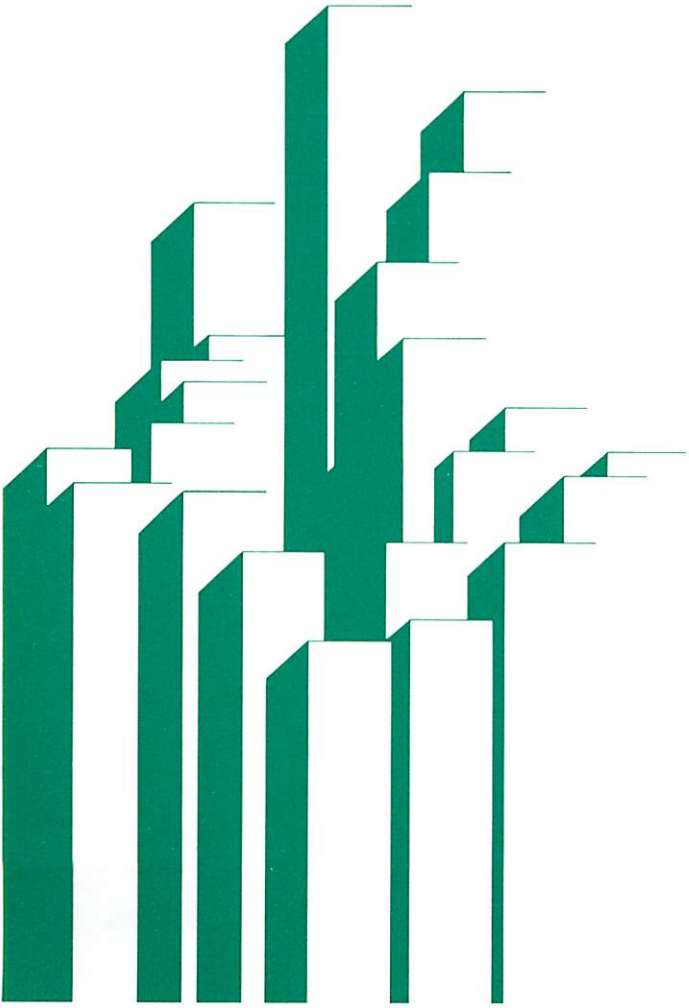
Radiation: Measure For Measure

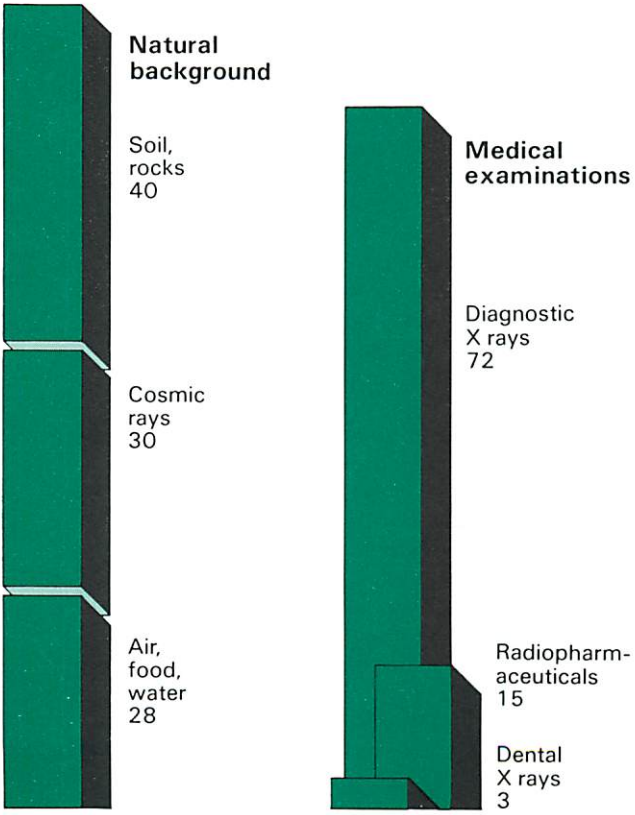


Cautious approach assumed

Since it is impossible to demonstrate what harm — *if any* — radiation may bring about in man at common exposures, potential hazards must be calculated using various scientific theories and mathematical principles.

One of the most cautious methods: *Assumes* that possible effects at extremely low doses are directly related to known consequences at very high exposures. *Assumes* that any amount of radiation, no matter how little, involves some risk and there is no level below which no damage occurs. *Assumes* that several small doses received at intervals produce the same impact as the sum delivered all at once. *Assumes* that biological mechanisms do not repair radiation injury.

