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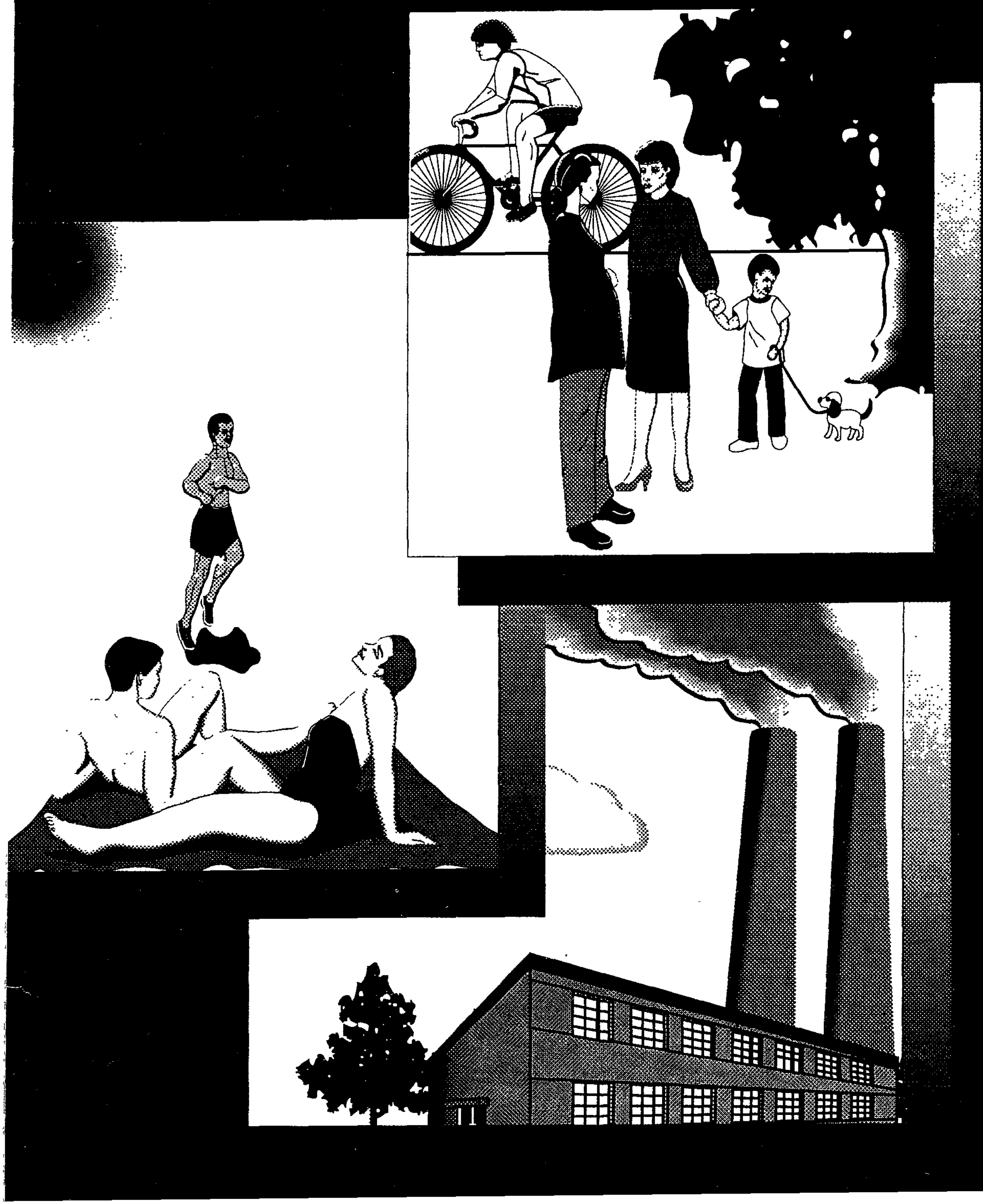
EPA

Environmental Risk: Your Guide to Analyzing and Reducing Risk



ENVIRONMENTAL RISK: YOUR GUIDE TO ANALYZING AND REDUCING RISK

People incur a certain amount of risk every day. Whether they drive a car, cross a street, use a knife, or varnish a piece of furniture, they put themselves in a potentially risky situation.

