

TOWARD A SCIENTIFIC RADIATION PROTECTION POLICY

Theodore Rockwell
Founding Officer, Radiation, Science & Health, Inc.
Founding Officer, MPR Associates, Inc.
3403 Woolsey Drive
Chevy Chase, MD 20815 U.S.A.

TEL: 301-652-9509 FAX: 301-652-0534

E-MAIL: tedrock@cpcug.org

ABSTRACT

The matter of permissible radiation levels raises a flurry of questions, most of them sociological, political, legal or psychological. In this situation, it is useful to consider the technical question *in vacuo*: *What is the best radiation protection policy considering only the health of the radiation worker and the public?* The effect on the *environment* can then be evaluated in terms of the damage, if any, that would be done to living biota by implementing this policy, or whether any other technical considerations might apply. This is not to argue that non-technical considerations are without merit; merely that it is simple logic as well as common sense, to separate the variables in a complex problem, so that each variable can be understood and appreciated as accurately as possible. Only then we can apply non-technical considerations to a sound technical base.

Scientists have an obligation to determine and promulgate the best technical analyses and recommendations, upon which they and others may then provide assessments (clearly labeled as such) as to what non-technical considerations should apply. For scientists to talk about what the public may be willing to accept, or what is politically feasible, before answering the technical question as clearly as possible, is an abdication of professional responsibility.

Once we have a sound analysis of the technical requirements, it is appropriate to ask whether the *cost* of implementing a policy based on these requirements is reasonable, where cost is measured in broad terms. Under current policy, where it is presumed for administrative simplicity, and in contradiction to scientific theory and data, that the smallest amount of radiation can cause a lethal cancer, the question of cost has not been adequately analyzed and seems to have no defined limit. So we have created a situation where *fear of radiation* kills literally thousands of people each year in the United States alone, while radiation itself has claimed almost no lives whatsoever. (IAEA data show an average of 1 death/year over the last 15-20 years, mostly from industrial radiography sources out of control in underdeveloped countries, plus Chernobyl. But *fear* of radiation keeps many people from getting mammograms and other life-saving radiomedical procedures, from using radiation to kill dangerous pathogens in food, and from enjoying the benefits of non-polluting nuclear-made electricity.)

Background

Let us look at what the scientific evidence tells us about the biological effects of radiation. Based on the extensive data compiled by T.D. Luckey, by Radiation, Science & Health, and others, substantial data confirms that small amounts of radiation are actually

beneficial, just as small amounts of toxins such as iron, zinc, selenium, boron, chromium and copper are put into vitamin supplements to ensure that we get our minimum daily requirement of these toxins. Small doses of radiation, like inoculations of disease germs, stimulate the body's defense systems. There is a vast amount of repeatable, statistically-significant scientific evidence on every level of plant and animal life, including humans, that demonstrates this beneficial effect. In fact, the first scientific publication of this effect was published just a few months after the discovery of x-rays (W. Shrader, "Experiments with X-rays upon Germs," *Electrical Engineering*, 22, 170 (1896)).

But more research is needed, to fill in the gaps and to continue longitudinal studies that were terminated because they contradicted the existing LNT premise. In addition, reports that are purported to support the LNT model should be re-examined, with a critical look at how the data were handled and interpreted. It is axiomatic in science that you don't see what you're not looking for, and experiments that were looking for detrimental health effects do not show beneficial effects, either because not enough measurements were taken in the low-level region, or low-level data were lumped in with higher-level data to show detrimental effects. The experimenters were counting dead mice, not looking for happy mice. A similar situation once existed with experiments on the nature of light. Since it was "known" in the first quarter of this century that light was wave-like, no one ever observed indications of its particulate nature until experiments were deliberately designed to produce such evidence. The January and May, 1998, issues of the *BELLE Newsletter* give a number of historical examples of this very situation.

