including what type of hazard (for example, fire or lung damage).
- Name and address of the manufacturer.

Some labels may include additional information and include words like “caution” or “harmful if breathed.”

By December 2015, all chemical manufacturers and suppliers will be required to label their products with information that complies with the new Globally Harmonized System (GHS) for hazard classification and labeling. Labels under GHS must include the following information for each chemical product:

- Product identifier
- Supplier identification
- Signal word
- Pictogram
- Hazard statement
- Precautionary statement
The pictograms are symbols that alert chemical handlers about the dangers of the product. They include:

<table>
<thead>
<tr>
<th>FLAME OVER CIRCLE</th>
<th>FLAME</th>
<th>EXPLODING BOMB</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Flame Over Circle" /></td>
<td><img src="image" alt="Flame" /></td>
<td><img src="image" alt="Explosion" /></td>
</tr>
<tr>
<td>• Oxidizers</td>
<td>• Flammables</td>
<td>• Explosives</td>
</tr>
<tr>
<td></td>
<td>• Pyrophorics</td>
<td>• Self-reactives</td>
</tr>
<tr>
<td></td>
<td>• Self-heating</td>
<td>• Organic peroxides</td>
</tr>
<tr>
<td></td>
<td>• Emits flammable gas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Self-reactives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Organic peroxides</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SKULL AND CROSSBONES</th>
<th>CORROSION</th>
<th>GAS CYLINDER</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Skull and Crossbones" /></td>
<td><img src="image" alt="Corrosion" /></td>
<td><img src="image" alt="Gas Cylinder" /></td>
</tr>
<tr>
<td>• Acute toxicity (severe)</td>
<td>• Corrosives</td>
<td>• Gases under pressure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEALTH HAZARD</th>
<th>ENVIRONMENT</th>
<th>EXCLAMATION MARK</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Health Hazard" /></td>
<td><img src="image" alt="Environment" /></td>
<td><img src="image" alt="Exclamation Mark" /></td>
</tr>
<tr>
<td>• Carcinogen</td>
<td>• Aquatic toxicity</td>
<td>• Irritant</td>
</tr>
<tr>
<td>• Mutagenicity</td>
<td></td>
<td>• Skin sensitizer</td>
</tr>
<tr>
<td>• Reproductive toxicity</td>
<td></td>
<td>• Acute toxicity (harmful)</td>
</tr>
<tr>
<td>• Respiratory sensitizer</td>
<td></td>
<td>• Narcotic effects</td>
</tr>
<tr>
<td>• Target organ toxicity</td>
<td></td>
<td>• Respiratory tract irritation</td>
</tr>
<tr>
<td>• Aspiration toxicity</td>
<td></td>
<td>• Hazardous to ozone layer</td>
</tr>
</tbody>
</table>
Safety Data Sheets

Safety Data Sheets (SDSs, formerly called MSDSs) are data sheets that contain information about the health and safety properties of workplace chemical products. They are written by the supplier or manufacturer of the product and provided to purchasers. When employers receive an SDS, they are required to let workers see and copy it.

An SDS is divided into sections, and must have certain required information. Each section provides a different type of information about the chemical product. In the past, these sections have not always been the same on every SDS.

Remember: All chemical products in the workplace should have labels. If a chemical is poured into a smaller container and taken elsewhere in the workplace, it still needs to have a label. The only exception is if the worker who poured it can carry a portable container at all times and empties it at the end of the shift.
What’s Required on a Safety Data Sheet?

Under Cal/OSHA's Hazard Communication standard, an SDS must contain certain information. This includes:

- **Section 1, Identification** includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use.

- **Section 2, Hazard(s) identification** includes all hazards regarding the chemical; required label elements.

- **Section 3, Composition/information on ingredients** includes information on chemical ingredients; trade secret claims.

- **Section 4, First-aid measures** includes important symptoms/effects, acute, delayed; required treatment.

- **Section 5, Fire-fighting measures** lists suitable extinguishing techniques, equipment; chemical hazards from fire.

- **Section 6, Accidental release measures** lists emergency procedures; protective equipment; proper methods of containment and cleanup.

- **Section 7, Handling and storage** lists precautions for safe handling and storage, including incompatibilities.

- **Section 8, Exposure controls/personal protection** lists OSHA’s Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; personal protective equipment (PPE).

- **Section 9, Physical and chemical properties** lists the chemical’s characteristics.

- **Section 10, Stability and reactivity** lists chemical stability and possibility of hazardous reactions.

- **Section 11, Toxicological information** includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.

- **Section 12, Ecological information**

- **Section 13, Disposal considerations**

- **Section 14, Transport information**

- **Section 15, Regulatory information**

- **Section 16, Other information**, includes the date of preparation or last revision.

*Note: Since other Agencies regulate this information, Cal/OSHA will not be enforcing Sections 12 through 15 (29 CFR 1910.1200(g)(2)).
Cal/OSHA is requiring employers to train their employees about the new labeling and SDS requirements by December 1, 2013.

The table below lists some of the information you can find about a chemical product by looking at its SDS.