The body's reaction to other physical and chemical substances — response decreasing as doses decline, lack of insult below minimum levels, recovery from injury — indicates these assumptions most likely overestimate radiation's risk to man.



In the absence of direct experience, however, this linear, non-threshold formula permits presumed effects at low doses to be projected and compared with the hazards of other activities.

Applying the equation

Applying this upper-limit theory of risk to the various natural and man-made sources of exposure produces an estimate of the potential contribution of radiation to health effects occurring in the U.S. from all causes.

Among the 225 million people in this country, from environmental and other factors:

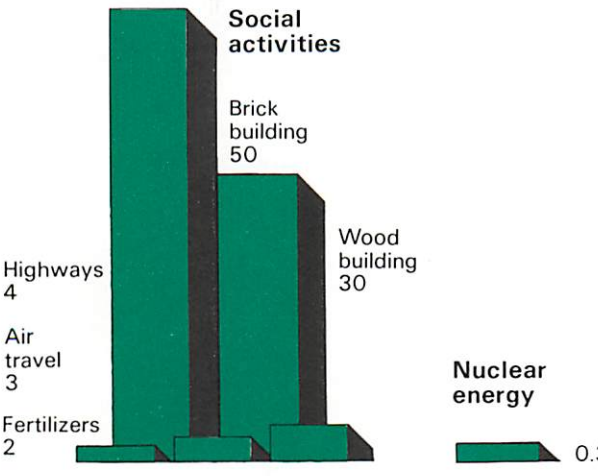
- About 400,000 persons each year die of cancer. Of these fatalities, all radiation *might* be responsible for approximately 4,500.
- About 390,000 of the children born annually will be affected by hereditary disability. Of these illnesses, all radiation *might* cause approximately 420.

If radiation at low levels does adversely affect man, then, exposure to all sources — natural and technical — could account for some 1 per cent of all cancer mortality, 1/10 of one per cent of serious genetic disease, taking place in this country.

Even smaller — hundredths of one per cent — would be the fraction from radiation associated with commercial nuclear power.

Similarly slight is the potential health impact of radiation exposures from the March 1979 accident at Three Mile Island on the nearby population, receiving an average individual dose of about 1 millirem. Among these 2 million area residents and their offspring, had radioactive materials not been released:

- About 4,500 persons annually would die of



cancer. Due to the accident: this number *might* increase — for just one year — to a maximum of 4,501.

- About 3,000 of the children born annually would develop serious genetic injuries. From the accident: this figure *might* rise — for only one year — to as many as 3,001.

For both these exposures — routine and accidental — the projected consequences of low level radiation are statistical: mathematically inferred results in dose regions where none ever has been — or ever will be — identified.

The predicted number of radiation health effects among these general and local populations, therefore, also could be zero.

What if, what is

In a society of ultimately limited resources — technical, material, financial — the hazards of various activities as well as the risks of alternative means to provide the same benefit must be meaningfully evaluated and carefully compared.

Otherwise, enormous sums may be spent to reduce small risks even further. And much larger hazards might receive relatively little attention.

Like any technological process today, the use of radioactive materials in medicine, research, industry and energy production involves a potential risk: radiation can increase the normal likelihood of developing human cancer and genetic disability.

However, many other agents — natural, physical, chemical — also produce these same effects. And by any reasonable estimate, radiation accounts — if at all — for a very minor portion of these injuries taking place from all causes.

Further, much less is known about the levels of harm, limits of detection, precision of measurement and effectiveness of control for these other materials.

Even were it possible, then, removing radiation from modern society would not significantly reduce cancer mortality and genetic disease. In fact, by using other methods to perform the same essential services, they might increase.

While continuing to ensure that exposures associated with the tremendous benefits of nuclear energy are kept as low as reasonably achievable —

Similar effort and resources applied by society to the hazards of other substances, to the dangers of other activities, would result in rapid, visible improvement in overall public health and safety.

The common denominator

Americans keep driving — to work, on errands, for pleasure. Many relax by swimming or boating. And travel by airplane.

These activities continue despite general awareness that some 50,000 people are killed in traffic accidents each year. That nearly 6,000 persons drown. More than 1,500 deaths are caused by aircraft crashes.

Immediate and visible in their impact, these dangers are concrete, familiar: society accepts them almost routinely. As a result, thousands of lives most likely will be lost this year from similar sources.