Design and Operational Implications

So a critical question is: *How do we express this new understanding in terms of industrial design and operating limits and standards?* There seems to be an Optimum Point, a radiation level above which additional radiation dose is increasingly harmful and below which *reducing* the radiation dose is also increasingly harmful. T.D. Luckey cites evidence to suggest that this optimum radiation level is in the range of 1 to 10 centigray (10 rad) per year, providing that the dose is delivered chronically, that is, not all in one burst (as from a bomb), but over weeks and months, as in a typical occupational situation. Ten cGy is a factor of 100 times the current limit of 1 milligray (100 mrad) per year. In other words, current regulations force us to deprive people of their "Recommended Daily Allowance" of radiation. We might be able to go to 100 times this optimum dose before we reach the Zero Effect Point (ZEP), above which additional radiation begins to become potentially harmful. So, for optimum performance perhaps we should consider setting the Optimum Point as our upper operating limit, but recognizing that no detectable health effects would be expected unless we exceeded the ZEP. Above the ZEP the detrimental health effects would increase from barely detectable to serious as the radiation dose increases. Are we ready to recommend such a change?

To answer this question (still in a purely technical mode), we need to know the answer to several additional questions: First, how well do we know this Optimum Point? We have enough data to conclude with reasonable confidence that there is such a number, but for a matter of such importance we should know more precisely the shape of the dose-response curve at low radiation levels, and the role of other variables, such as the nature of the radiation and the specific health effect being studied. There are many steps we could take now to rather quickly increase our knowledge; but up to now, pursuing the evidence that could illuminate this question has been discouraged and the results ignored. So, as previously noted, additional research and analysis to

fully define the health effects of low-level radiation should be carried out before we can confidently convert to official codes and standards the numbers that current knowledge suggests.

Money being allocated to “research the effects of low-level radiation” should include as a priority a thorough and objective review of existing data that has been ignored in setting current policy. This should include evaluating the effects on persons living in high natural radiation areas of the world and in heavily contaminated areas in Russia and eastern Europe. We should study medical records of persons using radium spas with radon content up to a million times current “permissible limits,” and re-examine the data on the radium dial painters and other radium-exposed populations. Data on persons given moderate to high levels of radiation as therapy are applicable. And oft-cited studies in which data have been forced to fit a presumed linear response should also be re-examined.

In addition to setting a weekly radiation exposure limit, one might want to set an additional annual limit. (For comparison, note the clinical work of Sakamoto and others where whole-body or half-body doses of 10 or 15 cGy of x-rays are given in a few minutes or less, every few days for a cumulative total of 150 rad, to stimulate the immune system. This treatment was established from extensive animal and biology studies that consistently proved beneficial, not harmful.)

Collective Dose

It seems clear that the current practice of using “*collective dose*” to predict injuries and deaths where no harm to any individual is expected has never been justified and should be discontinued, especially since it is now well established that the dose of radiation required to cause damage to the human gene pool is close to the lethal level and is thus not passed on to future generations. Similarly, the use of ALARA (As Low As Reasonably Achievable) for reducing radiation levels that are probably beneficial and certainly not harmful should also be discontinued. Such actions simply result in substantial public cost and fear, for no public benefit. Scientists are still making public statements that certain specific numbers of people will die from harmless radiation levels downwind from nuclear weapons tests, or the Chernobyl accident, or from an aborted space probe, or even from shipping shielded radwaste containers — which are now being called “mobile Chernobyls in the press. Such statements are scientific nonsense and should be loudly and bluntly refuted by other scientists who know better. If each individual receives a harmless dose, then no one is hurt. You simply cannot kill anyone by irradiating someone else!

Other Questions

A number of questions then remain: should there be a “safety factor” applied to these figures, even though the data show that reducing maximum permissible radiation doses below the optimum would be deleterious? What difference, if any, should apply to exposure of the public at large, as compared with the occupational dose? How should possible exposure to several ingested isotopes plus external radiation be accounted for? What account should be taken of those few individuals who may be more radiation-sensitive than the average? How does all this affect contamination limits for material to be disposed of and sites to be cleaned up? And are there other limiting effects to be considered in calculating environmental impact of radionuclides

(such as perhaps creating a problem for makers of photographic and certain scientific equipment where even tiny amounts of radioactivity could impair performance)?

