What's wrong with being cautious?

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The cost of trying to reduce harmless radiation exposures even more is exorbitant, and "predicting" casualties from such exposures generates groundless fear and distorts public policy. It is time to bring radiation protection policy into line with the data.

WHEN YOU PRESS them, many regulators will admit there is really no science to support the notion that any amount of radiation, no matter how small, can be harmful. They say, "We're not really saying it is harmful; just that it might be." But then they ask: "What's wrong with being cautious? We tell people it might hurt them, and perhaps it won't. Can that do any harm?"

The answer is: You bet! Plenty of harm. Let me describe five different kinds of harm: billions of dollars wasted, ridiculous regulations imposed that degrade the credibility of science and government, destructive fear generated, detrimental health effects created, and environmental degradation accelerated. Current regulations define as "radioactively contaminated" material that gives off less radiation than the natural background where people have lived happy and healthy for many generations. Storing even low-level radioactive waste requires multimillion-dollar studies with gro-tesque scenarios of atoms migrating through miles of desert soil to "contaminate" a possible water source in the distant future--water whose natural radioactivity would already be far above that of the mythical contaminant.

Let's look at a few examples. Some years ago (as described by Bob Bromm, who was there working for EG&G), a forklift at the Idaho National Engineering Laboratory (INEL--now the Idaho National Engineering and Environmental Laboratory) moved a small spent fuel cask from the storage pool to the hot cell. The cask had not been properly drained prior to its removal from the storage pool area, and so some pool water was dribbled onto the blacktop along the way. Despite the fact that a couple of characters had taken a midnight swim in such a pool in the days when I used to visit there and were none the worse for it, storage pool water is defined as a hazardous contaminant. It was deemed necessary, therefore, to dig up the entire path of the forklift, creating a trench two feet wide by a half-mile long that was dubbed Toomer's Creek, after the unfortunate worker whose job it was to ensure that the cask was fully drained.

The Bannock Paving Company was hired to repave the entire road. Bannock used slag from the local phosphate plants as aggregate in their blacktop, which had proved to be highly satisfactory in many of the roads in the Pocatello, Idaho, area that were paved with

this mix. After the job at INEL was complete, it was learned that the aggregate was naturally high in thorium and was actually more radioactive than the material that had been dug up, marked with the dreaded radiation symbol, and hauled away for expensive, long-term burial.

A similar case (reported by Rod Adams, editor of Atomic Energy Insights) involved a heroic effort to blast out "contaminated" soil near the PM-3A reactor at McMurdo Sound in Antarctica. Under incredibly severe weather conditions, the task was completed at considerable risk to the participants and at immense cost to the taxpayers, and the material was shipped to the United States. It was finally made into a parking lot at Port Hueneme, Calif.

Bernard Cohen, professor emeritus of physics and of environmental and occupational health at the University of Pittsburgh, writes about minor spills that make banner headlines and serial scare stories on the evening news. Specific radiation levels are seldom given in the news stories and are usually hard to track down. The fluid creating these headlines is generally less radioactive than the water in popular European health spas (from natural radium), and is often less radioactive than typical salad oil (from natural potassium-40). One notorious case involved the low-level waste facility in eastern Kentucky called Maxey Flats. A tiny amount of radioactivity was found off site, so small that no one could have received as much as 0.1 mrem total from it. This "problem" led to major news and TV coverage; the Washington Star story led off with: "Radioactive wastes are contaminating the nation's air, land, and water." The chairman of one congressional committee publicly called it "the problem of the century." Cohen told him that his staff was getting more excess radiation each day from the granite walls of the Capitol building than anyone received in toto from the Kentucky incident. But as a result of all the uproar, the facility was closed. A similar situation developed at a western New York State burial ground; even less radioactivity was released in that case, but enough public furor was created to close down the site. How many billions of dollars will we continue to waste on such "problems"?

"Scientific consensus" to law

Scientists tend to scoff knowingly at the foolishness of the public and the media, but these situations follow directly from current radiation policy. Regarding radiation, the law requires the NRC to defer to the judgment of the scientific community, which is presumed to be expressed by the National Council on Radiation Protection and Measurements (NCRP), chartered by the Congress in 1964 for that purpose. So the official consensus of the scientific community, as far as U.S. law is concerned, is stated in such documents as NCRP Report No. 121, which reads (page 47): ". . . it is generally accepted that a dose of radiation, however small, has associated with it a risk of eliciting a deleterious biological response" and (page 46) "risks to populations need to be evaluated . . . in the order of microgray (0.1 mrad) per year, or less than 0.01 Gray (1 rad) per lifetime."