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>WHAT TO LOOK FOR</th>
<th>SECTION OF THE SDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is this product?</td>
<td>• Name of chemical?</td>
<td>• Identification (Section 1)</td>
</tr>
<tr>
<td></td>
<td>• Who makes it?</td>
<td>• Manufacturer (Section 1)</td>
</tr>
<tr>
<td>Can this product harm my health?</td>
<td>• Ingredients</td>
<td>• Hazard identification (Section 2)</td>
</tr>
<tr>
<td></td>
<td>• Health effects</td>
<td>• Composition/information on ingredients (Section 3)</td>
</tr>
<tr>
<td></td>
<td>• Symptoms</td>
<td>• First aid measures (Section 4)</td>
</tr>
<tr>
<td></td>
<td>• Cancer hazard</td>
<td>• Toxicological information (Section 11)</td>
</tr>
<tr>
<td></td>
<td>• Emergency and First aid procedures</td>
<td></td>
</tr>
<tr>
<td>Does this product have other dangers?</td>
<td>• Fire and explosion hazard</td>
<td>• Fire-fighting measures (Section 5)</td>
</tr>
<tr>
<td></td>
<td>• Incompatible materials to avoid</td>
<td>• Physical and chemical properties (Section 9)</td>
</tr>
<tr>
<td></td>
<td>• Stable or unstable</td>
<td>• Stability and reactivity (Section 10)</td>
</tr>
<tr>
<td>How can you protect yourself?</td>
<td>• Personal protective equipment to use</td>
<td>• Accidental release measures (Section 6)</td>
</tr>
<tr>
<td></td>
<td>• Other control measures</td>
<td>• Handling and storage (Section 7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Exposure controls (Section 8)</td>
</tr>
<tr>
<td>How should the product be handled?</td>
<td>• Safe handling and storage</td>
<td>• Accidental release measures (Section 6)</td>
</tr>
<tr>
<td></td>
<td>• Spill and accidental release procedures</td>
<td>• Handling and storage (Section 7)</td>
</tr>
<tr>
<td></td>
<td>• Waste disposal</td>
<td>• Exposure controls (Section 8)</td>
</tr>
<tr>
<td>Where do you get more information?</td>
<td>• Name and phone number of manufacturer</td>
<td>• Identification (Section 1)</td>
</tr>
</tbody>
</table>
What are the Strengths and Limitations of an SDS?

WHY ARE SDSs USEFUL?

• An SDS provides more information than a label. If it’s well-written, it can be a valuable tool.
• It should give detailed health information.
• It should give comprehensive information on how to protect yourself and what your employer should do to protect you.
• It should give you information on safe storage, legal exposure limits, incompatibility, and what to do in an emergency.

WHAT ARE THE LIMITATIONS OF SDSs?

• One chemical could have many different SDSs from different suppliers.
• An SDS may be missing information.
• An SDS may be difficult to read and understand. It may require a lot of reading. It may be too technical. If you don’t read English, it may not be available in your own language. However, some companies have successfully asked their suppliers (the chemical manufacturers) to provide SDSs in other languages, like Spanish.

It’s also important to use other sources of information about chemical hazards, including the internet, factsheets, Cal/OSHA Consultation Service, and materials available from the Worker Occupational Safety and Health Training and Education Program (WOSHTEP) Resource Centers.
Evaluating Your Workplace Hazard Communication Program

Cal/OSHA regulations require employers to provide information to employees about the chemicals and other hazardous substances to which they may be exposed at work by providing SDSs, chemical labels and training. Use this checklist to see if your employer’s hazard communication program meets Cal/OSHA requirements. See Title 8, California Code of Regulations, section 5194 for details.

**DOES YOUR WORKPLACE HAVE THE FOLLOWING ELEMENTS IN PLACE?**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>A WRITTEN HAZARD COMMUNICATION PROGRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Is there a written hazard communication program for your workplace and is there someone who is responsible for preparing and maintaining the program?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does the written program describe how chemical containers will be labeled, how Safety Data Sheets (SDSs) will be compiled and maintained for each chemical at the worksite, and how employee information and training requirements will be met?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does the written program include a list of the hazardous substances that are present in the workplace (either for the workplace as a whole or for individual work areas)?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does the written program include the methods the employer will use to inform employees of the hazards that may be created by non-routine tasks or situations?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Is the written hazard communication program made available, upon request, to employees and their designated representatives?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For workplaces that have more than one employer, does the written program include the methods to be used to inform all employees in the workplace of the hazards and suggestions for protective measures?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>LABELS ON CHEMICALS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Is someone responsible for making sure chemicals are properly labeled?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does each chemical container have a clear label with the product name, hazard warnings, and the name and address of the manufacturer, importer, or other responsible party?</td>
</tr>
</tbody>
</table>
### SAFETY DATA SHEETS (SDSs)

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Is someone responsible for obtaining and maintaining SDSs for each chemical used in the workplace and making sure they are up-to-date?

<table>
<thead>
<tr>
<th>☐</th>
<th>☐</th>
</tr>
</thead>
</table>

Is there an SDS for each chemical used in the workplace?

<table>
<thead>
<tr>
<th>☐</th>
<th>☐</th>
</tr>
</thead>
</table>

Are SDSs readily accessible to workers? Do workers know where SDSs are kept?

### TRAINING

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Is someone responsible for providing health and safety training to workers?

<table>
<thead>
<tr>
<th>☐</th>
<th>☐</th>
</tr>
</thead>
</table>

Are training and information on the hazardous substances in employees’ work areas provided both at the time of their initial assignment and whenever a new hazard is introduced into their work area?

<table>
<thead>
<tr>
<th>☐</th>
<th>☐</th>
</tr>
</thead>
</table>

Does training include information on the following topics?

- The Hazard Communication standard requirements;
- The location and availability of the employer’s written hazard communication program;
- An explanation of the labeling system and where Safety Data Sheets are kept;
- The hazards of the specific chemicals used and how to protect oneself from exposure.
Table 1: Construction Jobs and Associated Job Tasks