We in the industry need to take the lead on this subject, making the necessary engineering calculations to put a cost on the actions taken under present regulations to protect people from harmless levels of radiation, the cost of documenting the fact that we are doing so, and the cost of defending against ALARA lawsuits claiming we should have gone even further. This should include such matters as the extra radwaste produced when a dozen maintenance people each spend a few seconds or minutes doing parts of a job that one person, using one set of clothing and tools, could accomplish under reasonable regulations.

We need to step back to Square One and look at the whole subject anew. If regulations were to reflect the fact that low levels of radiation pose no hazard, would we still want to evacuate people after an accident in a standard water-cooled reactor? Gunnar Walinder, Chairman of the Swedish Radiobiology Society, noted that when Swedes were told to stay in their houses to avoid fallout from Chernobyl, they actually received far more radiation from the natural radon in their homes than they would from the fallout. He argues that this attitude about nuclear radiation ‘has resulted in anxiety and inappropriate measures among the populations of Belarus and Ukraine that have been judged by competent observers to have caused more harm than the radiation itself.’ And this from an accident that released millions of times more radioactivity than could be expected from a nuclear plant built outside the former Soviet Union. If, after careful consideration, we conclude (based on new radiation standards) that evacuation of populations is not advisable, and in fact is apt to do more harm than good, then a vast program involving state, regional and local authorities may no longer be necessary. This is only one possible result from a thorough review of our radiation policy.

Another result, immediately obvious to this audience, is the impact of rational radiation standards on waste handling, disposal and remediation. We are now tied up worrying about single atoms migrating through miles of soil, totally harmless and not even detectable without very special equipment and techniques. On this basis, low-level and high-level waste facilities are both stymied, nuclear medical facilities shut down, and people are scared away from life-saving procedures involving radiation. We can and should change this.

It will take a substantial effort and clarity of scientific analysis to develop this new way of evaluating radiation protection policy. Only after we have done that should we ask what is publicly acceptable and politically possible.

Second-Guessing the Experts

Scientists are, properly, reluctant to question experts in technical areas outside their own specialty. But scientists, or anyone else confident of their ability to think logically and analytically, need not shrink from the challenge if they use only knowledge and skills of their own. An excellent example of how to do this is afforded by a recent case of a group of tobacco interests suing the EPA on its policy on second-hand smoke (US District Court, Winston-Salem, NC, 6:93CV00370, filed July 7, 1998). The Court made no pretense of offering its own judgment on the harmful effects of second-hand smoke. It merely looked at EPA’s arbitrary and capricious rule-making process and judged it on its own claims and merits. The EPA is at least as vulnerable to the same charges in the radiation area. The outcome of this important tobacco case was:

The Court ruled against EPA, strongly and specifically condemning its misuse of scientific data, arbitrary use of procedure, and distortion of evidence to reach a pre-determined finding.

The Court vacated the EPA's technical report that was the basis for EPA's basic finding that second-hand smoke was a Class A carcinogen.

The Court also found that EPA was exercising *de facto* regulation despite specifically worded legislative prohibition from doing so.

The Conclusion of this 90+ page five-year case stated explicitly:

“EPA publicly committed to a conclusion before research had begun;
excluded industry by violating the Act's procedural requirements;
adjusted established procedure and scientific norms to validate the Agency's public conclusion;
and aggressively utilized the Act's authority...to establish a de facto regulatory scheme.”

The Court also noted that, in conducting its risk assessment:

“EPA disregarded information and made findings on selective information;
did not disseminate significant epidemiological information;
deviated from its Risk Assessment Guidelines;
failed to disclose important findings and reasoning;
and left significant questions without answers.”