This is the official scientific consensus ("it is generally accepted"). Any knowledgeable scientist who does not speak up to question this position is assumed to accept it. The

regulators and legislators are merely putting this scientific position into practice. Scientists who have doubts as to the need or the ability to control radiation to less than the variation in a widely varying natural radiation background should express those doubts or concerns publicly and to the appropriate responsible bodies.

How did we get here?

We arrived at this situation not through stupidity or malice, but through a fairly reasonable historical process. Radiation protection standards and criteria were drawn up rather quickly after the first X-ray experimenters began to get radiation burns on their hands a hundred years ago. Those first experiences were limited to localized exposures to soft X rays. But after the Manhattan Project's dramatic entrance onto the world stage at Hiroshima, a more varied stable of radiant beasts had to be classified and protected against. Intensive research on mice was begun, to set occupational exposure limits. Evidence of the lack of health effects at low dose was ignored in the effort to catalog the various effects at high levels. Using Japanese survivors as a new source of data, an international team of physicians and scientists began to compare the health of those exposed to radiation with others who had not been exposed. This study has now gone on for more than 50 years and is looking at the third generation of survivors. A roughly linear relationship between radiation dose and various health effects (principally cancers) emerged for the region of about 40 to 600 rem and these data were used to set the standard, along with what laboratory and field data were available. The A-bomb radiation was delivered almost instantaneously, and it is known that radiation received over a longer period, as would be typical in occupational exposure, enables repair and healing to take place. Ignoring healing effects was just left as a conservatism--and a large one--since reliable quantitative data on the effect of dose rate on health effects were scarce.

Below about 40 rem, there were no observable health effects. But it was felt that cancers or genetic effects might show up decades later. So it was considered prudent at that time (in the early 1950s) to draw a straight line from the data to zero dose (see box, previous page). Statements made on the record at that time show that this was an administrative decision, made for radiation protection purposes; it was not made in light of what is now known about the molecular and cell biology of radiation damage. It was the same sort of decision that medieval popes made when they drew straight lines across maps of Africa and South America to divide up the turf. It seemed like a good idea at the time; the problems arose later.

Most of the pioneers of those early days never envisioned that this Linear No-Threshold (LNT) model would be taken for scientific gospel and applied to doses far less than the variations in the natural radiation background. But the LNT is now being solemnly cited as a scientific justification for trying to control radiation exposures of clearly harmless amounts. Quite apart from the radiobiological aspects, it is just not technically feasible, or even meaningful, in any branch of technology, to try to control any kind of signal against such a high and variable background.

God's good green radioactive earth

Three Mile Island's release of a few curies of radioactivity (plus relatively harmless inert gases) was considered the world's worst catastrophe until Chernobyl released several million curies. For people used to working with microcuries, these were tremendous numbers. A typical headline-making leak might involve a few millicuries. But we have to ask: compared with what? We live in a sitzbath of radioactivity and we should judge these numbers against those already given us by Nature.

The soils of the world contain uranium and thorium, and about 2 billion curies of radon produced from natural decay of these elements is released into the air each year. Uranium in the earth's core decays slowly, releasing heat equivalent to burning 1 million tons of coal per hour. This natural, nonfissioning nuclear power plant releases energy at four times the entire electrical generating capacity of the United States, keeping the earth's center molten. The world's oceans contain about 400 billion curies of potassium-40, 4 billion curies of rubidium-87, 1 billion curies of uranium, 200 million curies of carbon-14, and 20 million curies of tritium. These are numbers to keep in mind when we talk about "contaminating" the planet.

This natural radioactivity in our soil, air, water, and food, plus the bombardment of cosmic rays from beyond the galaxy, gives us a natural radiation background of about 300 mrem per year, with many locations on earth that are many times greater than this. The NRC presently requires a site to be cleaned down to 15 mrem per year in order for it to be freed for public use, and is considering raising this number to 25 mrem per year. As I write this, the EPA is telling the public, as well as the NRC, that this will result in "nearly doubling the allowed level of cancer risk to the public" and is therefore "simply unacceptably high." This is the kind of policy that has been properly characterized as "deeply immoral use of our scientific heritage."

The notion of "collective dose"

An even more bizarre concept has grown up: the notion of "collective dose." This is a calculational procedure that claims to predict health effects in a large population by adding up radiation doses that are individually negligible. NCRP-121 defines 1 mrem per year as "a negligible individual dose"--not harmless, mind you, but small enough "to be dismissed." Yet NCRP-121 hastens to add that even this small number is not trivial enough: "All doses should be included in calculations of collective dose; there is no conceptual basis for excluding any individual dose, however small."

