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FUSRAP Fact Sheet Risk Assessment

U.S. Army Corps of Engineers • Buffalo District

The Formerly Utilized Sites Remedial Action Program (FUSRAP) was initiated by the Atomic Energy Commission in 1974 to identify and clean up contaminated sites used in the early years of the nation's atomic energy program. Management of the program was transferred to the U.S. Army Corps of Engineers from the U.S. Department of Energy in October 1997.

Introduction

This is one in a series of fact sheets that provides information about regulatory, technical, and other issues considered in decision making within the Formerly Utilized Sites Remedial Action Program (FUSRAP). This fact sheet discusses risk assessment: what it is and how it is used in making cleanup decisions.

What is Risk?

Risk is the chance that some harmful event will occur. In the case of environmental cleanups, we think of risk as the potential for negative health impact as a result of exposure to contamination.

Health impacts are generally classified as carcinogenic or toxic. Carcinogenic risks are quantified as the risk of contracting cancer over a lifetime and usually are stated in scientific notation. (See discussion below about scientific notation.) Toxic health impacts are non-cancerous illnesses and are quantified using a health index. A health index of 1 or above is considered hazardous. Calculations of risk are used to identify threats and calculate cleanup levels.

Because it is a probability, risk is expressed as a fraction, without units. It takes values from 0 to 1.0. Zero is the absolute certainty that there is no risk (which can never be shown). One is the absolute certainty that a risk will occur. Values between 0 and 1 represent the chance that a risk will occur.

For example, we say that a lifetime cancer risk from carcinogen A at an average daily dose of B is 1 in 100,000 (0.00001 or 10^{-5}). If this number is accurate, it means that one in every 100,000 people exposed to carcinogen A at a lifetime average daily dose of B will develop cancer over a lifetime. The probability also describes the extra risk incurred by each individual in that exposed population.

People are more familiar with expressions of risk associated with various activities than they are with risks associated with chemical exposures. We speak, for example, of the annual risks of dying as a result of certain activities.

The annual chance of dying in automobile accidents for people who drive the average number of miles is about 1 in 4,000, according to federal statistics. The lifetime risk of developing cancer in the United States is about 1 in 5.

These types of expressions of risk are more familiar, but they mean roughly the same thing as those risks of toxicity from chemical exposures. However, information on death rates from automobile accidents, for example, is more reliable than the statistics pertaining to most chemical risks.

Most of the risks associated with environmental chemical exposures are not so well known. So although chemical risk information often is expressed in the same form as directly-measured risks such as automobile fatalities, chemical risk information is calculated using different methods. Chemical risk information almost always includes estimates where measured risk data are not available.

What is Risk Assessment?

Risk assessment is the science of defining the health effects of exposure to hazardous materials and situations. Within FUSRAP, risk assessment information helps determine what actions should be taken to clean up the site. Risk assessments are one type of information considered in risk management.

Although risk assessment is a science, it is not a perfect one. Most scientists agree that there is a great deal of uncertainty associated with risk assessment; however, to compensate for this uncertainty, the risk assessment process is deliberately conservative. That is, it errs on the side of safety when calculating potential risks to people.

Risk is a function of how much of a contaminant is present (dose), how dangerous a chemical is to humans (toxicity), how the chemical enters the body (method of exposure) and how often a person is exposed to the chemical (level of exposure).

A risk assessment should be able to answer the questions: *"What is the problem, and how bad is it?"*

Therefore the calculation may be expressed as:

Risk = Dose x Toxicity x Method of Exposure x Level of Exposure

Dose. The dose of a contaminant is represented as the concentration of the compound of concern at the point of human contact. These concentrations may be present in soil, sediments, surface water, ground water, or air. If human contact occurs in more than one of these media, the dose in each case must be taken into account to identify the cumulative risk from the contaminant.

