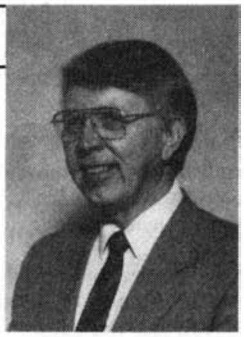
Interview: Robert Alexander



Nuclear radiation: facts versus scare stories

Robert Alexander, a Virginia-based consultant in radiation protection and health effects, is the immediate past president of the Health Physics Society and served on the science panel of the White House Office of Science and Technology Policy's Committee on Interagency Radiation Research Policy Coordination from 1982 to 1988. For 16 years he directed the radiation protection research and regulations development program for the Nuclear Regulatory Commission and its predecessor.

In this interview, he debunks some of the scare stories of the anti-nuclear lobby and the media, and he updates the figures that appeared in EIR*'s June 8 issue, in the box "Measuring radiation" on page 24. The interviewer is Marjorie Mazel Hecht, managing editor of* 21st Century Science & Technology *magazine.*

Q: People don't know very much about radiation, and this allows the anti-nuclear forces to scare people with all kinds of lies and misstatements about what radiation is. Can you give a brief description of what radiation is and how it is measured?

Alexander: Man and all life forms on Earth have evolved in a radiation environment. This radiation comes from two natural sources. One of these is solar radiation and radiation from space called cosmic radiation, which gives a radiation dose to every life form. Then there are naturally occurring radioactive materials on Earth, which give all life forms an additional dose. So radiation is the most natural thing in the world.

There are two basic forms of the type of radiation we are discussing. One is what the physicists call *electromagnetic radiation,* which is very much like light, except that it has more energy and can penetrate much farther. This kind of radiation is called gamma rays or X-rays.

Any other kind of radiation is *particulate,* composed of atomic particles that have weight and that travel at very high speeds. There are *beta particles*—really just electrons, the same as those that come through electric wires. There are also *alpha particles* that come from atomic nuclei and are much, much larger than electrons. Because they are large, alpha particles are not very penetrating. If the radioactive material that emits alpha particles is located inside the body, however, then the alpha radiation can do damage to the internal organs.

Particulate radiation also includes neutrons. Neutrons are somewhat smaller than alpha particles, but they don't come from radioactive materials. The neutron results from other nuclear phenomena, such as the operation of a nuclear reactor or a particle accelerator.

Q: How do these forms of radiation interact with the human body?

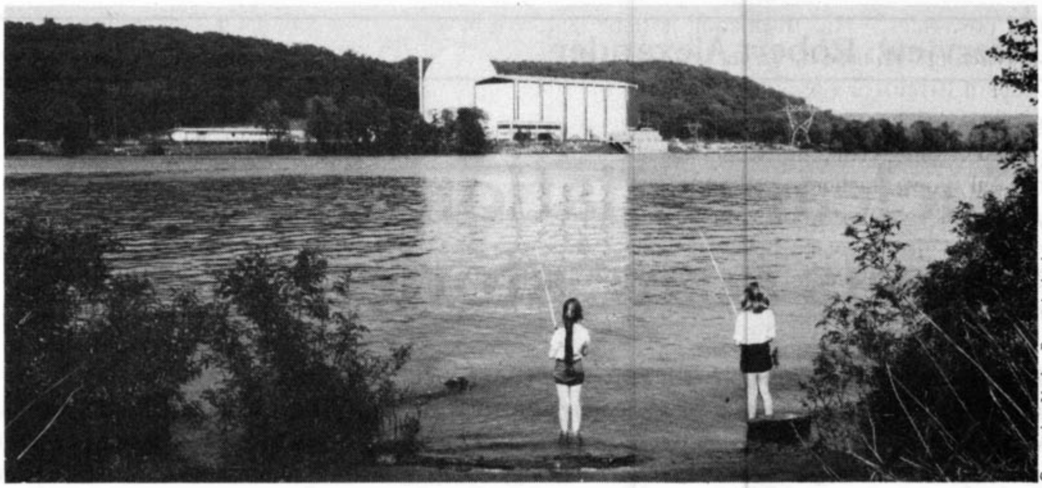
Alexander: In terms of penetrability into the body, gamma and X radiation are very efficient; beta radiation is normally stopped by the skin, but neutron radiation can penetrate to the internal organs. The alpha radiation is completely stopped by the dead layers of skin, so that it is only a hazard when radioactive materials that emit alpha particles are taken into the body by inhalation or ingestion.