The Court also concluded:

“EPA's conduct left substantial holes in the administrative record. While so doing, EPA produced limited evidence, then claimed the weight of the Agency's research evidence demonstrated [its case].”

All this resulted from the plaintiff's carefully constructed case proving conclusively the basis for the Court's actions. In addition to the necessary legal arguments, the technical data and rationale used were impressive, focusing on whether EPA had done an honest and competent job in proving its case, on its own stated terms. The plaintiffs saw a clear interest in contesting EPA's aggressive regulation, and were willing to devote the time and talent to win it, which they did decisively. To date, there has been no one willing and able to devote the necessary resources to take on the corresponding issue for radiation policy, even though the case is at least as convincing as the tobacco case, and now has the tobacco precedent to support it. Similar issues involving chemical toxins are handled by the Chemical Industry Institute of Toxicology. There is no such organization in the nuclear industry. There should be.

Is Corrective Action Likely in the Near Future?

Within the last few years, more and more scientists and policy-makers have become concerned over the disparities and contradictions between radiation policy and our scientific understanding of the effects of radiation on biological systems, not only because of the huge cost and the impact on other policy questions, but also because the distortions associated with defining and defending this policy reflect poorly on the integrity of science itself. In the face of this professional concern, the National Council on Radiation Protection and Measurements (NCRP) set up a special Scientific Committee 1-6 to review the validity of the LNT and to

recommend whether present policy should be revised. This committee issued its draft report in November 1998, which is now being critically reviewed by the NCRP's various scientific affiliate organizations. About the same time, the National Research Council convened a new BEIR committee (Biological Effects of Ionizing Radiation), to reassess the applicability of the LNT model.

In addition, a few knowledgeable individuals and groups have taken action. T.D. Luckey published a large book in 1980 with 1269 references, devoted solely to work on the beneficial effects of low-level radiation. He followed this in 1991 with another book with additional work on the same subject and 1018 references. In 1995, Zbigniew Jaworowski, former Chairman of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) published the following statement in *Nukleonika*, 40, 3-12:

In March 1994, UNSCEAR decided to publish its report on radiation hormesis, a phenomenon of beneficial effects of radiation. The report, "Adaptive Responses to Radiation in Cells and Organisms," approved after 12 years of deliberation, dispels the common notion that even the smallest dose of radiation is harmful...Myths are hard to banish, and until recently hormesis was a scientific taboo. This was because it contradicts an assumption which is a basis for the current philosophy and policy of radiation protection...Over the years, this assumption came to be regarded as a scientifically documented fact by mass media, public opinion and even many scientists.

James Muckerheide, State Nuclear Engineer for Massachusetts, organized numerous technical sessions on this subject at meetings of the American Nuclear Society, with dozens of researchers from around the world, and collected voluminous data that contradicts the LNT model. With such noted figures as Nobelist Rosalyn Yalow, he organized an international group of independent experts on radiation into a not-for-profit organization called Radiation, Science & Health, Inc. to address this problem. In the fall of 1995, the French Academy of Sciences published a report objecting to a proposal by the International Commission on Radiological Protection (ICRP) to lower permissible radiation limits still further. The Chief Editor of the report stated:

After examination of recent scientific and epidemiological data, the Academy has confirmed the opinion it gave in 1989, that there is no scientific reason to justify lowering the standards in force today, provided they are accompanied by a lifetime cumulative dose limit for occupational exposure of one Sievert [100 rem].

The Health Physics Society, the technical society for radiation protection professionals, published the following Position Statement in March 1996. It was drafted by the Science and Public Issues Committee (consisting of the current president, the president-elect, and three past presidents). After more than a year of consideration and discussion, it was approved by the Board of Directors:

The current philosophy of radiation protection is based on the assumption that any radiation dose, no matter how small, may result in human health effects, such as cancer and hereditary genetic damage. There is substantial and convincing scientific evidence for health risks at high dose. Below 10 rem (which includes occupational and environmental exposures)

risks of health effects are either too small to be observed or are non-existent.