<table>
<thead>
<tr>
<th>Job Title</th>
<th>Ask About</th>
<th>Job Tasks for this Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>insulator</td>
<td>a, b, c, 3</td>
<td>1, 2, 27, 28</td>
</tr>
<tr>
<td>roofer</td>
<td></td>
<td>1, 2, 5, 88</td>
</tr>
<tr>
<td>brick, block &amp; stone mason</td>
<td>a, b, c</td>
<td>1, 2, 29, 31, 58, 62</td>
</tr>
<tr>
<td>concrete or terrazzo worker</td>
<td>a, b, c, d</td>
<td>29, 58, 31</td>
</tr>
<tr>
<td>carpenter</td>
<td>a, b, c, d</td>
<td>1, 2, 27, 28, 39, 41, 44, 45, 50, 51, 63</td>
</tr>
<tr>
<td>construction, industrial or maintenance painter</td>
<td>a, b, c, 63</td>
<td>15, 41, 44, 45, 60, 62, 88</td>
</tr>
<tr>
<td>electrician/repairer of transformers, electrical, or electronic equipment</td>
<td>a, b, c, 3, 6, 10, 28</td>
<td>1, 7, 8, 78</td>
</tr>
<tr>
<td>plumber, pipe fitter, or steamfitter</td>
<td>a, b, c, e, 6</td>
<td>1, 2, 3, 5, 7, 8, 88</td>
</tr>
<tr>
<td>sheet metal worker</td>
<td>a, b, c</td>
<td>1, 2, 3, 6, 7, 8, 104</td>
</tr>
<tr>
<td>welder, cutter, or burner</td>
<td>a, b, c, e, 6, 8, 10, 62, 63</td>
<td>1, 2, 3, 7</td>
</tr>
<tr>
<td>heating &amp; air conditioning installer</td>
<td>a</td>
<td>1, 2, 3, 7, 8, 10</td>
</tr>
<tr>
<td>dry wall taper, plasterer</td>
<td></td>
<td>105</td>
</tr>
</tbody>
</table>

The middle column lists questions to ask the worker while taking the occupational history.

a. Ventilation adequate--work indoors or in confined spaces?

b. If work in buildings, old or new? Or if in shipyard, repairing old or building new ships?

c. If work in production area, what product made and what other workers doing?

d. Exposed to chemicals in pipes?

e. Paint?

---

Table 2: Construction Job Tasks and Associated Chemical Exposures
<table>
<thead>
<tr>
<th>Job Task Name</th>
<th>Potential Chemical Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. remove insulation</td>
<td>asbestos, fiberglass, mineral wool</td>
</tr>
<tr>
<td>2. install insulation</td>
<td>asbestos, fiberglass, mineral wool (no asbestos after 1975)</td>
</tr>
<tr>
<td>3. weld, braze or flame cut (includes thermal degradation of coatings and pigments)</td>
<td>CO; NO₂, phosgene; fluorides, inorganic; lead; cadmium; manganese; chromium, iron oxide; zinc chloride fume; nickel; molybdenum; copper; aluminum; vanadium; titanium oxide; tungsten; barium, soluble; antimony; butyraldehyde; acrolein; phthalic anhydride; methyl methacrylate; welder fumes</td>
</tr>
<tr>
<td>5. apply asphalt to cables, pipes or roofs</td>
<td>asphalt</td>
</tr>
<tr>
<td>6. machine metal</td>
<td>oil mist (mineral); chromium, nickel, cobalt, formaldehyde, nitrosamines</td>
</tr>
<tr>
<td>7. degrease metal</td>
<td>methylene chloride, 1,1,1-trichloroethane, TCE, Perc. &amp; CFCs</td>
</tr>
<tr>
<td>8. solder</td>
<td>lead, rosin, tin, silver</td>
</tr>
<tr>
<td>10. repair air conditioning or refrigeration</td>
<td>CFCs</td>
</tr>
<tr>
<td>15. paint (2-part epoxy or urethane)</td>
<td>epichlorohydrin, diisocyanates &amp; trimellitic anhydride, lead, cadmium, chromium</td>
</tr>
<tr>
<td>27. work with glue solvents</td>
<td>xylene, toluene, n-hexane, methylal, mek, benzene, cyclohexane, TCE, perc, 2-nitropropane, DMF, naphtha</td>
</tr>
<tr>
<td>28. work with adhesives</td>
<td>methyl-2-cyanoacrylate, methyl methacrylate, ethyl acrylate, epichlorohyrdrin, TDI, tricresyl phosphate, formaldehyde</td>
</tr>
<tr>
<td>29. mix &amp; lay cement or concrete</td>
<td>Portland cement</td>
</tr>
<tr>
<td>31. clean masonry</td>
<td>HCl</td>
</tr>
<tr>
<td>39. machine or sand wood</td>
<td>wood dust, formaldehyde</td>
</tr>
<tr>
<td>41. use paint or varnish remover</td>
<td>Methylene Chloride, Cyclohexanethiol, Dimethylformamide, Isopropyl ether, 1,2,3-Trichloropropane, Isomyl alcohol, Toluene, sec-Butyl alcohol, 2-Ethoxyethanol; 2-Ethoxyethyl acetate, Methyl acetate, Mesityl oxide, Isobutyl alcohol, Ethylene dichloride, Cyclohexanone, Propylene dichloride, Potassium hydroxide</td>
</tr>
<tr>
<td>44. paint &amp; varnish (oil-based)</td>
<td>acetone, methylene chloride, Stoddard solvent, VM &amp; P, turpentine, xylene, toluene, lead, cadmium, chromium</td>
</tr>
<tr>
<td>45. spray paint (water-based)</td>
<td>ammonia, formaldehyde, dipropylene glycol methyl ether, 2-butoxyethanol, Stoddard solvent</td>
</tr>
<tr>
<td>50. apply wood preservatives</td>
<td>pentachlorophenol, creosote, arsenic, copper</td>
</tr>
<tr>
<td>51. work with preservative-treated wood</td>
<td>pentachlorophenol, creosote, arsenic, copper</td>
</tr>
<tr>
<td>58. grind or cut tiles, stones, bricks or terrazo</td>
<td>silica, asbestos</td>
</tr>
<tr>
<td>60. spray paint (metallic pigments)</td>
<td>chromium, nickel, lead, cadmium, cobalt, titanium</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>62. sandblast</td>
<td>silica, nickel, cadmium, chromium, lead, beryllium</td>
</tr>
<tr>
<td>63. surface preparation of metal alloy</td>
<td>lead, cadmium, chromium, beryllium, nickel, zinc</td>
</tr>
<tr>
<td>78. remove or replace fluid in transformers</td>
<td>PCBs</td>
</tr>
<tr>
<td>88. use solvents for equipment clean up</td>
<td>gasoline, MEK, turpentine, Stoddard, VM &amp; P, methylene chloride, tetrachloroethylene, 1,1,1-trichloroethane, CFCs, toluene, xylene</td>
</tr>
<tr>
<td>104. forge metal</td>
<td>CO, oil mist (mineral), PAHs</td>
</tr>
<tr>
<td>105. mixing, spraying, or sanding drywall compound, fireproofing plaster or accoustical cement (during new construction before 1975)</td>
<td>asbestos</td>
</tr>
</tbody>
</table>

Thanks to Trish Stewart at the National Cancer Institute for her assistance with these two tables.


brownjay@haz-map.com
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WELCOME TO...