It is important to distinguish between radioactive material and radiation itself. Radioactive material is just regular chemicals that all of the Earth is composed of, except that some of the atoms are unstable—that is, radioactive. They give off radiation as they decay to a stable state. Radioactive material can give off gamma rays and even X-rays, and it can give off beta and alpha particles. When certain radioactive atoms fission—the atoms split in two—they give off neutrons.

Q: How do you measure how much radiation is reaching the body?

Alexander: We measure radiation with an assortment of devices that can detect the various interactions that radiations have with matter. As the radiation goes through matter of any kind, it interacts with the electrons that are part of the atoms composing that matter. Those disturbances can be measured.

Some of our instruments give us readings while we are looking at the instrument. We also have passive measuring devices, through which we can look at the cumulative effect of the radiation later and see what dose was delivered. In the old days, we used film very similar to photographic film, and the radiation affected the film in much the same way that light does. These days we use thermoluminescent dosimeters, which can be processed after they have been exposed to radiation to tell what the dose was.



The average annual radiation dose for those who live near a U.S. nuclear power plant is about 7 microrems per year. A person who lived in Washington, D.C., and spent a year in Denver would probably receive an extra 100,000 microrems. Shown here: the Connecticut Yankee nuclear power plant.

Connecticut Yankee Power Authority

Q: What kind of units do you use to measure the radiation dose?
Alexander: In radiation the principal quantity we use is called the *dose equivalent*, and it is measured in units called *rems*. A rem tells you how much radiation energy was absorbed by the tissue that it passed through, as well as the effectiveness of that radiation in producing a particular biological response. The response that we worry the most about is cancer. So the rem is just a unit of radiation-effectiveness on the tissue that absorbs it in terms of producing cancer in that tissue. The rem was established as the unit for physicists to use in controlling radiation risk, so that we can tell whether people are being exposed in a safe, controlled manner. The radiation standards are given in rem units: The millirem is one-thousandth of a rem and the microrem is one-millionth of a rem.

Q: What are some examples of background radiation?
Alexander: In the United States, natural radiation causes an average of about 300 millirems per year. So if a person lives for 70 years, that would be about 21 rems during his or her lifetime.

Q: And if one lives at a higher altitude, as in Denver, wouldn't the dose be greater, because of the cosmic radiation?
Alexander: Yes, 300 millirems is the national average; this is higher than what people who live in coastal areas receive, and it is lower than what people who live in mountainous areas receive. This is primarily because the atmosphere serves as a shield against the radiation from outer space. The more air you have above you, the less cosmic radiation you get; the higher the altitude, the less air and the more cosmic radiation you get.

The variations are not small. Variations from one locale to another may be as much as 100 millirems per year. This is an important fact to consider when establishing regulatory limits on radiation dose.

Q: The anti-nuclear propagandists talk about the radiation you get from living next to a nuclear power plant. But if you live in Denver, you get far more radiation—naturally.
Alexander: Oh, yes. Let me give you some numbers. The average annual radiation dose to people who live in the vicinity of a U.S. nuclear power plant is about 7 microrems per year—seven-millionths of a rem—a lifetime dose of about one-half of a rem. A person who lived in Washington, D.C., and spent a year in Denver would receive probably an extra 100 millirems, which would be 100,000 microrems. Compare the extra dose from living one year in Denver of 100,000 microrems with the 7 microrems from living next to a nuclear power plant, and you can see that the concern about environmental radiation from nuclear power plants is not well founded. The concern is just an emotional reaction, through misinformation that has been distributed.

Q: What about riding in an airplane or watching color television?
Alexander: Unless you are seated very close to a color television set, you don't receive an appreciable amount of radiation. A child sitting within two or three feet of some color TV sets could receive a few millirems per year. It's low, on the order of what one would receive from a diagnostic chest X-ray, that is, about 20 millirems.

If you fly from coast to coast, the radiation dose you are going to receive would be on the order of 5 millirems. A person would probably not hesitate to make a round trip from Washington to San Francisco and back and receive maybe 10 extra millirems from cosmic radiation—that's 10,000 microrems. But the same person living in the vicinity of a nuclear power plant receiving 7 microrems might worry about *that*. . . .

