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FEAR OF HYPOTHETICAL DEATHS DOES NOT JUSTIFY KILLING REAL PEOPLE

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ABSTRACT

Present policy and regulations world-wide require users and producers of ionizing radiation to monitor, control and account for radiation exposures down to a fraction of the routine variations in natural radiation background. This not only affronts common sense, it is also contraindicated by scientific theory and data. The rate of exposure is virtually ignored. This is like saying that if 100 aspirin tablets, taken at one sitting, will kill a person, then taking one tablet a week for 100 weeks will also be lethal.

This policy also extends to a concept of "collective dose," which claims to predict injuries and deaths in a population by adding up individually-harmless doses. This is like saying that giving one tablet to each of 100 persons will result in one death among the group.

This policy is not only scientifically and logically indefensible, it is also doing great and widespread harm. It claims to be conservative but it is in fact destructive of human health and the environment, as well as costing hundreds of billions of dollars for no discernible benefit. A few examples illustrates this point:

Countless lives are lost each year because fear of radiation keeps people from getting needed mammograms and other life-saving radiomedical procedures. Excessive regulation and unwillingness to settle the low-level waste problem have already forced some hospitals to close down their nuclear medicine facilities and threaten to price these procedures off the competitive health care market.

Widely-published "collective dose" estimates predicted 30,000 cancer deaths among the 100,000,000 people downwind of the Chernobyl reactor accident. In that situation, the year following the accident produced 100,000 additional abortions among this population. Unnecessary evacuation forced hundreds of thousands of people to abandon their traditional villages, creating widespread despair, suicides and economic loss. Swedes were warned to stay indoors although each minute indoors created more radiation dose (from natural radon) than would be received all day in the Chernobyl fallout.

Fear of radiation may be costing nearly 10,000 American deaths each year from food-borne pathogens that could easily be prevented by pasteurizing food with ionizing radiation. Tens of thousands die each year in the U.S. from particulate air pollution from fossil-fired power plants. The worldwide death toll is unknown. Shortage of fresh water is considered a major problem by world planners, only because use of energy to desalinate the oceans is precluded by policies that give energy conservation overriding priority.

This situation is created by the assumption that making extreme, pessimistic hypotheses on nuclear safety will best serve the public interest. The premise that trivial amounts of radiation may be lethal is one such hypothesis. Others, such as the China Syndrome, the need for massive evacuation procedures, the need to bury nuclear waste for thousands of years--such premises lead to the conclusion that the dangers of nuclear technology are extreme and unprecedented. This is turn leads to sacrificing real lives and huge amounts of money to avoid hypothetical casualties that have no counterpart in the real world.

These extreme hypothetical scenarios were constructed by the nuclear community and then assumed by the public to describe reality. We must now speak out to refute them. We have been complicitous in developing a phobic fear of radiation in the public mind, and this fear has created real public health problems and is pushing humanity down a harmful road to an energy-starved future.

THE PRIMACY OF ENERGY

Engineers have the chore, the responsibility, and the privilege of envisioning, building, operating and maintaining those things that make it possible to live long, healthy, productive and comfortable lives in a clean, healthy and attractive environment. The primary resource to accomplish this is energy. People, like all living organisms, outwit the first law of thermodynamics by using energy to garner materials from the outside world for their own purposes. Any plan for the future that fails to recognize the primacy of this fact is working against Nature and the good of the species.

Throughout history, humankind has discovered new sources of energy just in time to take the next step in its development. Animal power, water and wind, and then burning wood came in turn. Coal replaced wood just in time to save the forests. Oil enabled us to eliminate choking air

pollution and to drive ships, cars and aircraft. And now we have nuclear energy to replace dwindling supplies of fossil fuels and to provide energy without pollution. It also provides new sources of radiation for medical, industrial and consumer uses. It would seem to provide answers to some of our most pressing engineering problems. Yet for many policy-makers, it is being written off as irrelevant to our future.

RADIATION PHOBIA

Pundits give many reasons why the promise of nuclear technology is not being fully pursued. I believe all these reasons derive from one: a clinically phobic fear of radiation has been created. The image of radiation is of something mysterious, alien and unnatural, that presents an unprecedented threat to the future of the race and of the entire planet. Moreover, the lack of public confidence in government, science, institutions and authorities adds to the dilemma by eroding the credibility of any statements that attempt to allay unwarranted fear. "Well, that's *your* opinion," scientists are told, when explaining how physical and biological laws limit the ability of radiation to cause cancer and death.