Health Hazards in Construction

Construction workers are exposed to a variety of health hazards every day. These men and women have the potential for becoming sick, ill and disabled for life.

Learn the health hazards on your job and know how to protect yourself…

Sadly, these health hazards (e.g., dangerous dust and other chemicals) can be unexpectedly brought home…

Learn how to protect your family!

This publication contains:

1. The purpose for the Occupational Safety and Health Administration (OSHA) and its enforcement duty under law.
2. Common health hazards found in construction.
3. An explanation of Industrial Hygiene and toxicology.
4. Important terms and definitions used in health standards and toxicology.
5. Procedures for how to anticipate, recognize, evaluate and control health hazards in construction.
7. Respiratory protection program for contractors.
8. Hearing conservation program for contractors.

This program is dedicated to all the workers who have sustained a life threatening or disabling illness as a result of an occupational exposure.
Acknowledgements & Credits

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(800) 552-7744       www.buildsafe.org

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This material was produced under grant number SH-19495-09-60-F-17 from the Occupational Safety and Health Administration, U.S. Department of Labor. It does not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.
To describe the amount of a chemical, **units of concentration** such as parts per million (ppm), milligrams per cubic meter of air (mg/m³), micrograms per cubic meter of air (µg/m³) and fibers per cubic centimeter of air (f/cc) are most often used.

### Units of Concentration

<table>
<thead>
<tr>
<th>(ppm)</th>
<th>(mg/m³)</th>
<th>(µg/m³)</th>
<th>(f/cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts per Million</td>
<td>Milligrams per Cubic Meter of Air</td>
<td>Micrograms per Cubic Meter of Air</td>
<td>Fibers per Cubic Centimeter of Air</td>
</tr>
<tr>
<td>Used to express the amount of a gas or vapor; one part of a gas or vapor per million parts of air.</td>
<td>Used to express the amount of a toxic fume, dust or mist; the amount of a substance (mg) in a given amount of space (m³).</td>
<td>Used to express the amount of a highly toxic fume, dust or mist; the amount of a substance (µg) in a given amount of space (m³).</td>
<td>Fibers are any particle longer than 5 microns (µm), one millionth of a meter, and have an aspect ratio (length : width) greater than 3:1</td>
</tr>
<tr>
<td>$1 \times 10^{-6}$ or .000001</td>
<td>$1$ milligram (mg) = $\frac{1}{1,000}$ gram = $0.001$ gram</td>
<td>$1$ microgram (µg) = $\frac{1}{1,000,000}$ gram = $0.000001$ gram</td>
<td>$1$ micron (µm) = $\frac{1}{1,000,000}$ meter</td>
</tr>
<tr>
<td>$10,000$ ppm = $1%$ volume of air</td>
<td>One cubic meter (m³) = $35.31$ cubic feet (f³)</td>
<td>One cubic meter (m³) = $35.31$ cubic feet (f³)</td>
<td>One cubic centimeter (cc) = $0.061$ cubic inches</td>
</tr>
<tr>
<td><strong>Example (PEL)…</strong> Carbon Monoxide (CO) (50 ppm)</td>
<td><strong>Example (PEL)…</strong> Iron Oxide Fume (10 mg/m³)</td>
<td><strong>Example (PEL)…</strong> Lead (50 µg/m³)</td>
<td><strong>Example (PEL)…</strong> Asbestos (0.1 f/cc)</td>
</tr>
</tbody>
</table>

### Scale of Numbers

<table>
<thead>
<tr>
<th>.000001</th>
<th>.001</th>
<th>0.01</th>
<th>0</th>
<th>100</th>
<th>1000</th>
<th>1,000,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro (µ)</td>
<td>Milli (m)</td>
<td>Centi (c)</td>
<td>Hundred</td>
<td>Thousand</td>
<td>Million</td>
<td></td>
</tr>
</tbody>
</table>
**Chemical Hazards – Units of Concentration**

*Parts per Million (ppm)*

*(Ratio: 1/1,000,000)*

**Example:**

One part per million is equivalent to four (4) eye drops of liquid in a 55 gallon barrel.

*Milligrams per Cubic Meter of Air (mg/m³)*

&

*Micrograms per Cubic Meter of Air (µg/m³)*

**Weight / Volume**

**Example:**

[One (1) packet of artificial sweeter is 1 gram]

*(µg/m³)*

One (1) packet of artificial sweeter in the volume of the Empire State Building is equivalent to 1 microgram per cubic meter of air (1 µg/m³).

*(mg/m³)*

One thousand (1,000) packets of artificial sweeter in the volume of the Empire State Building is equivalent to 1 milligram per cubic meter of air (1 mg/m³).

---

50 artificial sweetener packets in the volume of the Empire State Building is equivalent to 50 µg/m³ (OSHA PEL for Lead).
Fibers per Cubic Centimeter (f/cc)

[Amount (Number of Fibers) / Volume]

Fiber – Means a particulate form of asbestos, 5 micrometer (µm) or longer, with a length-to-width ratio of at least 3 to 1.

Why f/cc for Asbestos?

The unit f/cc (Fibers per Cubic Centimeter) is used to describe limits for asbestos because it’s the number of fibers, not the overall weight of the material that is of concern. Asbestos fibers that are in size and shape (5µm long and length to width ratio of 3:1) are needle sharp particles that damage the inner portions of the lungs. In contrast, asbestos fiber that is shorter or of a length-to-width ratio less than 3:1 does not cause significant damage.