The Advisory Committee on Nuclear Waste (ACNW) reported July 10, 1996 to its sponsor, the Nuclear Regulatory Commission (NRC):

We conclude that a reexamination of the regulatory model is appropriate...The first task...is an impartial review of the data and their quality...

The increasing emphasis placed by the NRC on risk-informed regulation makes it imperative that the actual health risk of low levels of ionizing radiation be assessed accurately....We recommend that the need for special attention be conveyed to the NCRP regarding its study. Such attention should include:

- 1) Assurance that the study includes scientists other than those who are "recognized experts" with a reputation built on the LNT;
- 2) An evaluation of the data by an entity with an expertise in statistics or information science but no prior position on LNT...
- 3) Consideration of essentially all studies that could relate to the LNT.

We will follow the [NCRP] program...and will report to the Commission on the study and its implication.

A meeting July 31 to August 3, 1997, on this topic sponsored by the Council of Scientific Society Presidents involved representatives from the international and the national councils on radiation protection (ICRP and NCRP), the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the Health Physics Society (HPS), the Nuclear Regulatory Commission (NRC), the Environmental Protection Agency (EPA), the Department of Energy (DOE), the Food & Drug Administration (FDA), the Center for Disease Control (CDC), the National Institutes of Health (NIH), and other knowledgeable organizations and individuals such as BRER, RERF, ANS and the CRCPD. The participants agreed that there is no significant evidence of health effects below about 10 Rem and that efforts should be initiated to change existing requirements for extreme, high-cost programs aimed at reducing trivial radiation levels. Participants also urged that the data on low-level radiation exposure be reviewed and filled in where lacking. The American Nuclear Society and the International Nuclear Societies Council are both studying this matter and will probably issue position statements on it soon.

Against this background, the best case that can be made for using the LNT and its offspring, the notion of "collective dose," is summarized in NCRP Report 121, a 106-page definitive report on the use of LNT to calculate collective dose:

Few experimental studies, and essentially *no human data*, can be said to prove or *even to provide direct support* for the concept of collective dose with its implicit uncertainties of non-threshold linearity and dose-rate independence with respect to risk. The *best* that can be said is that *most* studies do not provide quantitative data that, with statistical significance, contradict the concept of collective dose. Ultimately, confidence in the linear no-threshold dose-response relationship at low doses is based on our understanding of the basic mechanisms involved. ...It is *conceptually possible*, but with a vanishingly small probability, that any of these effects *could* result from the passage of a single charged particle,

causing damage to DNA that *could* be expressed as a mutation or small deletion. It is a result of this type of reasoning that a linear non-threshold dose-response relationship *cannot be excluded*. [emphasis added]

This authoritative statement makes clear that the LNT rests on dubious ground scientifically. It provides no basis for the near-certitude demanded of those who would challenge the policies it has spawned. Yet this same report states confidently:

Since it is generally accepted that a dose of ionizing radiation, however small, has associated with it a risk of eliciting a deleterious biological response, there is no conceptual basis to exclude even the individuals receiving the lowest dose from a calculation of collective dose.

CONCLUSION

Present knowledge and understanding are sufficient to support a decision now to stop committing vast sums of money to protect against harmless levels of radiation, and to refocus our resources on bringing radiation policy into line with the best scientific data and theory. To that end, we should move quickly to re-evaluate existing data and fill in with additional research as necessary to provide a solid technical base for changing present radiation policy as indicated by the data and by our experience with radiation over the past century. The U.S. Congress has allocated a generous amount of money to the Department of Energy for that purpose. We must assure that this money buys us a fresh and objective look at the evidence and a determination to act wisely to create a sensible, practical, conservative radiation policy. It will take a serious effort to assure that this money is not given to the same people and the same organizations, to continue the course that has led to our current dilemma.