Cost is cited as a barrier to nuclear plant development, but high cost is not inherent in nuclear technology. Much of the high cost results from excessive requirements for security, safety, insurance, radiation monitoring and control, and the massive paperwork, delays and shutdowns associated with licensing. Some plant designs now consume as many engineering man-hours for earthquake analysis as was formerly put into the entire plant design. A burgeoning industry has sprung up to train people to prepare safety reports and environmental impact statements. If plant requirements were based on engineering considerations rather than political ones, costs would be easily competitive with other forms of energy production.

A clear example of the fear-driven political influence on costs is illustrated by a recent statement by UK Energy Minister John Battle that the UK will impose its Fossil Fuel Levy on nuclear energy so that "nuclear would not have an unfair advantage over other sources of electricity, such as coal."

THE COST OF THE FEAR

The fear of radiation is not only scientifically and logically indefensible, it is also doing great and widespread harm. It claims to be conservative but it is in fact destructive of human health and the environment, as well as costing hundreds of billions of dollars for no discernible benefit. A few examples illustrates this point:

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Widely-published "collective dose" estimates predicted 30,000 cancer deaths among the 100,000,000 people downwind of the Chernobyl reactor accident. Such fearful statements led to 100,000 additional elective abortions among this population during the year following the accident. Unnecessary evacuation forced hundreds of thousands of people to abandon their traditional villages and to destroy crops and livestock, creating widespread despair, suicides and economic loss. Swedes were warned to stay indoors, although each *minute* indoors created more radiation dose (from natural radon) than would be received all day outside in the Chernobyl fallout.

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This situation is created by the assumption that calculating the results of extreme, pessimistic hypotheses on nuclear safety will best serve the public interest. But doing so has led to sacrificing real lives and huge amounts of money to avoid hypothetical casualties that have no counterpart in the real world.

THE SOURCE OF THE FEAR

The root cause of the fear derives from several false premises as to how radiation affects living organisms: A major source of radiation data was from the Japanese A-bomb survivors, plus experimental work with animals, mostly mice and rats. There were many little-understood problems in applying the animal data to humans. The irradiated Japanese population had four important characteristics:

- The radiation exposures were received almost instantaneously.
- High radiation levels produced deleterious health effects in many individuals.
- Individuals were observed from shortly after irradiation to time of death, and descendants of victims were also studied, so that delayed effects such as cancers and genetic damage could be measured.
- Accurate individual dose values could not be determined, nor could the confounding effects of malnutrition, food contamination, stress, and other potential contributors to illness.

These data were applied to radiation protection standards as follows:

- *The effects of dose-rate were virtually ignored.* Health effects were presumed to match the Japanese data, whether the exposure was acute or chronic. This is like concluding that if 100 aspirin tablets, taken at one sitting, will kill a person, then taking one tablet a week for 100 weeks will also be lethal.

- *The notion of "collective dose," was created,* which claims to predict injuries and deaths in a population by adding up individually-harmless doses. This is like saying that giving one tablet to each of 100 persons will result in one death among the group. This concept may have merit when one is looking for contamination of the human gene pool. But when no genetic degradation was observed in bomb survivors, the concept was shifted over to cancer, where it is totally inapplicable.
- *The linear no-threshold (LNT) model of radiation damage was postulated.* Since cancer deaths seemed to decrease linearly with decreasing radiation exposure down to about 50 rem (500 mSv), it was assumed that this linear relationship between cancer deaths and exposure continued all the way down to zero exposure, without any safe threshold. This gave rise to the notorious idea that there is no amount of radiation small enough to be harmless. "One gamma ray can kill you," we were told.

These premises as to how radiation interacts with living organisms now constitute legal and scientific dogma. Awards are made by courts to litigants claiming injury from radiation exposures far below doses where any injury has actually been observed. Plans for locating nuclear facilities or waste storage sites are successfully opposed on this basis. Regardless of lack of scientific merit, these premises now determine public policy.

FANTASTIC SCENARIOS

The impact on the public of these premises about the biological effects of radiation is greatly amplified by the basic approach taken on all aspects regarding safety of nuclear facilities. Because the technology was new in the 1950s, and the mechanisms and institutions for evaluating safety were also just beginning to evolve, there were few precedents to fall back on. Lawyers were replacing engineers and scientists as key policy-makers. Nuclear engineers looked at the history of boiler and pressure-vessel safety, where serious explosions occurred about once every day before the Hartford Insurance Company and the ASME jointly started to develop safety standards. We didn't want to follow that model. We found tons of poisonous chlorine gas stored in large numbers of rusty tanks up-wind of some large population centers and shipped through crowded cities, and we thought we could do better than that.