OSHA PEL for Asbestos

The Occupational Safety & Health Administration (OSHA) has established a Permissible Exposure Limit (PEL) for asbestos; 0.1 f/cc over a time weighted average (TWA) of 8 hours.

On average, a worker will breathe 10,000,000 cubic centimeters (cc) of air in a typical work shift (8 hours); this is about the volume of 10 refrigerators. The number of asbestos fibers allowed by OSHA during this time period (0.1) can fit onto the tip of a pencil (about 1 million fibers).
Respirable Particles

Dust, fibers, fumes and other particles that can go past the nose and mouth and enter deep into the respiratory system are considered to be respirable; these particles are less than 10 microns (µm) in diameter.

Respirable dust is less than 10 microns (µm) in diameter!

A micron is 1 millionth of a meter (1/96,000 of an inch).

Human hair is between 80 – 120 microns (µm) in diameter.

Some exposures in construction, such as toxic fumes, dusts and mists occur from particles that are less than 10 microns (µm) in diameter; these exposures are invisible.

Examples of respirable (invisible) fume or dust:

- Silica
- Lead
- Asbestos
- Hexavalent Chromium

Human hair is between 80 – 120 microns (µm) in diameter.
Respirable Particles

Fumes, dusts and some mist particles are so small that they are invisible; these particles can enter deep into the lungs and cause serious health effects.

Particle Diameters

![Particle Diameters Diagram]

1 Micron = 1µm = \( \frac{1}{1,000,000} \) Meter

1 Red Blood Cell = 7µm

High Efficiency Particulate Air (HEPA)

High-efficiency particulate air filtration, or HEPA, is capable of filtering 0.3 micrometer particles with 99.97% efficiency, for use in contaminated environments.

Where airborne particles are less than 10 microns (µm) in diameter, a HEPA (100) rated respirator is highly recommended.

(See Respiratory Protection Program, page 201)

Examples of respirators with high-efficiency particulate air (HEPA) filtration; these are recommended to be used where airborne particles are less than 10 µm in diameter.
How do chemicals enter my body?

In order for a chemical to become hazardous to a person’s health, it must first contact or enter the body and the chemical must have some biological effect on the body. There are four major routes:

- Inhalation (breathing)
- Skin contact
- Digestive system (ingestion or eating)
- Injection

Breathing of contaminated air is the most common way that workplace chemicals enter the body. Some chemicals, when contacted, can pass through the skin into the bloodstream. Less commonly, workplace chemicals may be swallowed accidentally if food or cigarettes (or hands) are contaminated. For this reason workers should not drink, eat, or smoke in areas where they may be exposed to toxic chemicals.

Injection is the fourth way chemicals may enter the body. While uncommon in most workplaces, it can occur when a sharp object (e.g., needle) punctures the skin and injects a chemical (or virus) directly into the bloodstream.

The eyes may also be a route of entry. Usually, however, only very small quantities of chemicals in the workplace enter through the mouth or the eyes.

Regardless of the way the chemical gets into the body, once it is in the body it is distributed to anywhere in the body by the bloodstream. In this way, the chemicals can attack and harm organs which are far away from the original point of entry as well as where they entered the body.

What happens to contaminated air when I breathe it in?

Contaminated air in the workplace can be inhaled. Air is drawn through the mouth and nose and then into the lungs. An average person will breath in and out about 12 times a minute. Each of the 12 inhalations brings in about 500 mL of air, corresponding to 6 litres of air per minute, together with any contaminants that the air contains.

People involved in hard physical work will breathe harder and take in more than 6 litres a minute. Over an 8-hour working day, more than 2,800 litres of air will be breathed in and out of the lungs. In conditions of hard physical work, up to 10,000 litres may be exchanged. Air breathed in through the nose is filtered by the nasal hairs so that large, solid particles in the atmosphere are prevented from going any further. Inside the nose there are small bones and cartilages that cause the
inhaled air to swirl around. This swirling air can cause some large contaminating particles to be deposited in the nose and trapped by the moisture of the mucus lining.

Air coming in from the nose and the mouth reaches the back of the throat and enters an area known as the pharynx. The pharynx, which is the entrance to the airways, divides into two tubes, one called the esophagus, which carries food to the stomach, and one called the trachea, which leads down towards the lungs. Contaminated air passes into the trachea which itself divides into two large tubes, each called a bronchus. Each bronchus enters a lung. Once inside its lung, each bronchus starts to branch. The tubes of the bronchus get thinner and thinner as they spread, rather like the branches of a tree. Eventually, the tiniest tubes, which are called bronchioles, end in thin-walled air sacs. Each of these sacs is called an alveolus. Collectively, they are called alveoli and there are many thousands of these in each lung. The walls of the alveoli are very thin and are richly supplied with tiny blood vessels (capillaries). Waste carbon dioxide from the body, carried in the blood inside the veins, can pass out of the veins through the walls of the alveoli to become a part of the air which is exhaled.

See How Do Particulates Enter the Respiratory System? for a diagram and more details.

Oxygen in the inhaled breath crosses the alveolar walls to enter the blood within the capillaries. Once oxygen has become attached to the blood inside the veins, it is then distributed throughout the body. Chemical vapours, gases and mists which reach the alveoli in the lungs can also pass into the blood and be distributed around the body.

Sometimes, the concentration of chemicals reaching the alveolar air sacs is lower than in the workplace air. This is because the airways contain a lining of sticky, thick fluid called mucus. Tiny hairs, known as cilia, on the inside of the tubes constantly carry this mucus upwards towards the back of the throat. In some instances, a portion of the gases, vapours and mists may be dissolved in this mucus before they reach the alveolar sacs.

