LOW-LEVEL IONIZING RADIATION: UPDATE 1979

Until the last few years, there was conflict in the scientific community over whether low-level ionizing radiation (under 5 rem) is harmful to people. The nature of the conflict was clear in the proceedings of two Congressional Seminars that took place less than two years apart. The first, on May 4, 1976, centered on whether evidence of the effects of low-level radiation on humans was adequate to constitute proof of a threat. On one side were those who stated that experiments involving humans were based on small population samples, and that human data did not include evidence from contact with radiation at a low enough level to accurately reflect the effects of radiation at low levels.

On the other side were those such as Dr. Irwin Bross, Director of Biostatistics at Roswell Memorial Institute for Cancer Research, who said:

> The statement has been made that there is no evidence of human beings exposed to low-level radiation. I would say that our data is entirely based on diagnostic x-rays which are at this level or lower. We are not, and let me emphasize this, we are not extrapolating from very high levels to very low levels. We are talking about actual data on human beings exposed.... /This data/ is coming from the Tri-state data on a population base of 13 million people in designated parts of three states...these data are just as valid as any data produced by an animal study.[1]

The argument was long and emotional, but by the time of the second Congressional Seminar on Low-Level Ionizing Radiation, it was clear that Dr. Bross's side had won.

The second Seminar took place on February 10, 1978. Instead of centering on whether low-level radiation was dangerous, it dealt with how low a level is dangerous. At that time, Dr. Bross noted that both the scientific community and the public "are well aware of low-level radiation hazards even if some regulatory agencies seem reluctant to admit the truth." He explained the difference between the two Seminars: "To me the most important thing is the question of attitude. I think we got into this mess by taking the attitude that these low levels of radiation were harmless. I think that the most important thing this group could do is to transmit the message that low-level ionizing radiation...is hazardous to your health."[2]

This year, a Federal Interagency Task Force on the Health Effects of Ionizing Radiation reported on the current state of knowledge:

> Theoretical considerations suggest that no threshold exists below which radiation has no carcinogenic effect. Because of these considerations and because of the obvious statistical impossibility of proving that no risks exist at low doses, it is prudent to assume that any dose of radiation, no matter how low, involves some risk of cancer.[3]

The controversy on low-level radiation has gone from heated debate to general agreement in the relatively short period of three years.

WHY HAS THERE BEEN SO MUCH CONFUSION ABOUT THE EFFECTS OF LOW-LEVEL RADIATION?

One of the reasons that scientific debate on the effects of low-level radiation has been so heated, certainly, is that part of adequate scientific investigation is comparison of data from many sources and discussion of alternative interpretations of that data. But the debate on low-level radiation has been particularly heated for a number of reasons.

Two reasons for the extra debate are historical. Nuclear power, for peaceful and warlike uses, has been the central factor in the Atomic Age. As David Lilienthal, first Chairman of the Atomic Energy Commission, noted, "Once a bright hope shared by all mankind, myself included, the rash proliferation of atomic power plants has become one of the ugliest clouds overhanging America."[4] This change in attitude has been difficult for all of us to accept.

The second historical reason for the debate on radiation was the atmosphere of this country during the 1950's. The Deputy Inspector of Mines for the State of Colorado, Norman Blake, talked in 1970 about attempts at radiation standard reform during the McCarthy Era: "It was often hard to get anything done about radioactivity in the mines in those days. Anybody that said a thing against uranium mining was suspected of being a Communist."[5] The caution people learned continued to stifle dissent for some time. In the last few years, though, attitudes have changed rapidly.

One reason for the confusion over the effects of low-level radiation is simply that the evidence has multiplied in the last 5 years. Not only that, but the more research has been done, the more effects of radiation have been found. However, this factor and the historical background do not combine to explain the magnitude of confusion over radiation. In addition, radiation is special -- it is different from other pollution and from other naturally-occurring substances.

Because radiation is different, attempts to define its effects using conventional benefit-cost analysis have fallen short, as outlined by the National Academy of Sciences. First, conventional benefit-cost analysis does not allow for effects on future generations, and "dangerous long-lived radionuclides produced today for a present benefit will be a cost to future generations." Second, conventional analysis assumes that decisions made today will be reversible, and this assumption does not hold true for the effects of radiation. Third, benefit-cost analysis assumes that "human welfare...may be measured in monetary or materialistic terms."

But that assumption, for example, cannot handle "situations in which the risks and benefits do not accrue to the same people." Commonly, the people most affected by nuclear power are those living near mines, mills, waste sites, and power plants; these are not necessarily the people who use nuclear-generated electricity.

Summing up the problems of attempting to balance the benefits and costs of radiation under conventional theory, the Academy of Sciences states, "Benefit-cost analysis can be applied effectively to nuclear power production at the level of technical decisions. However, where national policy is involved, decisions must inevitably be made on the basis of value judgments, to which economics...can make only a limited contribution."[6] The decisions on whether to use nuclear-generated energy, and thus whether to expose people to radiation, have been government policy decisions; the value judgment to date has been that the costs are worth the benefits.