We found that we could make very pessimistic assumptions as to what might happen in a nuclear plant and then show that our design was still safe. The newly-established regulators found themselves challenged to pose ever more difficult *what if*s. If we could meet these outlandish requirements, we felt we had made our case. We thought we were being very conservative. Out of this situation, we developed such whoppers as the following:

- *What if all the radioactivity in a nuclear reactor core were released into the air all at once, during the most unfavorable weather conditions imaginable?* The US Nuclear Regulatory Commission asked this question in 1980 of the Sandia atomic bomb laboratory, which ran off an in-house computer program to produce a row of numbers for each of the 129 U.S. nuclear power plants then running or under construction. The first column showed "Early Deaths" ranging (for different plants) from 173 to 102,000, and "Early Injuries" from 3,130 to 710,000. The "Fatal Radius" was up to 25 miles, the distance for serious radiation injuries

was up to 70 miles, and financial consequences from $13 *billion* to $314 *billion* in 1980 dollars, *not* including "socioeconomic costs, health care costs, and 'incidental costs'." This table of data, with little explanation, appeared in the first section of most of the nation's major papers. (In the *Washington Post,* the table headings were askew, and a reader could conclude that the fatal radius for one plant was 710,000 miles—28 times around the world!) The NRC was surprised that this information upset people. They tried to explain that this was just an upper limit; they expected the real cases to be less severe. A similar exercise could have been run on how many people could be drowned in the local swimming lake. (You can drown a person with less than a gallon of water, so a million-gallon lake could drown a million people.) But nobody would pay for such a study.

- *Assume the reactor core melts down* (never mind how) and the molten fuel drops to the bottom of the reactor vessel. We're not sure what sort of eutectic alloy it might make with the steel of the vessel wall, so we'll assume it melts right through and keeps going on toward China — the notorious China Syndrome.
- When it came time to talk of *storing radioactive wastes,* it was the same kind of story. Nuclear plants produce so little waste that we could be extravagant. We put double, then triple linings in the waste casks. We tested the casks by burning them, driving them into walls, dropping them onto up-turned spikes. And then we topped it off by putting them deep underground. We did this because we had told people that this waste would remain toxic for thousands of years. Nobody thought to tell them that many non-radioactive toxins such as mercury, lead, arsenic, selenium, stay toxic *forever*.
- While plant designers were dreaming up these scenarios, the standards setters and policy makers were coming up with their own. For example, on June 3, 1997, the Department of Energy issued a report "after six years of study and analysis," predicting that 23 people will be irradiated to death as a result of *shipping shielded casks of radioactive waste* from the weapons program (not civilian waste). This estimate is a product of the LNT model: you give each of a million bystanders one-millionth of a lethal dose, and you have delivered a lethal dose somehow to the crowd. No individual has received a harmful dose of radiation, but there is a death. Why should we be surprised that the public feels it's being played with, if not lied to?
- In case the scenarios of the designers and the evacuation drills of the Department of Energy were not enough, the EPA began to issue scare pamphlets and ran an expensive TV ad campaign showing a happy American family in their living-room. With funeral music in the background, a narrator spelled out the danger of the invisible killer gas (natural *radon* from God's green earth) that had invaded their house. One by one the parents, the children, and finally the dog turned to skeletons before our eyes. The EPA had a big investment in building up fear. They had some very expensive programs in mind.

WHAT DO WE KNOW ABOUT REACTOR MELTDOWNS?

In the course of writing reactor safeguards reports, we've conjured up some pretty scary pictures of "radioactive wastelands the size of Pennsylvania." But, after spending hundreds of millions of dollars on reactor safety studies, we also have some physical experience to draw on. Not only have large-scale experiments and theoretical studies been made, but we had the real thing at Three Mile Island in 1979. Nearly half the core melted down, and tons of the molten stuff fell down

onto the bottom of the pressure vessel. That is supposed to start the China Syndrome scenario. But in fact the core penetrated only a small fraction of an inch into the thick vessel wall and stopped. Negligible radioactivity was released; the nearest residents got about as much radiation from the accident overall as they get *each day* from the natural radiation background (having nothing to do with the nuclear plant). No one was hurt, not even the operators. When I pressed a Nuclear Regulatory Commission official as to why this was not more nearly the model for a major reactor accident, rather than various theoretical speculations, he looked shocked and said: "If I really thought that, I'd have to ask what I'm doing here!" I assured him he should ask exactly that, as we all should. So, after 40 years experience and running more than a hundred U.S. nuclear power plants (plus twice that many in the Navy), plus hundreds more in other countries, the Three Mile Island accident is the worst the real world of European/American/Pacific Rim commercial reactors can offer: nobody hurt, no environmental damage.