Risk is defined as the **probability*** of injury, disease, or death under specific circumstances. All human activities carry some degree of risk.

Environmental risk is the risk associated with the likelihood or probability that a given chemical **exposure** or series of exposures may damage human health. Environmental risk takes two factors into account: the amount of a chemical present and its relation to the amount the exposed person can tolerate. Each person reacts to risk situations differently, both physically and mentally.

*Words in bold are defined in the glossary

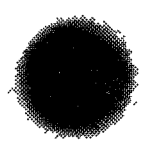
HISTORY

Managing environmental risk is an endless and challenging task of Government agencies, especially of the United States Environmental Protection Agency (EPA). Government agencies became heavily involved in risk management after World War II, when production of industrial chemicals surged without a complete understanding of their effects on people and **ecosystems.** Two other important events contributed to the growing awareness of risk: the focus of public attention on specific chemicals, or classes of chemicals (such as **pesticides** and **asbestos**) and the realization that people were potentially exposed to them not only in one area but worldwide. Epidemiologists (scientists who study the spreading of diseases in a human population) also discovered that some types of cancer were related to environmental pollution.

It is very difficult to come up with the precise risk associated with toxic chemicals. With certain types of chemicals, when someone is exposed to a high level, that person immediately experiences some form of injury, perhaps even death. This makes it easy for epidemiologists to determine the cause. However, there are instances of everyday environmental threats for which there are no immediate observable forms of injury or disease. For example, a person who has smoked heavily for 20 years may contract cancer only years later. It is known that the more cigarettes you smoke, the greater your chances or risk of developing lung or other forms of cancer. The risk may not be obvious to smokers because sometimes it takes years for cancer to develop.

The public seeks and deserves information on the safe levels of toxicants in foods, water, or air. The term "safe" in common usage means "without risk." However, scientifically speaking, there is no definite way to determine the conditions under which a given chemical exposure is likely to be absolutely without risk. That is where the science of risk assessment comes into play. It would be ideal if EPA could guarantee "zero risk" for a certain chemial, but that is often not possible to achieve without prohibiting all uses of the chemical. Science can, however, describe the conditions under which risks are so low that they are generally considered to be of no practical consequence. Informing the public as to which chemicals or technologies are hazardous is a realistic goal of EPA.

RISK CONCEPTS

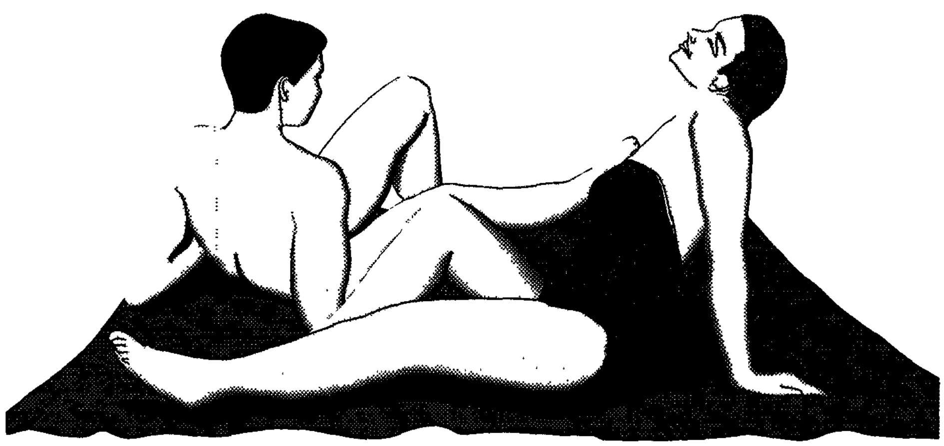


Since the early 1970's, one of EPA's goals has been to reduce risks to human health and the environment caused by toxic substances. Through risk assessment, EPA identifies the most serious risks by determining the size of the risk and the number of people or wildlife exposed. EPA then develops **regulatory** procedures to lower these risks to acceptable levels. If chemical A poses 1,000 times more risk to people than chemical B, chemical A will have greater priority for regulatory action than chemical B. This does not mean that EPA ignores chemical B — only that EPA believes it to be more important to reduce risks from chemical A first.