Q: We are often told that more is known about radiation than any other agent that causes cancer. Is this true?
Alexander: No. To make the statement true we cannot say "radiation"; we have to say "radiation delivered at high doses

and dose rates." This distinction is important. We have a convincing data base for large, instantaneous doses—on the order of 10 rems or more—and that is all. For small, instantaneous doses and for large doses delivered over an extended period of time, cancer induction has not been observed. We can only guess. Is there no effect? Is cancer caused? Is cancer prevented? No one knows. We only know that if cancer *is* caused, it cannot be detected using our most sensitive epistemological techniques, and that the probabilities must be very small indeed.

Q: What about higher levels of radiation—the lethal doses, for example, from the Chernobyl accident. What happens then?

Alexander: There you shift your focus from cancer, which is a biological response that occurs years after exposure, to more immediate biological responses, where the tissues are damaged so severely by the radiation that you get a very rapid response. In extremely high doses, radiation kills so many cells that the organs can no longer function properly and the person dies.

Q: What would be the threshold dose?

Alexander: I don't think anyone has ever died from a dose of less than about 400 rems. Below 400 rems, the chance of recovery is good. When you get somewhat above 400, the chance of recovery is not so good, and by the time you get to about 800 rems, it is becoming hopeless. If it is penetrating radiation to the whole body, just about all of the organs are going to be affected, and there is little chance of surviving.

Of course, there are two things about these doses that everyone needs to remember: one is that they are very large, close to a billion millirems; two is that the doses are instantaneous. If these amounts of radiation are distributed over a period of time so that the body has an opportunity to recover, then they are not so dangerous.

Q: You mean if you accumulate a large total dose over a period of a year in small increments, your chances of survival would be better?

Alexander: That's right. The International Commission on Radiological Protection (ICRP) believes that if we limit the radiation dose in any one year to any organ to 50 rems or less—that is, 50,000 millirems or 50 million microrems—none of the biological effects *other than* cancer would ever occur. In other words, 50 rems per year is considered to be a threshold for the type of effect we have talked about as causing cellular damage that prevents an organ from working properly.

Q: The press is full of stories where the anti-nuclear people proclaim that "there is no safe level of radiation." From what you have said, this statement is absurd, since we get so much radiation naturally. In fact, we would not be here if there were no natural radiation.

Alexander: To say that there is no safe level of radiation, depends on one's definition of the word "safe." That idea springs from a *supposition that just one* interaction with radiation in the nucleus of a cell could cause that cell, when it divides, to start dividing out of control, causing cancer. No one has ever been able to prove that that can happen, or that it cannot happen. That's something that no one knows. It isn't very likely that we will ever know the answer. But, as I am going to explain, it is really not important.

For example, if I live here in a nice quiet neighborhood, and if I go outside and back my car out of the driveway and park it in front of the house, there is a finite probability that I will be killed in the process. There are many ways that could happen. For example, a big truck might come along and hit me. An airplane might crash into me. A tree could fall and crush me. So, I could say that there is no safe way to drive your car out of your own driveway and park it in front of your house.

You have the same thing with this question of the interaction of radiation with the cell nucleus. The point is really not whether it can happen, but what are the *chances* that it can happen. Should I refrain from parking my car in front of my house because the probability is not zero? The answer is, of course not. At the other extreme, if I want to drive my car 120 miles an hour on one of the interstate highways, then the risk of death becomes real.

With radiation, at some point there are enough interactions in the nucleus of the cells that the cancer probability becomes high enough to start considering it, and making decisions about what you are and are not going to do. That's what is important, that we understand the probabilities, and make our decisions in a reasonable way for ourselves and for those for whom we are responsible.

The *existence* of a risk is not nearly as important as the *probability* that the event will occur. In the case of low-level radiation we have no evidence that it is harmful—only supposition. In addition to that, we worry about such low doses that, even if they *can* produce cancer, the probability is too low for reasonable people to take them into consideration.

Q: I think you said the key word there—"reasonable." It seems to me that a lot of the claims being made are totally unreasonable, and if applied to the rest of what people do in society, people would not be doing very much at all, including the people writing these scare stories.

Alexander: That's true. From the scientific information that we have, there are *no* data indicating that low-level radiation causes cancer. In fact, there is quite a lot of information from studies of people who receive extra-high background radiation showing that low-level radiation may be beneficial. So if an extraterrestrial being were to come here and look at our regulations and at the actual data, and remain unaffected by our emotions, he would think we are crazy.