Toxicity. The U.S. Environmental Protection Agency and other government agencies have calculated the toxicity of many hazardous compounds. Much of this information is gained from statistical evidence from laboratory tests on animals. Not all compounds have well understood toxicity values. Special consideration is given to populations such as pregnant women and children that may be especially susceptible to a contaminant's toxic effects.

Method of Exposure. Exposure to contamination may occur from many routes, including direct ingestion from air inhalation, water consumption, accidental consumption of soil or wind-blown particulates, or eating contaminated foods. Exposure also can occur through direct contact between contaminants and skin.

Level of Exposure. The level of exposure is defined by the activities taking place at the point of exposure. Factors calculated into level of exposure estimates include the amount of time (e.g., hours per day of direct exposure) or volume (e.g., liters of water consumed per day or number of breaths per day).

What is Risk Management?

Risk management is the process of weighing policy alternatives and selecting the most appropriate regulatory action. Risk management is not a science; rather it combines information about risk with economic, political, legal, ethical, and value judgments to reach decisions.

The term "risk management" describes a type of decision making. First, a decision must be made as to whether an assessed risk needs to be reduced to protect public health and the environment. Second, a decision must be made about the means to reduce that risk, should action be deemed necessary.

For environmental cleanups at Superfund sites, risk management decisions are primarily driven by legal requirements. The U.S. Environmental Protection Agency is responsible for developing risk assessment guidelines for the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), which is more commonly known as Superfund. Current Superfund regulations consider the range of 1 in 10,000 to 1 in 1,000,000 excess lifetime risk of cancer to be acceptable. An excess lifetime risk of cancer is the probability above the 1 in 5 risk of developing cancer in the United States.

Interpreting Risk Numbers

Risk is expressed in scientific notation, which is the use of numbers raised to a power, such as 10^4 or 10^{-6}. Writing numbers in scientific notation is much more concise on a page, but that economy of space often sacrifices comprehension for the non-technical audience.

If the number has an exponent, it is multiplied by itself the number of times indicated. (The exponent is the small number to the upper right.) For example, 10^2 (2 is the exponent) is 100, or 10 x 10.

Negative exponents are different; a negative exponent indicates a fraction. So 10^{-4} is the same as 1/(10 x 10 x 10 x 10) or 1 divided by (10 x 10 x 10 x 10). This is 1/(10,000), which equals 0.0001. Another way to think about 10^{-4} is to think that it is 10,000 times smaller than 1.

Here are the most common numbers, "translated" from scientific notation:

10^6	1,000,000
10^5	100,000
10^4	10,000
10^3	1,000
10^2	100
10^1	10
10^0	1
10^{-1}	0.1 (or 1/10)
10^{-2}	0.01 (or 1/100)
10^{-3}	0.001 (or 1/1,000)
10^{-4}	0.0001(or 1/10,000)
10^{-5}	0.00001 (or 1/100,000)
10^{-6}	0.000001(or 1/1,000,000)

Other examples of scientific notation:

$1.5 \times 10^1 = 15$
$7.3 \times 10^{-4} = 0.00073$
$4.18 \times 10^2 = 418$

How Do I Get More Information?

To get more information about risk assessment or other FUSRAP issues, or to be added to the program's mailing list, contact:

U. S. Army Corps of Engineers
FUSRAP Public Information Center
70 Pearce Avenue
Tonawanda, NY 14150

(716) 871-9660

FUSRAP also maintains a 24-hour, toll-free telephone number. An answering machine records comments or questions, and all calls are returned. The number is 1-800-253-9759.

References and Further Reading:

Calculated Risks: the Toxicity and Human Health Risks of Chemicals in Our Environment, Joseph V. Rodricks

Risk Assessment in the Federal Government: Managing the Process, National Research Council

Risk Analysis: A Guide to Principles and Methods for Analyzing Health and Environmental Risks, John J. Cohrssen and Vincent T. Covello

Risk Assessment Guidance in Superfund, U.S. Environmental Protection Agency

Environmental Risks and Hazards, Susan L. Cutter, ed.