You will often hear the words **chronic** v. **acute** associated with risk. An acute health risk is a risk which is currently dangerous and needs to be dealt with immediately, sometimes within hours or days. A chronic health risk may persist for a long time without showing any significant effect. Take suntanning. It poses an acute health risk when a person is out in the sun all day and develops a painful sunburn. Remedies applied in the short run may consist of a lotion or aloe to ease the pain or heal the blisters. In contrast, suntanning can pose a chronic health risk if a person sunbathes frequently over many years. Such a person may never experience acute sunburn, but may have an increased chronic risk of developing skin cancer later in life.

Dose and **response** are usually used together in determining risk. Dose refers to the amount of a certain chemical to which someone is exposed. Response refers to a person's reaction to that exposure.

Certain scientific terms of measurement are used to describe risk after it is **assessed.** Scientists may come up with a figure like 1×10^{-5} (0.00001) after they assess the risk of a pesticide used on certain fruits and vegetables. It means that one person in a 100,000 people who eat the food sprayed with that pesticide may contract cancer. The use of these numbers



represents a method that EPA uses to express the risk in terms of human health.

Another common term the Government uses is parts per million (ppm). For instance, there may be 1 ppm of a chemical in a pesticide that is sprayed on crops. To put this unit of measurement in perspective, one part per million is equivalent to one facial tissue in a stack taller than the Empire State Building.

NEED FOR RISK ASSESSMENT

Because "zero risk" does not exist in the environment, both the EPA and the public need to manage the threats that chemicals introduce. First, the risk to the community has to be determined so that management decisions can be made. Regulatory actions differ, depending upon the particular law that Congress has passed. For example, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which governs EPA's regulation of pesticides, is often called the balancing **statute** because it requires EPA, when making regulatory decisions, to weigh the risk of pesticides against their possible economic and social benefits.

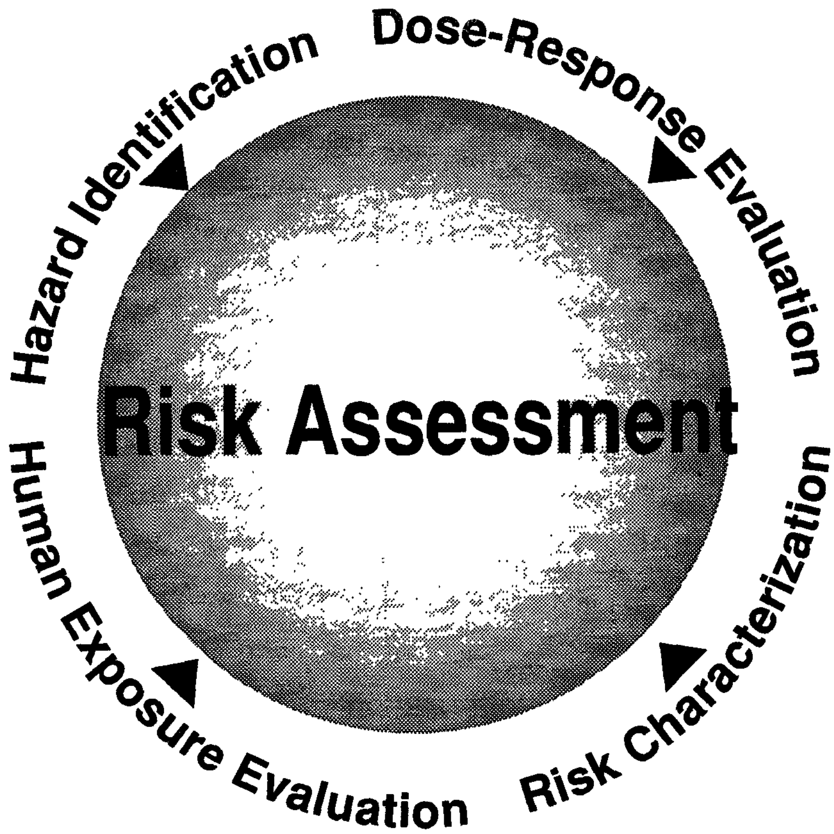
FIFRA offers EPA many risk management options to reduce risks wherever possible — without doing away with the benefits of a pesticide. For example, depending on the nature of EPA concerns, such options might include: requiring protective clothing or equipment to minimize risks to pesticide applicators, reducing the rate or frequency of application to lower pesticide residue levels on harvested crops, or imposing national or regional restrictions against using a pesticide in areas where it could contaminate **ground water.**

FIFRA also gives EPA the authority to cancel a pesticide or issue an emergency suspension. Strong evidence is needed for such an action and it clearly represents a challenging risk management situation. Making decisions on the regulation of pesticides is just one example of the risk management process at EPA. However, before any decision is made, EPA needs to assess the risk involved. The next section describes the risk assessment process.