At the same time, many people express concern over nuclear energy — about reactor safety, fuel shipments, waste disposal — based primarily on fear that radioactive materials may be released, that radiation might harm residents of surrounding communities.

This alarm remains even though, during two decades of commercial nuclear power in this country, not a single death from radiation ever has been observed among the public — even at Three Mile Island. And the likelihood of such a fatality taking place in the future is very small.

Radiation, then, arouses anxiety more for its *potential* risk than for its *actual* hazard: a force considered new, unknown, escaping the senses and causing unique injuries which may not appear for many years.

In fact:

- Radiation from a nuclear power plant is identical in physical behavior, identical in effect on man, to that already and always existing in nature.
- Radiation produces no biological damage that does not occur also from other natural, physical and chemical causes.
- Radiation after more than 80 years of intensive study is the most scientifically understood, easily detected, precisely measured, effectively controlled and strictly regulated of all environmental agents.

Examining the sources and amounts of radiation encountered in everyday life, analyzing and comparing their potential contribution to excess health effects, will lead to further understanding and realistic perspective on this compelling, fundamental issue.

Sum of many parts

From cosmic rays and the sun; from deposits of uranium, radium and thorium in the earth's crust; from radon in the air and radioactive potassium in food and water, man has been surrounded by radiation since time began. Today these naturally occurring sources expose an individual in the U.S. to an average dose of about 100 millirem each year.

A *millirem* measures radiation's biological effect, as degrees gauge temperature or inches, distance.

This environmental radiation varies widely, depending primarily on altitude and concentration of radioactive minerals in the ground. On coastal plains, such as in Florida, the typical dose per person is about 70 millirem annually; on mountain plateaus, such as in Colorado, approximately 165 millirem each year.

Remaining the largest share — about half — of man's total annual exposure, little can be done to reduce this inevitable natural background radiation. Just the *variations* in dose from place to place — among which no difference in number of health effects ever has been established — exceed by far routine public exposures from any industrial activity.

Of the radiation contributed by man's technology, most comes from the use of X rays and radioactive materials in medical diagnosis and therapy: an average individual dose per year of about 90 millirem.

Mining minerals, burning fuels, building structures and other social actions which redistribute natural radioactive elements; fallout from past testing of nuclear weapons; consumer products such as color television, smoke detectors, luminous dial watches and miscellaneous sources add approximately 10 millirem each year.

Finally, from routine operation of all commercial nuclear power plants and all the facilities in their fuel cycle, the calculated average annual dose to an individual in the domestic population today is about 1/3 of one millirem.

Nuclear energy, then, is only one — and among the least — of the many sources of radiation present in society today. Without nuclear electricity, the average American now receives about 200 millirem annually. With nuclear power, approximately 200.3.

Biological effects of radiation

Very large amounts of radiation — far above the levels found in daily life — can result in early death or delayed injury, principally cancer and genetic defects.

Convincing medical evidence that radiation increases the normal chance of eventually developing cancer comes mostly from the few groups of people — pioneers in medical radiology, patients treated with X rays, victims of Hiroshima and Nagasaki — subjected to massive doses — from tens of thousands to millions of millirem — usually in one or a few incidents.

Many more people have been studied extensively over several decades to determine if a link exists at lower levels of exposure. Below about 10,000 millirem, all experience with human adults generally has been negative.

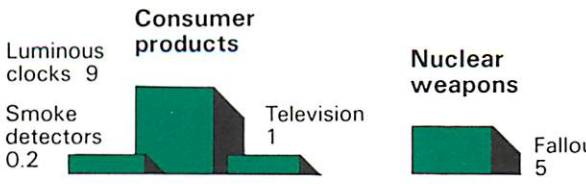
Hereditary illness related to radiation has been observed only in laboratory experiments with animals. Although it is prudent to assume that similar damage may take place in man, none ever has been discovered — even at extremely high doses.

Both these injuries associated with radiation cannot be distinguished from those occurring naturally and caused by other factors; further, they may not develop for several decades after the exposure assumed to produce them. At typical natural and technological doses, therefore, a population of hundreds of millions would have to be carefully investigated for many years to reveal any significant — statistically apparent — increase in fatal cancers or inherited disorders.

That health effects at relatively low levels of radiation are too small or occur so rarely to be detected may be part of the problem — *but it is also part of the solution.*

Typical radiation exposures

(millirem per individual, annually or by activity)



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