Solid, visible particles found in dusts, fumes and smoke that have escaped the filtering mechanisms of the nose may also be trapped by the mucus. The mucus is wafted by the tiny cilia hairs until it reaches the back of the throat where it is either expelled through the mouth or swallowed and passed to the stomach. In this latter case, the contaminating chemicals will enter the body in the same way as contaminated food or drink. This is dealt with in more detail in the section on the digestive system.

Much smaller particles (so small that they cannot be seen by the eye) may not be stopped by the mucus in the trachea and bronchiole tubes. They travel through the various branches of the airway and eventually reach the alveoli. Solid particles which cannot pass through the thin wall of the air sacs may lodge and stay where they are. Some may dissolve, others may be attacked and destroyed by the scavenger cells of the body's defence system. Others may prove too big or too insoluble to be disposed of in this way and simply stay in the air sacs. Some of these particles, if they are present only in small quantities, do no apparent harm. Other types of dusts may damage the surrounding alveolar walls. The damage may be permanent and may cause scars to form, which eventually interfere with the lung's ability to pass oxygen into the blood stream.

Some acids, caustics or organic chemicals, when inhaled in sizable amounts, can cause serious and irreparable "burn" damage to the mouth, nose, trachea, bronchi and lungs.

**What are examples of chemicals that I can inhale?**

**Gases and Vapours**

Workplace chemicals can enter the air in a number of different ways. Simple evaporation is probably the most common way. Organic solvents, such as toluene, methyl ethyl ketone (MEK) or alcohols, generally evaporate more rapidly than water, acids or caustics, though this is not always
the case. Evaporation produces vapours. Vapours are formed from substances that exist as solids or liquids under normal temperature and pressure conditions. Substances that do not exist as solids or liquids at normal temperatures and pressures are called gases. Gases as well as vapours can contaminate the workplace air.

**Mists**

In some instances, an industrial process might produce tiny liquid droplets that are able to float in the air. These droplets are called mists. Mists are formed by gases that condense into small liquid droplets in the air. Alternatively, mists may form by breaking up, splashing or atomizing a liquid. Examples include acid mists from electroplating, oil mists from cutting and grinding, or paint spray mists from painting operations.

**Dusts, fumes and smoke**

Other workplace processes can generate tiny solid particles which are light enough to float in the air, and these are referred to as dusts, fumes and smoke. Dusts are solid particles often generated by some mechanical or abrasive activity. They are usually heavy enough to settle slowly to the ground. Fumes are very tiny solid particles which can remain airborne that are formed when a heated metal has evaporated in the air and then condensed back to a solid form. This occurs in welding operations. Smoke is carbon or soot from burning. Smoke particles can settle or remain airborne depending on their size.

**How does a chemical enter my body through the skin?**

Chemicals which pass through the skin are nearly always in liquid form. Solid chemicals and gases or vapours do not generally pass through the skin unless they are first dissolved in moisture on the skin's surface.

The skin is the second most common route by which occupational chemicals enter the body. It consists essentially of two layers, a thin, outermost layer called the epidermis and a much thicker underlayer called the dermis. The epidermis consists of several layers of flat, rather tightly-packed cells which form a barrier against infections, water, and some chemicals. This barrier is the external part of the epidermis. It is called the keratin layer, and is largely responsible for resisting water entry into the body. It can also resist weak acids but is much less effective against organic and some inorganic chemicals. The keratin layer contains fat and fat-like substances which readily absorb chemicals which are solvents for fat, oil, and grease.

**What are examples of chemicals that can enter by the skin?**

Organic and caustic (alkaline) chemicals can soften the keratin cells in the skin and pass through this layer to the dermis, where they are able to enter the veins and hence the blood stream. Areas of the body such as the forearms, which may be particularly hairy, are most easily penetrated by chemicals since they can enter down the small duct containing the hair shaft. Chemicals can also enter through cuts, punctures or scrapes of the skin since these are breaks in the protective layer. Contact with some chemicals such as detergents or organic solvents can cause skin dryness and cracking. There can also be hives, ulcerations or skin flaking. All these conditions weaken the protective layer of the skin and may allow chemicals to enter the body.

Chemicals can vary enormously in the degree to which they penetrate the skin. Some solvents such as trichloroethylene, naphtha and toluene may soften the keratin layer but are not believed...
to penetrate much further unless there is prolonged skin contact. On the other hand, chemicals such as benzene, carbon tetrachloride, carbon disulfide and methyl alcohol can readily pass through the epidermis and subsequently enter the blood stream. Some chemicals are so corrosive they burn holes in the skin, allowing entry for infection or other chemicals.

In some instances, chemicals may enter by accidental injection through the skin. This may occur in hospital settings or in industrial hole-punching or injection processes. Once in the blood stream, the chemicals can be transported to any site or organ of the body where they may exert their effects.

**How can chemicals enter my digestive system?**

Chemicals can enter the stomach either by swallowing contaminated mucus which has been expelled from the lungs, or by eating and drinking contaminated food. Food and drink are most frequently contaminated by contact with unwashed hands, gloves or clothing, or by being left exposed in the workplace. Nail-biting and smoking also contribute.

Once inside the mouth, workplace chemicals pass down the esophagus and then into the stomach. Food in the stomach is digested with a strong acid produced by the stomach. A few chemicals, such as alcohol, may pass across the stomach wall and enter the veins and the blood stream here, but most chemicals move from the stomach into a long, twisting tube known as the small intestine. The inside of the small intestine has many hundreds of tiny finger-like projections called villi. The villi have very thin walls and are filled with tiny blood vessels. This allows the digested food to pass from the small intestine across the walls of the villi and enter the veins. The food is then carried around in the blood stream to the parts of the body that need it.

Some workplace chemicals which contaminate food or drink can also pass across the thin walls of the villi and into the blood stream in this manner. Other workplace chemicals, which are not soluble or whose basic units (molecules) are too big to pass across the villi walls, will stay in the gut and pass out through the feces without being absorbed into the blood stream to any extent.

Some acids, caustics and organics may cause severe "burn" damage to the digestive system if ingested in high concentrations.