RISK ASSESSMENT

According to the National Academy of Sciences, risk assessment is a scientific activity that evaluates the **toxic** properties of a chemical and the conditions of human exposure to it. It determines the likelihood of harmful exposure and characterizes the nature of the effects people may experience. In essence, by assessing the risk of a chemical, EPA can **quantify** the degree of hazard to which people might be exposed.

There are four parts to every risk assessment:



Hazard Identification

Hazard identification is a process where potential toxic effects are determined. Scientists gather and evaluate data on the types of injury or disease that may be caused by a chemical. They also determine what happens to the chemical once it enters the body.

Dose-Response Evaluation

Evaluating dose and response (amount and reaction) is the second step. Scientists evaluate the relationship between the amount of exposure to a substance and the extent of toxic injury or disease it causes. The information comes from either animal data or, less frequently, from studies of human exposure. In basic terms, it is the amount of a chemical taken in and how the system reacts to it. The dose-response relationship needs to be put in numerical terms, such as one in a million (1×10^{-6}) or 0.000001, so that the risk associated with a specific substance can be compared to other similar studies.

For instance, once the pollutant's hazards have been identified, the scientist looks at studies evaluating how much of a chemical in drinking water people can ingest before it produces an adverse response in their bodies. Scientists try to come up with the dose-response relationship that is most protective of human health.

Human Exposure Evaluation

In step three, scientists analyze the exposed population. They determine the number of those exposed and their ages. They look at the amount and the length of exposure to a toxic chemical. The evaluation could be based on past, present, or future exposure.

In the example using drinking water, the population that drinks the water would be evaluated, so that scientists could have a clear picture of who was actually exposed to the chemicals in the water. How much water do people drink each day? Knowing such information makes it easier to assess the risks. Sometimes, when no exposure data are available, scientists must use assumptions to make estimates.

Risk Characterization

Risk characterization is the final step of risk assessment. It brings together the results of the first three steps, then determines the likelihood that people will experience any of the various forms of toxicity associated with a substance.

In the drinking water example, to come up with a risk characterization, the potential toxins in water are determined (hazard identification), the amount of water a person can ingest without having adverse health effects is calculated (dose-response), and the age and type of person involved is examined (human exposure). An alternative to this process is to perform health studies on exposed people.

RISK MANAGEMENT

Once a risk has been characterized, it must be properly managed. First, EPA must decide if a situation is risky enough to present a public-health concern. If it is, the risk has to be controlled. In the drinking-water example, determining whether the risk is acute or chronic will determine whether the community will be advised to start using bottled water instead of tap water, or to keep watching health advisories for further directions. Several factors are considered in deciding how to best manage a previously assessed risk:

Magnitude of the risk

The magnitude, or size, of the risk has a direct bearing on how rapidly the risk will be managed. Lifetime cancer risks greater than one in a hundred thousand (10^{-5}), or one in ten thousand (10^{-4}) are generally unacceptable. In most cases, when risks exceed these levels, EPA will take action to reduce these risks unless severe technical or economic constraints are present.

Social Concerns

EPA must often determine how a risk management decision will affect society. Will people lose jobs or be required to move? Will the decision disrupt personal lifestyles and community life? The EPA, as a protective agency, considers societal concerns and, particularly, impacts to communities before it takes action on risk assessment information.

Technical and Economic Constraints

EPA must assess whether it is technically and economically possible to reduce risks. Can industry keep up with the innovations needed to continually manage a risky situation? Does such technology exist, to begin with?