As if the above reasons were not enough to create confusion, two other factors have entered into the debate over the effects of low-level ionizing radiation. One has been this government policy of actively promoting the development and use of atomic energy. The implementation of the policy has created several conflicts of interest. One such conflict, that one agency both promoted and monitored atomic energy, was ameliorated by the division of the Atomic Energy Commission in 1975. A second conflict of interest is still evident: most research on radiation is funded by the government.

Governmental conflict of interest is also evident as the major effects of low-level radiation on human health and the environment are confirmed. It is in the government's interest to downplay the effects of radiation, because its advocacy of nuclear energy could lead to legal liability for the health results of the industry. So the government must attempt to minimize radiation's dangers, while at the same time providing safeguards, insuring implementation of safeguards, and providing public information on safety.

These conflicts between policy and implementation have led to problems in the way government agencies use terminology. And since the main source of information on atomic energy has been the government, terminology problems have added much confusion to the discussion of radiation. Two important terms that have been clouded are "low-level" and "risk." Regarding the former, R. V. Durham and Stephen J. McDougall of the International Brotherhood of Teamsters commented on the 1979 Interagency Task Force Report on the Health Effects of Ionizing Radiation:

> The catch term 'low-level' is used interchangeably to describe both background population exposures and all workplace exposures, and implies that the risks are equivalent.... General population exposures to 'low levels' of background radiation on the order of

> 30-95 mrem/year do not equate with worker exposures to so-called 'low levels' of radiation on the order of 1 or even 5 rem/year.[7]

The other clouded concept has been "risk." Robert Alvarez and Craig Swick of the Radiation Health Information Project put it this way in their comments on the Interagency Task Force Report: "The Science Work Group...delivers two contradictory messages. First, that the risks of low-level radiation exposure are unknown, and secondly, that these risks are very small. It appears that this contradiction is derived by extrapolating the risks from high dose human studies down to low doses."[8]

All these conflicts of interest and their results, added together, have done much to create public and scientific confusion about the effects of low-level radiation. One other factor contributing to the confusion has been the focus on cancer by researchers, government, and the public.

Dr. Rosalie Bertell, Researcher with the Ministry of Concern for Public Health, has repeatedly emphasized that cancer is not the only concern:

> The risk of acceleration of the natural aging process, causing gradual breakdown of the body's ability to cope with infection and stress, is very large, about 100%. ...radiation exposure generally undermines health and can be manifested in benign tumors, anemia, immuno-depression, atherosclerosis, diabetes, heart disease and other maladies. The general impression conveyed by public information...is that the risk of death from cancer is 'low,' with the implication that there is no other risk.[9]

The factors contributing to popular and scientific confusion about the effects of low-level ionizing radiation are substantial. Part of the reason that the state of scientific consensus has changed dramatically in the last few years is certainly clarification of past confusion.

WHAT IS THE CURRENT STATE OF SCIENTIFIC KNOWLEDGE ON LOW-LEVEL RADIATION?

Dr. Irwin Bross, in his comments on the 1979 Interagency Task Force, compared the present state of knowledge on the effects of low-level radiation with the state of knowledge of the effects of x-ray exposure in the 1960's:

> In those days there were only a handful of cancers in the critical series that gave positive results and it seemed as if the hazard was very iffy and uncertain--just as today. But in retrospect there is no question that the evidence of hazard was there. In those days there were a handful of seemingly disparate and unrelated studies which could be disparaged and dismissed individually and this is the situation with the low-level nuclear radiation studies today.

Dr. Bross estimates that therapeutic x-rays of the head and neck have resulted in 15,000 cancers "and probably 75,000 before the story is over." On the state of current low-level radiation research, he states, "Depending on what is counted, there are now between half a dozen and a dozen positive reports of hazards to

persons exposed to nuclear radiation in the 1 rad range. It is virtually impossible that they are all false alarms."[10]

Not counting the now accepted danger from medical radiation, the studies have explored uranium mining and transportation, weapons and reactors, and occupational exposure.

One of the most important factors in radiation research, according to Dr. Karl Morgan, former Director of Health Physics at Oak Ridge National Laboratory, is that cancer resulting from radiation exposure "may manifest itself in one to two years, or after, say 50 to 80 years...."[11] As the Atomic Age enters its fourth decade, we may have noticed only the first signs of radiation danger. It will take time and continued intensive research to outline the full range of problems faced.

The studies on uranium mining have shown two predominant dangers in that part of the nuclear fuel cycle. The first is that uranium miners run a high risk of lung cancer and other radiation-related illness. The second is that the wastes from uranium mills, called tailings, "become the dominant contribution to planned radiation exposure from the nuclear fuel cycle."[12] This "front end" of the nuclear cycle and its contribution to radiation exposure is considered more fully in a separate paper.