Is it possible to have an even more severe accident? The answer is theoretically yes, if you are willing to consider multiple extreme assumptions piled one on another. The corresponding case for airline safety would be to assume that two fully-loaded 747s collide in mid-air at low altitude and explode over a superbowl game. Even with that kind of speculation, the worse that the NRC can imagine leads to less than 100 deaths. Many of these are hypothetical cancer deaths, occurring several years later, if at all. So the specter of unprecedented nuclear devastation seems dealt with, even under grotesquely extreme assumptions. We should tell people that.

WHO'S TO BLAME?

We in the nuclear community like to point out that the public is scientifically illiterate, that the media print only bad news and sensationalize that, and the anti-nukes are irresponsible. All true. But the bottom line is that these fantastic scenarios were not created by Ralph Nader, they are the products of our lucrative research and analysis contracts. And if we use those stories to talk about nuclear technology, the public has every right to be scared. They'd be foolish not to be. What we must do, if we are to be credible, is to work from real-world knowledge. The fantastic scenarios may be helpful in guiding our thinking toward areas that need further research. But too often they are just a means of making a living.

There are ways to check our scenarios against real experience. For example, a reporter at the radon press conference on February 19,1998 showed one way. The BEIR-VI committee of the U.S. National Research Council had just issued a thick report resulting from an EPA-financed four-year study to present recommendations as to the degree of public health hazard posed by natural radon in the home. The report said that radon causes up to 21,800 deaths from lung cancer in America each year. That was said to be the authoritative word. One reporter decided to test the reality of this dreadful figure. He asked, simply: *I would like each of the panel members to tell me what he did to alleviate this problem in his own home.* The panel members fumbled in embarrassment, and finally one member, Roger McClellan, said that he was not a smoker, so he felt radon was not a problem for him. Panel Chair Jonathan Samet said he had measured the radon in his house. Asked what levels were found and what action he took, Samet said merely that he was satisfied he was not in danger. No other panel member was willing to respond.

So the problem that was claimed to be serious enough to justify billions of dollars of expenditures was apparently not real enough to get individual panel members to spend a few dollars to protect their families from it. Or even to check the radon level in their own homes.

WHAT DOES THE REAL WORLD TELL US ABOUT RADIATION?

If we turn our mesmerized eyes away from our worst-case scenarios and look at the world around us, we can bring the situation back to reality. Does radon in homes really cause lung cancer? Prof. Bernard L. Cohen of the University of Pittsburgh compared the average radon levels and the number of lung cancer deaths, county by county, for 90% of the U.S. population. With such a large number of data points the statistics is very good, meaning we can have a high confidence in the answers. His data show that the counties with the highest radon levels in the home had the *lowest* number of lung cancer deaths, while the lowest radon levels had the highest lung cancer deaths, and those in between connect the two extremes in a smooth curve. This is just the opposite of the claims of the EPA. Many other investigators have come up with the same answer, along with supporting research, analysis and data. Using EPA's own data on radon levels, the highest radon area in the U.S. is the Rocky Mountain states and the lowest radon is in the Pacific Northwest. American Cancer Society data show that lung-cancer mortality in the Rocky Mountain States is 14% (one seventh) the rate of BEIR predictions; and the lung-cancer in the Pacific Northwest is 390% (4 times) the BEIR predictions. Lung cancer mortality in the remaining regions of the US consistently decrease with increasing radon, as shown by Cohen and contrary to the EPA/BEIR results. We also know radon levels and lung cancer deaths for a number of locations in the world where radon levels are very high, many times the U.S. average, and the same results are seen.