RISK COMMUNICATION

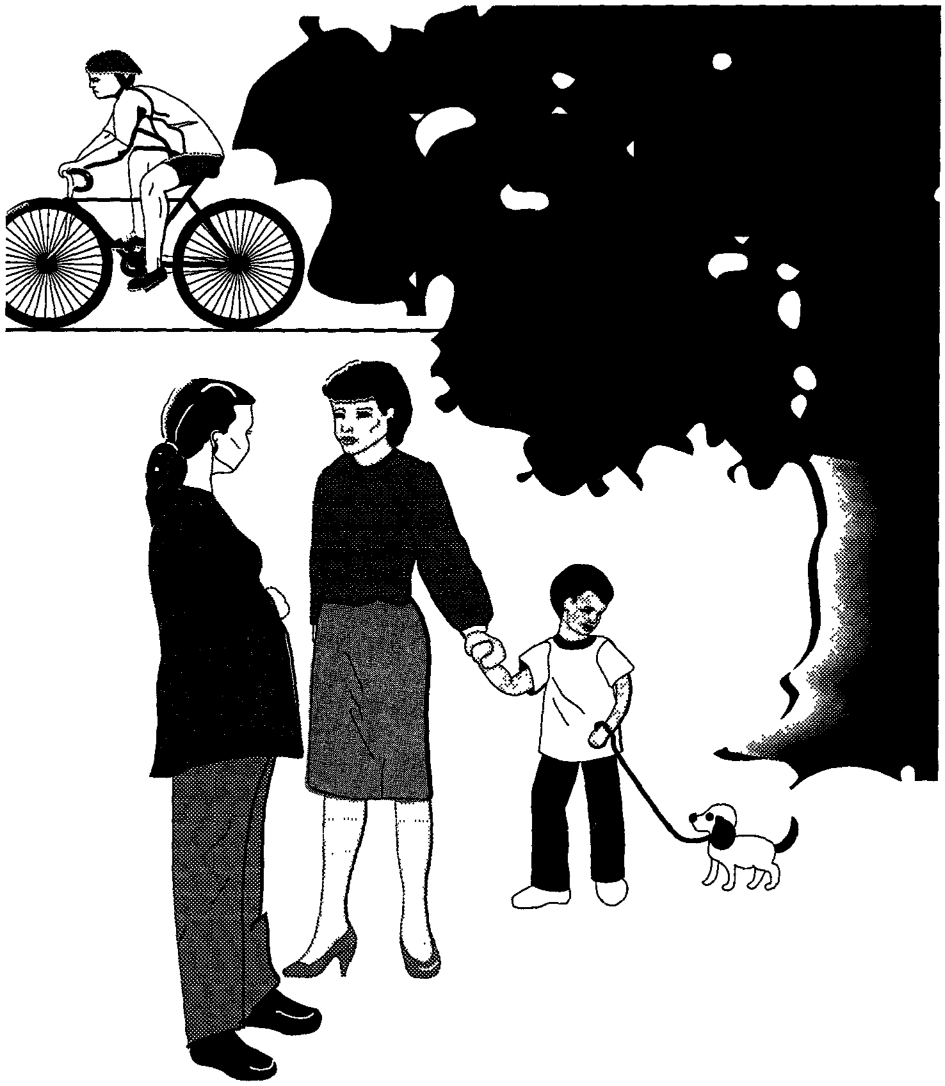
The third part of dealing with risk is risk communication. Once the risk has been assessed and the methods to manage it have been chosen, EPA must communicate the findings in a way that everyone involved will understand.

The key to communicating any risk situation successfully is realizing that each person reacts to the situation differently. In fact, different publics even define the word "risk" differently. In a community, "publics" include parents, children, politicians, economic experts, scientists, and even employees who work at a plant that may be causing environmental problems in the community.

An employee may look at the risk of being unemployed as greater than the risk of chemical exposure. A parent may view any risk to children, no matter how small, with outrage. EPA tries to take into account these different risk perceptions. To the Government scientist, risk means hazards presented by a chemical or a situation. Some social scientists have defined risk perception as hazard plus outrage.

Scholars who study the way people understand risk have focused on how the public reacts to risk situations. They can then guide experts and Government decision-makers in the process of making risk management and communication decisions.