**What are examples of chemicals that can enter my body by ingestion (swallowing)?**

In workplaces, dusts, smoke or fumes can enter the digestive system by accidental ingestion (e.g., swallowing contaminated mucus which has been expelled from the lungs) or by eating something with contaminated hands (e.g., lead paint on unwashed hands).

**How can chemicals enter my body through my eye?**

Although eye splashes or eye contamination by workplace chemicals is fairly common, large quantities of chemicals probably do not enter the body this way. Small amounts of chemicals may enter by dissolving in the liquid surrounding the eyes, and larger, but probably not significant amounts, may enter the eyes if they are splashed with chemicals.

The eyes are richly supplied with blood vessels and many chemicals can penetrate the outer tissues and pass into the veins. The eye may or may not be damaged during this process, depending on the corrosive nature of the chemical and its ability to penetrate the outer tissues.
What are examples of chemicals that can enter my body by the eye?

Any chemical, whether in the form of a liquid, dust, vapour, gas, aerosol or mist, can contact and enter the eye. For example, the organic solvent toluene can pass through the outer layers of the eye and probably enter the blood stream. During this process it can cause keratitis, an inflammation of the outer layer of the eye.

Want more information?

You may be interested in these related products and services from CCOHS:

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CHEMpendium™

**Courses**

WHMIS for Workers

Personal Protective Equipment: The Basics

For further assistance with a particular workplace topic or issue, contact our Inquiries & Client Services team. This service is free, reliable, and confidential.
What is a chemical?

Everything in the physical world around us is made of chemicals. The earth we walk on, the air we breathe, the food we eat, the cars we drive, and the houses we live in are all made of various chemicals. Living organisms such as plants, animals, and humans are also made of chemicals.

Some of the chemicals we contact in our daily lives are man-made. These include some drugs, cosmetics, workplace chemicals, household cleaning agents, and so on. Many more chemicals which we are exposed to each day occur naturally and are found in our food, in the air, and in water. There are far more natural chemicals in our environment than man-made ones. Both man-made and natural chemicals can have poisonous effects.

What makes chemicals poisonous?

There are several factors which can influence the degree of poisoning caused by a chemical. These are as follows:

- Route of entry into the body
- Amount or dose entering the body
- Toxicity of the chemical
- Removal from the body
- Biological variation

What are the routes of entry into the body?

No chemical can cause poisonous effects without first coming into contact with the body.

Breathing of contaminated air is the most common way that workplace chemicals enter the body. Some chemicals, when contacted, can seep through the skin. Less commonly, workplace chemicals may be eaten if food or cigarettes are contaminated. The eyes may also be a route of entry. Usually, however, only very small quantities of chemicals in the workplace enter through the mouth or the eyes.
Why does the amount or dose entering the body matter?

The amount or dose of a chemical entering the body is probably the single most important factor which determines whether a chemical will cause poisoning. The amount of a chemical which causes poisoning depends on the chemical.

Consider, for example, what happens when water is drunk on a warm summer day. The water cools the body and quenches the thirst. Normally, water would be classified as a harmless chemical. What if instead of just one glass, many glasses were consumed one after the other, non-stop. A point would be reached where beneficial effects would disappear and harmful effects would start to be noticed. Drinking too much water causes water intoxication. In severe cases, this kind of poisoning causes convulsions and seizures. There are reports of such poisoning in small children and in psychiatric patients. The reason water "changes" from being harmless to being harmful is directly related to the amount of it taken into the body at one time. Drinking "too much" water causes the toxicity. Taking "too much" of a chemical into the body causes toxicity. This relation is true for all chemicals regardless of whether they are natural or man-made.

What is the toxicity of the chemical?

Toxicity is a measure of the poisoning strength of a chemical. Chemicals that are only weakly toxic require large doses to cause poisoning. Strongly toxic chemicals only need small doses to cause poisoning.

Toxicologists often use animal tests to determine whether small or large doses of a particular chemical cause toxicity. One such test measures the dose of a chemical that causes death to 50% of the animals being tested. This test is called the "Lethal Dose 50" (LD₅₀).

There is a tendency to think of chemicals in terms of those which are poisonous or toxic and those which are harmless. These categories are used for convenience, but they imply that toxicity or its absence is an all-or-nothing property of a chemical. This is not the case because any chemical can cause poisoning if a sufficient dose of it is taken into the body.

To put it another way, all chemicals can be toxic. It is the amount or dose taken into the body that determines whether or not they will cause poisonous effects. Poisoning, then, is caused not just by exposure to a particular chemical, but by exposure to too much of it.

What is meant by the rate of removal from the body?

Many workplace chemicals which enter the body are excreted unchanged. Others are broken down. The breakdown products may be more toxic or less toxic than the original chemical which entered. Other chemicals still are stored temporarily in body organs and are removed over a short period of time. Eventually most chemicals and their breakdown products are removed as waste in the feces, urine, sweat or exhaled breath. A few chemicals such as graphite or silica dusts can be inhaled into the lungs where they lodge for many years and may never be completely removed.

As a general rule there is less risk of chemically caused disease if the body can do one or both of the following:
• break down the chemical into less toxic products
• rapidly remove the chemical from the body.

What is biological variation?

Several characteristics of the exposed person or animal can influence the degree of poisoning which occurs. These include age, sex and individual susceptibility.

How are we exposed to amounts of chemicals sufficient to cause poisoning?

There are two main ways that too much of a chemical can enter the body and cause poisonous effects:

By sudden or short term exposures

A one-time exposure to relatively large amounts of the chemical can overwhelm the body. In the workplace this may happen through improper handling of the chemical, or when there is an accidental spill or a leak from a valve or pipe carrying chemicals. It might also happen during maintenance or cleaning of equipment that normally contains chemicals (such as a solvent vat). The ill-health effects caused by one-time, sudden, high exposures are often called "acute toxicity" effects. Some examples of acute toxicity are listed below:

• Inhalation of high concentrations of acid vapours might cause serious burns of the mouth and airways leading to the lungs.
• Skin contact with substantial amounts of certain organic solvents that are absorbed through the skin may cause dizziness and nausea.
• Inhalation of dusts can cause irritation of the respiratory tract, dryness in the throat, and coughing.