The BEIR-VI committee's response to this real-world contradiction of its conclusions is to summarily dismiss all such studies with the words, "the committee believes that ecological studies of indoor radon exposure and lung-cancer are essentially noninformative and shed little light on the association of indoor radon-progeny and lung-cancer." By "ecological" they mean studies where individual exposures to radon were not measured, that average levels were used. For its own conclusions the committee relies heavily on data for uranium miners, where individual lung cancer deaths were recorded. But for the miners, individual radon exposures are also not measured; they are inferred from measurements of radon levels at various places in the mines. This is no different from inferring exposure of individuals from radon measurements in the home. Use of average figures instead of individuals should be satisfactory when very large numbers of samples are used. If this were not the case, the data would be widely scattered. If low-level radon did, in fact, cause cancer, there is no way that statistical scatter could consistently make high radon areas show low cancer rates and vice versa, with a smooth transition in between. In addition, many questions arise when one tries to predict the effects of radon in homes from data on uranium miners working in atmospheres laden with such known carcinogens as arsenic, silica and uranium dust, tobacco smoke and diesel exhaust.

WHAT DOES SCIENCE TELL US ABOUT RADIATION?

Is it really possible that low-level radiation can be beneficial rather than harmful? What does our knowledge of cellular biology and radiation science tell us about this? The answer is, we have learned a great deal about how radiation and other potentially harmful agents affect the body. Laboratory data and biological theory demonstrate the effectiveness of the body's natural repair and defense mechanisms, which work to prevent damage, to repair damage, and to remove damaged cells from the body. When small quantities of disease germs, chemical poisons or other toxins enter the body, they stimulate these defense mechanisms, leading to improved longevity and health. Radiation appears to work the same way. Selenium, arsenic, molybdenum, vanadium, chromium, boron and other deadly toxins are present in many vitamin supplements because they are essential to health. If the EPA's argument that radiation is harmful at any level were applied to nutritional supplements, we would all be suffering from severe trace mineral deficiencies.

The BEIR-VI committee argues that alpha particles emitted by radon progeny are not like any other toxin; that a single alpha particle can damage a cell and lead to cancer. The idea that a cell damaged by alphas is a unique problem for the body ignores evidence that metabolism resulting from routine eating and breathing creates free radicals. These free radicals damage millions of cells for every one damaged by radon at the level found in homes. Thus, the net effect of exposure to a small, tolerable amount of any toxin (including radiation) is to stimulate the body's defense mechanisms so as to *decrease* the number of damaged cells and strengthen the body's resistance to further degradation.

RADIATION, SCIENCE & HEALTH, INC.

Since the early 1950s, a succession of scientists has tried to confront radiation protection policy-makers with the discrepancy between the science and the policy. Each dissenter has been disparaged, and the offending research has been defunded, terminated, ignored, suppressed, misinterpreted, and distorted. The situation was portrayed as a case of individual rebels against the whole mass of scientific consensus. However, when you look behind the facade you see a small number of scientists dominating all of the relevant committees. The dissenters among them have quit or been weeded out. The linear no-threshold model and its associated baggage, which was established as a simple and conservative administrative protocol, has become scientific dogma and legal precedent. Reputations and incomes are based on it, and no one wants to turn back. A way was needed to give clout to the protesters whose lone voices were too easily drowned out.

In this situation, James Muckerheide, with John Cameron and others, set up a not-for-profit public interest research and education organization called Radiation, Science & Health, Inc., to give prestigious institutional presence to these lone voices. They had no trouble assembling an international group of individuals knowledgeable in radiation science and public policy, committed to changing radiation science policy. Starting with Rosalyn Yalow, the Nobel laureate in nuclear medicine, who agreed to serve as an honorary member of the Founding Board of Directors, they lined up prominent radiation experts from Germany, Japan, Canada, Sweden, Poland, France, England and the U.S., many of whom have served with distinction on the National Council for Radiation Protection and Measurement, the International Commission on Radiological Protection,

the United Nations Scientific Committee on the Effects of Atomic Radiation, the U.S. Nuclear Regulatory Commission and the Department of Energy.

RSH is committed to:

- collecting, interpreting and disseminating data and theoretical studies on the health effects of low-level ionizing radiation that have not yet been considered in developing policy and regulations for radiation protection;
- gathering and interpreting data on the cost of this policy position in dollars and in loss of potentially beneficial uses of nuclear technology in solving urgent societal problems;
- presenting this information to appropriate policy bodies and the general public; and
- working to help bring about the necessary changes to make radiation policy consistent with the best scientific data and theory.

For higher radiation levels, where both experience and science demonstrate that negative health effects can occur, there is less urgency to reexamine existing requirements; current radiation protection policy is conservative and effective.

RSH is seeking additional qualified personnel and professional and financial support. It can be contacted at:

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