Studies have shown that a **voluntary** risk is much more acceptable to people than an involuntary risk. People are willing to engage in voluntary risks. People feel safer when they are in control of a situation. Most people view driving a car as a safer activity than being a passenger in a plane, even though the risk of dying in a car crash is 1 in 100 in a lifetime...and less than 1 in a 1,000,000 in an airplane.



REDUCING ENVIRONMENTAL RISKS

We are all concerned about reducing our risks. EPA and other organizations have evaluated environmental risks and have ranked them on the basis of magnitude.

Since cancer is of great concern to people, shown below are various cancer risks from environmental agents:

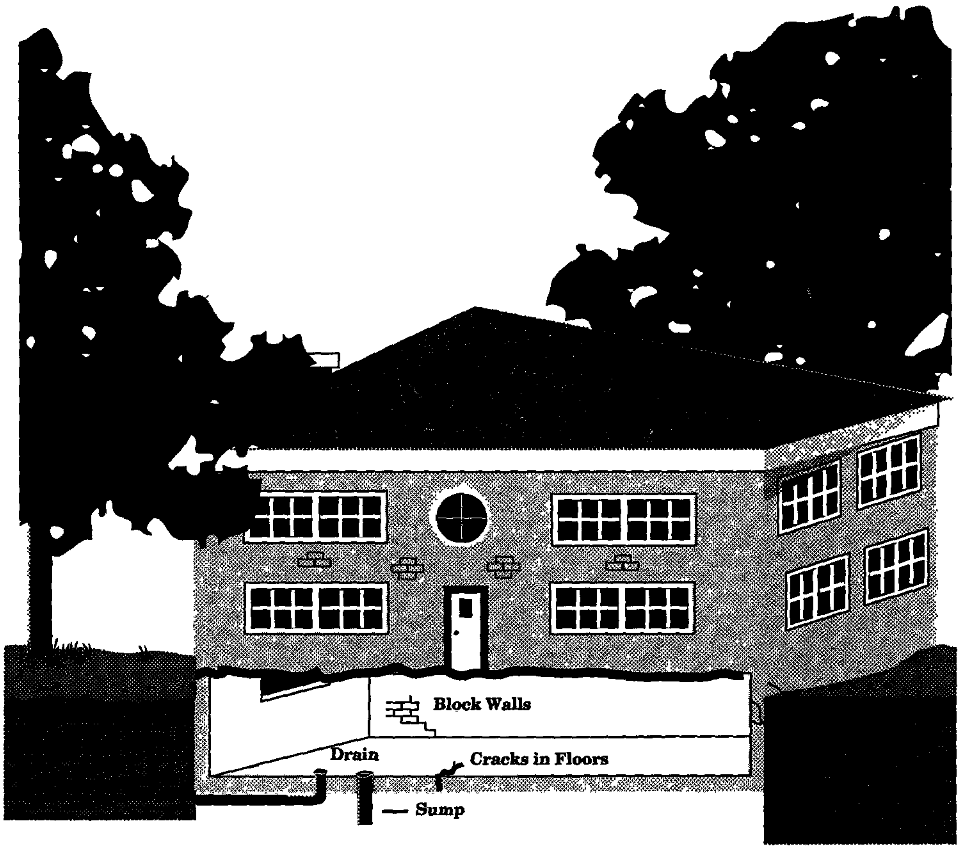
Cancer-Causing Agents or Situations	Approximate Lifetime Risk of Cancer
1. Exposure to the sun (skin cancer)	1 in 3
2. Cigarette smoking (based on smoking a pack or more per day)	8 in 100
3. Natural radon in indoor air at home	1 in 100
4. Outside radiation (radon and cosmic rays)	1 in 1,000
5. Persons in room with a smoker	7 in 10,000
6. Human-made chemicals in indoor air at home	2 in 10,000
7. Outdoor air in industrialized areas	1 in 10,000
8. Human-made chemicals in drinking water*	1 in 100,000
9. Human-made chemicals in most foods	1 in 100,000 or less
(a) 2oz. of peanut butter per week (naturally caused **aflatoxin** present)	8 in 100,000
(b) one meal per year of small Lake Michigan trout	1 in 100,000
10. Chemical exposure at most uncontrolled hazardous waste sites	1 in 10,000 to 1 in 1,000,000

* Some chlorinated waters may have slightly higher risks. Chlorination is used to destroy disease-causing organisms often found in drinking water.