This is exactly the process by which people calculate that 30 000 people will die from Chernobyl. They multiply a trivial dose by 100 million people downwind and calculate a collective dose that predicts 30 000 deaths. When I asked an NCRP official if he really believed such a number--did he honestly think 30 000 deaths would result from that exposure--he said, "It doesn't matter. You'd never see 30 000 deaths among the twenty or thirty million people in that population who will die of cancer from other causes." I

consider that position morally, as well as scientifically, indefensible. Knowledgeable scientists cannot legitimately dodge questions that they are most qualified to answer. If we really believe that thousands will die from that accident, we should certainly behave differently than if we believe this is an unreal figure.

Gunnar Walinder, the noted Swedish radiobiologist who studied under the legendary Rolf Sievert, illustrated the point beautifully in his excellent book Has Radiation Protection Become a Health Hazard? He describes a man sitting in a room full of risk evaluators and asking, with a twinkle in his eye, "Tell me: is it safe for me to get up out of this chair?" All of the risk experts but one assure him it is perfectly safe, that the exercise might even be good for him. "You'd have to have an awfully weak heart to be hurt by getting up out of a chair," they agree. But the nuclear risk expert objects strenuously: "I can in no way assure you that it is safe to get up. You might have a very weak heart." What is a layperson supposed to do with such advice?

I have heard radiation experts claim that the only honest answer to the effects of low-level radiation is "I don't know." That is simply nonsense, and it is irresponsible. We have been studying the problem for nearly a century and we know more about it than most other hazards we face. Having accepted all that research money down through the years, we owe the public a straight answer. And it's not "I don't know." There is still more research needed, especially in the low-level radiation area, to clear up certain important specifics. But if we are not willing to make some clear, unambiguous statements about what we know to date, we should not be given any more money.

Data are available

If we advocate dropping the current nonscientific basis for radiation protection, then we must offer something in its place. Defenders of the status quo argue that it is difficult to prove the absence of a health effect, that it would take an experiment involving hundreds of thousands of human beings. There are two answers to this argument; first, the "experiment" has in effect been done, and more than once. There are places on earth--in India, Iran, Brazil--where people have lived for countless generations in high natural radiation fields, 10 times and more above the U.S. average. The various indicators of health have been monitored in detail, comparing the health of people in these locations with the health of others whose radiation exposure is much less. There is no observable damage from the higher radiation exposure.

A second way to disprove the linear relationship is to show that at low levels the effect of radiation is not just harmless, but actually beneficial. This positive effect of low-dose radiation is called hormesis, and it turns out there is a great deal of evidence for it. Because it runs completely counter to the prevailing model, it has been brushed aside for decades, but the accumulation of evidence is now too great to ignore.

So when one begins to look seriously for data to challenge the linear model, it appears in abundance. Dozens of the world's most knowledgeable radiation scientists have presented definitive papers in 14 ANS meeting sessions in 199496. The evidence is continuing to grow

and to be distributed. A new international organization called Radiation, Science & Health, Inc. (RSH), composed of independent scientists knowledgeable in radiation protection, has been formed to dig out, analyze, and interpret relevant data and make it available to appropriate technical and policy bodies and to the public (see sidebar). James Muckerheide, president of RSH, summarized some of the data in the September 1995 Nuclear News. It is becoming clear that there is relevant research that has not been cited in the critical policy reports. There is other challenging research that was discontinued in midstream, and still other important work that was never reported in final form. And when the raw data are closely examined in reports whose conclusions support the LNT model, it often develops that data have been bent, merged, omitted, or misinterpreted to support the straight line that "everybody knew" was the way the curve was supposed to go. This is an inherent problem in all research, but when a new model is finally accepted, it is surprising how clear it all looks in hindsight. We are rapidly approaching that point with respect to low-level radiation.

Preaching to the nuclear choir

I've been asked: "Why put this message in Nuclear News? Isn't that just preaching to the choir?" My answer to that is: "This choir isn't singing! If knowledgeable scientists don't think this message is important enough to sing out about, and if industry managers and executives don't understand and support action to convert this information to policy, how can we expect journalists, legislators and regulators to do anything about it?" Unfortunately, many of the choir are too involved in making money and reputations from the premise that low-level radiation is mysterious and dangerous, and that we'd better have more research and more protection and more remediation, not less. This may be a fruitful course for some, for a while, but it is eroding the credibility of science and undermining the future of the nuclear technologies essential for the well-being of our children and grandchildren.
