8. How Do We Assess Risk?

Life is full of hazards. The way we live our lives exposes us to some that we accept almost without thinking, as part of daily living. Everyone has read statistics about automobile accidents, but we still use our cars. Why? Many people smoke even though they have heard thousands of times that it poses a risk of lung cancer and emphysema. Why? In this Fact Sheet we will discuss the concept of risk — and specifically the risks associated with low-level radioactive waste disposal.

➤ What Is Risk?

Risk measures the likelihood that something bad will happen. It can be expressed in the same sort of way as gamblers express odds: "There is a one percent chance that you will die in the next year" means that this will happen to about 1/100 of the population. For any one individual, they either will, or will not, die in that time - but no one can know beforehand. When the year is up, you will be either alive or dead - there is no longer any uncertainty. Insurance companies, for example, need to be able to predict life expectancies for large numbers of people. They cannot predict what will happen to an individual.

Risk is closely tied to uncertainty. An estimate of the magnitude of a risk will be improved with greater knowledge, and this improved knowledge may increase or decrease the risk estimate.

For example, the insurance company may be willing to offer a lower life insurance premium if the policyholder is a non-smoker, because this additional information decreases uncertainty in the person's health condition. But additional information that, for example, the policyholder works in a hazardous occupation (such as firefighting) may cause the insurance company to demand a higher premium. The additional information has decreased the uncertainty in the person's health, or life expectancy, in the opposite direction to the information that she is a non-smoker. Additional information may lower or increase the estimate of risk, but will usually lower the uncertainty in the risk estimate.

➤ Hazard and Risk

Something is a hazard if it represents a potential for doing harm. The chance that some harm will actually occur is called risk. The size of the risk will depend upon the amount of exposure to the hazard. It is easy to confuse risk and hazard. An example will help. Toxic chemicals and radioactive materials, by their very nature, are hazardous - they have the potential to harm our health. But the level of risk depends on such things as

- how much is present;
- how easy it is for them to interact with our bodies;
- short halflives and their potential for harm decreases rapidly, and some chemicals such as arsenic or lead are toxic forever.)

So a barrel of toxic waste is hazardous, whether it is in a well-regulated disposal facility, or sitting in your living room. But obviously the risks would be very different in these two cases!

➤ How Is Risk Estimated?

There are lots of ways to estimate risk. One way is to make use of available statistics on what has happened before - for example, on how many automobile accidents happen per 1,000,000 miles driven. For purposes of illustration, let's take this as 10 accidents per

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1 million miles driven. But it is not easy to predict the risk of future activity for some individual. We may, for example, try to predict from the above statistic that if you drive 10,000 miles in one year your chances of an accident would be 10%. This is because 10 per million miles = 1 per 100,000 miles = 0.1 per 10,000 miles. But you either do or do not have an accident, so your chances (risk) of an accident is 1 in 10, or 10%. But not everyone drives equally well! For a careful driver the chances of an accident may be a lot less than this; for a careless one the chances may be a lot more. Also, highway driving and driving in town may not have the same risk of accident; where you drive may be as important as how you drive.

Another way to estimate risk is by comparing the activity to something similar. We cannot ethically experiment on human beings to find out how much radiation will cause cancer. But we can sometimes find people who have been exposed to a similar hazard, perhaps at higher levels or in different environments, and try to extrapolate from their health experience. An example are the survivors of the atomic bombing of Hiroshima and Nagasaki in 1945. Several hundred thousand survivors have been studied and the increased incidences of various cancers in them are known. Other people, such as uranium miners, have been exposed to radiation in their work, and again their health (in this case the increased incidence of lung cancer) has been measured together with the level of their exposure to radiation. Studies like these form the basis for scientific estimates of the risks of radiation exposures.

➤ How Can We Compare Risks?

Can we compare apples and oranges? Can we compare the risk of automobile accidents and toxic chemicals, or radiation? The answer in both cases is yes, with qualifications.

To compare any two things we must establish a common basis for comparison. For apples and oranges, a sensible basis might be nutritional value. Both have vitamins and minerals that are good for our health - but is an apple “better for you” than an orange? It takes a good nutritionist to make a scientific comparison. But there is always a subjective element. Maybe I just like apples more than oranges! For me, taste may be more important than nutrition. So a decision to buy apples rather than oranges includes more than their relative nutritive value. My basis of comparison — taste — is not the same as that of the expert nutritionist.

Similar considerations apply to risk. There is always a subjective element to how much risk we are willing to accept. Many studies have shown that the acceptability of a risk depends on other factors besides the numerical value of risk assigned by experts. Risk has a different meaning to different people. Another factor is whether the risk is voluntary, or forced. I may object strongly to someone throwing me off a bridge with an elastic cord attached to my feet, but some people will pay money for the same experience!

We tend to exaggerate the risk associated with unfamiliar things, and underestimate the risk of familiar things. Household cleansers containing hazardous chemicals (ammonia, lye) are commonplace and we accept them readily in our homes. Radioactive waste is unfamiliar and we worry about it being in our community.

➤ Risk Vs. Benefit

Risks frequently are associated with benefits - we drive our car even though it is (statistically) safer to walk. The benefit of time and effort saved is "worth the risk". We use potentially hazardous materials in our homes because they do a better job at cleaning, or pest destruction than old-fashioned soap and water, or flyswatters.

A community that is considering housing a low-level radioactive waste disposal facility must also weigh risks and benefits. The acceptability of the facility will be determined ultimately by the community's assessment of the magnitude of the risk, in comparison with the economic benefits to be derived.

➤ For More Information

If you would like to read more about the assessment of risk, some of the references listed below may be helpful.

- P. Slovic, B. Fischoff, S. Lichtenstein in "Societal Risk Assessment: How Safe is Safe Enough?" R. Schwing and W.A. Albers, Jr., Eds. Plenum Press, New York 1980, pp. 181-216.
- Peter M. Sandman "Hazard versus Outrage in the Public Perception of Risk", *Effective Risk Communication*, 45-49. Plenum Press, New York, 1989.
- Richard Wilson and E.A.C. Crouch, "Risk Assessment and Comparisons: An Introduction." *Science* 248, 267-270, 1987.
- Paul Slovic, "Perception of Risk", *Science* 236, 280-285, 1987.

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