As you can see from the chart, the greatest risk of contracting cancer is from exposure to the sun. Although most skin cancers are not fatal, one type of skin cancer, called melanoma, yields a high risk of 2 in 1,000. This means that if 1,000 people are exposed, 2 may die of skin cancer over their lifetime. Doctors now strongly recommend using protective clothing and sunblocking agents to reduce the risk of skin cancer. It is most important to avoid a sunburn because even a single sunburn in one's lifetime may cause serious, and often fatal, forms of skin cancer.

Smoking cigarettes over a lifetime yields a voluntary risk of 8 in 100 of contracting cancer. The most common form of cancer from cigarettes, lung cancer, is not readily curable. It is important to note that nonsmokers, in the presence of smokers, also experience a very high risk of cancer — 7 in 1,000, or only about 10 times less than the smoker. Quitting smoking not only reduces the risks to smokers, but also to those around them.

An extremely high risk of cancer (an average of 1 in 100) results from naturally occuring radiation, in the form of



radon in the home. It is estimated that 4,000- 5,000 deaths per year occur in the Great Lakes Region (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin) due to radon exposure in homes. EPA has frequently recommended that people test their homes for radon, but less than 5 percent have done so nationally. Yet exposure to radon, like smoking cigarettes, is known to cause lung cancer.

Studies show that people are less concerned about natural risks, such as radon, than they are about unfamiliar risks, such as living near an uncontrolled hazardous waste site. Most hazardous waste sites before cleanup pose cancer risks ranging from one in a million to one in ten thousand — or 100 to 10,000 times less than posed by radon in homes. But people are far more concerned about getting cancer from hazardous waste sites, even if cancer risks are as small as one in a million. The hazardous waste site is human-made, less understood, and is therefore perceived to be more threatening than radon in homes. However, radon in homes presents a far greater danger than most hazardous waste sites. Fortunately, simple measures exist to reduce radon. EPA encourages homeowners to test their homes and, if necessary, take steps to reduce radon. (For more information write to: Radon Publication Coordinator, EPA Region 5, 77 West Jackson Blvd., Chicago, IL 60604).

Researchers have shown that the indoor air in homes has chemicals other than radon with the potential to cause cancer. Some of these human-made chemicals found include solvents in paints, cleaning agents, and pesticides. EPA has found that indoor air cancer risks from these chemicals (2 in 10,000) generally are greater than risks from cancer-causing agents found outdoors in heavily industrialized areas (1 in 10,000). This was an unexpected finding.

You can reduce your exposure to cancer-causing agents in the home by minimizing your use of solvents, cleaning products, or deodorizers containing chloroform, trichlorethylene, tetrachloroethylene, benzene, and dichlorobenzene.

If you are using chemicals to strip wood, you should use protective gloves, good ventilation or a carbon respirator to protect yourself from these chemicals. If you use pesticides in and around your home, or have them applied professionally, ask if they cause cancer or have other serious toxic effects. As a general rule, pesticides should be used only if absolutely needed.

Homes may also contain **formaldehyde** as a component of glue in wood paneling or in insulation (urea-formaldehyde foam). Find out if wood paneling contains formaldehyde, particularly if you plan to use a great deal of paneling in your home. Also, before you buy or sell a home, find out if urea-formaldehyde insulation foam is present. If so, you may wish to test the air for formaldehyde.

home. Also, before you buy or sell a home, find out if urea-formaldehyde insulation foam is present. If so, you may wish to test the air for formaldehyde.

Asbestos is also a known human lung carcinogen and you should know if your home contains asbestos. Asbestos in homes is most often found in insulation for hot water pipes or furnaces. Asbestos poses a danger when the fibers are loose or crumbling. To determine if material contains asbestos, send a bulk sample to a laboratory. But be careful not to disturb the suspected material when collecting a sample. Do not try to remove asbestos yourself; there are licensed asbestos contractors for that. A list of approved laboratories and contractors is available from your EPA office at the address for radon publications on page 11. Cancer risks from human-made chemicals in drinking water and in foods are generally low. You can reduce both human-made and natural cancer-causing chemicals in your diet by eating foods low in fat. A diet high in fiber reduces the chances of colon cancer, a leading form of cancer. Washing or peeling fruits and vegetables will help remove traces of pesticides.