By repeated exposures over a long period of time

A repeated exposure over a long period of time can also cause too much chemical to enter the body and produce poisoning. This kind of poisoning occurs because the exposure is repeated day after day over many years. The exposure levels may be too small to cause any acute toxicity. Ill-health effects caused in such situations are often called "chronic toxicity" effects. The following are some examples of chronic toxicity:

• Inhalation of certain acid vapours at concentrations which do not cause acute toxicity may, over long periods of time, cause loss of tooth enamel, eventually leading to extensive tooth decay.
• Inhalation and skin absorption of some organic solvents at concentrations which do not cause acute toxicity may, over long periods of time, cause damage to nerve tissue.
• Repeated exposure to dusts containing quartz can cause scar tissue in the lungs. This leads to severe and permanent lung damage.

What else do we know about acute and chronic toxicity?

Most chemicals can cause both acute and chronic toxicity depending on the conditions of exposure. The adverse health effects caused by the chemical in the two types of toxicity are often quite different. It is not usually possible to predict what the chronic toxicity of a chemical
might be by looking at its acute toxicity, or vice versa.

**Acute toxicity**

In most cases, much more is known about the acute toxicity of a chemical than its chronic toxicity. The understanding of acute toxicity usually comes from studies with animals exposed to relatively high doses of the substances. Accidental overexposure, spills and emergencies have added to our knowledge of acute toxicity in humans. The health effects may be temporary, such as skin irritation, sickness or nausea, or they may be permanent: blindness, scars from acid burns, mental impairment and so on.

Acute toxicity is often seen within minutes or hours after a sudden, high exposure to a chemical. However, there are a few instances where a one-time high-level exposure causes delayed effects. For example, symptoms of high exposures to certain pesticides may not appear for several days.

**Chronic toxicity**

Much of the knowledge we have about chronic toxicity comes from animal experiments. In addition, much has been learned from studying groups of people occupationally exposed to a chemical for many years. As a general rule, chronic toxicity appears many years after exposure first began. The resulting disease occurs only because the exposure has taken place repeatedly over many years. Chronic toxicity diseases do not seem to be caused by sudden one-time exposures. Chronic toxicity is thought to occur in one of two main ways. These can be explained by using sodium fluoride and n-hexane as examples.

- Sodium fluoride, at very low concentrations (such as in toothpaste or drinking water), causes no noticeable adverse health effects, even after years of exposure. Indeed, at these low levels, the effects are considered beneficial for teeth. However, if much higher concentrations of sodium fluoride enter the body repeatedly, they deposit and build up in the bones. At first, the amount of fluoride in the bone may not cause any problems, but after years of repeated high exposure, symptoms of bone disease may appear.
- On the other hand, the chemical n-hexane is not deposited or accumulated in the body. It is broken down in the liver. One of the breakdown products can "attack" nerve cells in the fingers and toes. These kinds of cell are not replaced easily. With continued exposure for many years the damage to the cells increases until a point is reached where symptoms appear in the nerves of the fingers and toes.

One special case of chronic toxicity is cancer. Repeated exposure to some chemicals for long periods of time may cause cancer. Often people express concern about cancer developing after a one-time exposure to a cancer-causing agent. While there is no absolute proof that cancer will not occur from a one-time exposure, most of the evidence indicates that repeated exposure over a long period of time is necessary before cancer develops.

**What are the differences between toxicity and hazard?**

There is a tendency to believe that if only small amounts of a chemical are needed to cause poisoning, then the chemical is highly hazardous. This is not necessarily so. A highly toxic chemical can have a low health hazard if it is used with proper precautions and care. On the other hand, it is possible that a chemical of low toxicity may present a high health hazard if it is used carelessly or inappropriately. Toxicity is a measure of the poisoning strength and is an unchanging characteristic of a chemical. Hazard is not the same. It is a variable feature of a
chemical. Hazard is the likelihood that a chemical will cause poisoning, given its poisoning strength and the amounts and manner in which it is used, stored and handled. The toxicity of a chemical cannot be changed, but the hazard it presents can be controlled and minimized.

Want more information?

You may be interested in these related products and services from CCOHS:

**Courses**
- WHMIS for Workers

**Databases**
- CHEMpendium™
- RTECS®

**OH&S Programs and Management Systems**
- MSDS Management Service

For further assistance with a particular workplace topic or issue, contact our Inquiries & Client Services team. This service is free, reliable, and confidential.
Your patient is a construction worker with exposure to wet cement. Construction workers are exposed to a number of chemicals known to cause irritable and allergic dermatitis. Portland cement, found in plaster and in concrete mixes, is extremely alkaline. Wet plaster also contains slaked lime, or calcium hydroxide, which is even more caustic than portland cement.

Further, portland cement contains trace amounts of hexavalent chromium. Hexavalent chromium is a strong sensitizing agent responsible for allergic dermatitis in cement workers around the world. Other sensitizing agents include various epoxy adhesives and sealants in addition to various chemicals present in the admixtures used with cement and plaster. Finally, construction workers may use products such as lanolin creams or lotions to soften their skin. Lanolin is a sensitizing agent. Some industrial hand cleaners contain limonene, also a sensitizing agent. The rubber in rubber gloves also may cause allergic dermatitis.

This pamphlet contains a partial listing of skin disorders, potential etiologic agents, and possible medical surveillance. Please keep this in your patient's file. Sources of additional information about occupational dermatitis are printed on the back.
Skin Disorders/Agents

Etiologic Agents

FINDINGS/SYMPHOMES

INFERRATION/REMEDIES

Contact dermatitis (hypersensitivity)}

Complications

Contact irritants (hypersensitivity)}

Complications

Complications

Complications

Complications

Complications

Complications

Complications

Complications

Complications

Complications