

FACT SHEET

Risk and Risk Assessment

What is risk?

Webster's *New World Dictionary* defines risk as the chance of injury, damage, or loss. To put oneself "at risk" means to participate either voluntarily or involuntarily in activities that could lead to injury, damage, or loss. Voluntary risks are associated with activities that we decide to undertake (e.g., driving a car, smoking cigarettes). Involuntary risks are associated with activities that happen to us without our prior consent or knowledge (e.g., acts of nature like flooding or lightning, inhaling pollution from car exhaust).

What is risk assessment?

Risk assessment is a formalized process to integrate knowledge on chemical toxicity and potential exposures to predict the likelihood of harm from such an exposure.

How are risks associated with environmental exposures?

Risk is determined by:

- the ability of an activity to cause adverse effects at different levels of exposure,
- the type of toxicity associated with a chemical and the dose-response characteristics of the chemical, and;
- the level of exposure that occurs.

Usually, a higher exposure leads to more serious effects, or to a greater likelihood that adverse effects will occur, so the risks are higher. Typically, at some low exposure level, the risks tend to become insignificant.

Why does the Department of Environmental Protection assess risk?

Assessing risks from toxic chemicals in the environment informs us of many things, including:

- what problems exist;
- how big the problems are;
- the relative sizes of different problems; and
- to help develop approaches to solve the problems.

Estimates of risk are essential for some environmental decisions so that we can address the highest risk problems first, and know when action is needed to minimize or reduce risk.

What other factors are involved in environmental decision-making?

Risk estimates are only one factor in sound environmental decision-making. In most environmental decisions, risk is balanced with many other factors including:

- technical feasibility of controlling the risk,
- economic cost, and
- social values.

Only in extreme cases where the risk is very high will it alone drive environmental decision-making.

What risks are assessed by DEP?

DEP is responsible for evaluating adverse effects to human health and the environment that result from involuntarily exposure to harmful contaminants. Risks can only be estimated, not measured, because risk assessment is predictive. DEP generally looks at the likelihood of a population getting cancer or other adverse health effects from a particular exposure to a particular chemical.

What are some examples of adverse health effects?

- Irritation of skin, mucus membranes;
- behavioral effects;
- changes in immune system response to agents;
- developmental or reproductive effects;
- changes in hormone or enzyme levels;
- headaches or sleepiness; and
- cancer.

How are risks estimated and expressed?

Risk is estimated by scientific studies of populations via epidemiological studies or by applying mathematical models and a series of assumptions to extrapolate animal data to infer risk to humans. The risk associated with the potential to develop cancer is usually expressed as a probability of cancer associated with a particular activity and/or exposure level to harmful contaminants. Risks associated with the potential to develop cancer are expressed as a fraction, without units, from 0 - 1.0, where at 1.0 there is absolute certainty that a risk will occur. Scientific notation is generally used to present this type of information.

Actual Number	Scientific Notations		Read As
1/10	1×10^{-1}	1E-01	One in ten
1/100	1×10^{-2}	1E-02	One in a hundred
1/1,000	1×10^{-3}	1E-03	One in a thousand
1/10,000	1×10^{-4}	1E-04	One in ten thousand
1/100,000	1×10^{-5}	1E-05	One in a hundred thousand
1/1,000,000	1×10^{-6}	1E-06	One in a million
1/10,000,000	1×10^{-7}	1E-07	One in ten million

For potential non-cancer toxic effects, the likelihood and magnitude of adverse health risks are estimated in the form of non-cancer hazard quotients (HQ), which is the ratio of the pollutant intake to its reference concentration (RfC). A RfC is a concentration in the ambient air that individuals (even sensitive ones) can be exposed to day in and day out over a lifetime without risk of an adverse health effect. A ratio of less than 1.0 indicates that adverse non-cancer health effects are unlikely.

Some well-known risk numbers:

- The risk of dying prematurely as a result of smoking: one in two.

- The risk of getting into a car accident this year: one in eight.
- The risk of being struck and killed by lightning this year: one in 2.5 million.

Risk Assessment and the Real World

Risk assessments may incorporate extremely large uncertainties in their estimates of exposure and risk. Most of these uncertainties arise because measurements needed to determine risk precisely cannot be made in real individuals, settings, and time frames. Alternatives are used, from which answers are extrapolated. The magnitude of the uncertainties from such extrapolations is typically unknown, but can be estimated. It is unknown how close risk assessment estimates are to the actual exposures and risks present in the real world. It is critical that the uncertainties in risk assessment not be forgotten. However, prudent public health policy dictates that limits are set without perfect information so that the public is protected to the maximum extent possible given the current level of knowledge.