There are also significant noncancer environmental risks that we often do not think about. The risk of death from a fall in your lifetime is 4 in 1,000; from drowning, 3 in 1,000; from fire, 2 in 1,000; and, electrocution 4 in 10,000. Numerous safety measures exist which, if used, will reduce these other risks, too.

RISKS TO ECOSYSTEMS

EPA is also concerned about risks to wildlife and to the many complex and diverse ecosystems. Recently, in an EPA Region 5 project comparing these risks to the environment, several problems were found to cause significant risks to ecosystems. For example, physical destruction of terrestrial and aquatic ecosystems caused by certain types of agriculture, forestry, and urbanization is a major stress on the environment. Pesticides and other chemicals were also found to have undesirable risks to wildlife. In addition, very significant potential risks to animal and plant life, including agriculture, may result from global warming, stratospheric ozone depletion, and accidents involving chemical or nuclear materials.

To prevent present and future damage to ecosystems to which we are directly dependent, EPA believes additional environmental protection measures are needed. Similar conclusions regarding the need to protect ecosystems were reached in September 1990, by the Science Advisory Board, an independent advisory group to EPA.

RISK COMPARISONS

dependent advisory group to EPA.

If you wish to obtain more information on comparative human health and ecological risks, you can contact the EPA and ask for the following reports:

"A Risk Analysis of Twenty-six Environmental Problems," U.S. EPA Region 5, 1991.

Reducing Risk: "Setting Priorities and Strategies for Environmental Protection," U.S. EPA, Science Advisory Board, Washington, DC, September 1990.

WHAT EPA IS DOING...

In addition to the pollution control activities of EPA's air, water, and land programs, EPA Region 5 has created a new, centralized office for handling risk assessment activities — the Office of Health and Environmental Assessment (OHEA). Its main functions are:

- to communicate environmental and human health risks to the public and the media;
- to establish priorities for assessing and reducing risk to human health;
- to provide other EPA staff with technical assistance, advice, and direction on health and environmental matters; and,
- to expand and enhance risk assessment and communication expertise within the Region by conducting risk-training courses.

WHAT YOU CAN DO

- Reduce personal risk through some of the suggestions in this brochure.
- Take an active role in community meetings that involve environmental activities.
- Work with local environmental agencies on issues that may pose environmental risk.
- Make an effort to learn more about the risk assessment and risk management process by requesting EPA employees to come and speak to your community.
- Contact EPA Region 5 at:
  77 West Jackson Blvd.
  Chicago, IL 60604
  (312) 353-2072

In Illinois 1-800-572-2515
In Indiana, Minnesota, Michigan, Ohio, Wisconsin
1-800-621-8431

The social activism of the 1960's and the 1970's has left a legacy that is evident in today's public debates about the environment. People demand to be more involved in the decision-making process. To be more effective, EPA seeks a more open dialogue with the public. The more we work together and understand each other's concerns, the closer we will be to reaching our goals — protecting public health and the environment for generations to follow.

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GLOSSARY

acute: having a sudden onset, sharp rise, and short course (in respect to a disease)

aflatoxin: any of several toxins produced by fungi that can cause cancer

asbestos: a noncombustible, nonconducting, or chemically resistant mineral

assessed: determined in terms of importance, size, or value

chronic: marked by long duration or frequent recurrence

contract: to acquire, usually involuntarily

dose: a measured quantity of a substance

ecosystem: community and its environment functioning as a unit in nature (i.e.: a forest ecosystem, a lake ecosystem, etc.)

exposure: a condition or instance of being subject to an influence (in this case to chemicals)

formaldehyde: a colorless, pungent, irritating gas, chiefly used as a disinfectant, preservative, and synthesizer of other compounds.

ground water: water beneath the surface of the earth

ingest: to take in, as if for digestion

pesticide: an agent used to destroy pests

probability: a chance that something will occur

quantify: to put in terms of amount or number

regulatory: governing actions controlled by the law

response: the activity or inhibition of previous activity of an organism or any of its parts resulting from stimulation

statute: a law enacted by the legislative branch of Government

toxic: of, relating to, or caused by a poison

voluntary: preceeding from one's own choice or consent

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