Between the mine and the mill, the mill and the reactor or weapons facility, and the facility and the waste site arise the problems of transportation of radioactive materials. Government regulation of transportation of these materials has been widely criticized. Part of the problem with regulation is that transportation exposes so many different areas and groups of people to radiation.

Another problem with regulation of transportation has been the rapid growth in the movement of radioactive materials. According to the 1979 Interagency Task Force, "Annual transport of radioactive materials increased from 200,000 packages in 1961 to approximately 2.5 million today.[13] Truck drivers and loaders are particularly likely to be exposed to high levels of radiation, but the public can be exposed as well.

Study of the amount of in-transit exposure has been minimal. Research was spurred by 118 highway incidents involving radioactive spillage between 1971 and 1976 and, in particular, by "a highway accident in September 1977 in Springfield, Colorado, in which several tons of uranium concentrate (yellow cake) were spilled, necessitating an extended clean-up...." According to the Interagency Task Force, the post-Springfield study result was that "The study group cited a low benefit to risk ratio for most of the proposals. There is some concern, however, that

citizen and environmental groups should have an opportunity to present their views on the proposals."[14] The problems associated with using benefit-cost ratios in assessing radiation effects have already been noted. In addition, the input of citizen and environmental groups should be important because, as a result of a radioactive traffic accident:

> Under fair weather conditions, a person one half mile downwind from an accident releasing a radioactive gaseous cloud could receive a dose of approximately 160 rems. This is greater than the amount received by many of the 300,000 Hiroshima fatalities. In an urban area...a substantial area of land would need evacuation and would remain contaminated for a very long time.[15]

Clearly, further study and citizen input are needed in regard to transportation of radioactive materials.

Information on the effects of radiation from facilities such as nuclear power reactors and weapons plants is more complete; it is certainly easier to study a fixed site than a shipment in transit. Several studies on nuclear facilities have recently been published.

Two of the most recent are the studies at the Millstone power plant in Connecticut and Dr. Carl Johnson's study of the effect of Rocky Flats weapons plant on the Denver area. The Millstone study was reported by Dr. Ernest Sternglass of the University of Pittsburgh. Dr. Sternglass measured strontium-90 in the environment and found that the concentration of radioactivity was greater the nearer he moved to the plant. He then compared the level of radioactivity to the level of cancer and reported: "...cancer rose 58 percent in the town of Waterford /by the plant/ between 1970 and 1975; 44 percent in New London, four miles away; and decreasing with distance in every direction away until one gets to Maine, cancer during that same period was declining 6 percent."[16] The basic cancer correlation was supported by a correlation between strontium-90 in residents' bones and strontium-90 in local milk. Sternglass's results also showed that people of different ages were affected in different degrees, a finding that supports earlier studies on low-level radiation.[17]

These age differences show that the developing fetus, the young child, and older adults are affected most by low-level radiation. The older adults, Sternglass asserts, are affected more because their "immune system is known not to be as effective in protecting against the proliferation of cancer cells as in the middle-aged adult...."[18] The increased effects on the fetus and young child have been known for some time, particularly as a result of studies of children who were exposed to x-rays or bomb radiation while still unborn. The reason for the

increased effect in children is that the cells of the very young divide and differentiate at a rapid pace.[19]

Dr. Sternglass also found that the effects of radiation are disproportionately high for women, as did a study at the Hanford, Washington, atomic works.[20] Data from Dr. Johnson's Rocky Flats study contradict this finding, and the difference in effects for the two sexes remains clouded.

Another difference in the effects of radiation on different populations was found by Dr. Sternglass and is supported by other studies. This is that people in poorer socioeconomic groups suffer more from radiation. This result is an example of the interaction of radiation with other environmental and dietary factors. As Dr. Sternglass reports: "It is not just one factor of radiation which is involved." The increase in cancer for the white population in his study was 14%; for the non-white population the increase was 51 percent.[21]

Perhaps the most interesting of Dr. Sternglass's observations, however, dealt with the nation as a whole:

> If one examines the rate of change of cancer mortality in the United States for every state during /1972-1975/, one finds that the greatest upward changes have taken place for the states that have the largest nuclear facilities such as Hanford (Washington), Oak Ridge (Tennessee), Savannah River (South Carolina), or that have nuclear reactors with known large releases in very densely populated areas /New Jersey, Rhode Island, Connecticut/.... In fact, according to the figures published annually in the U.S. Monthly Vital Statistics Reports, the six highest rates of cancer increase in the U.S. occurred in these states: Washington, +8.9%; Connecticut, +8.6%; Tennessee, +8.1%; Rhode Island, +8.0%; New Jersey, +5.7%; South Carolina, +5.4% compared with a U.S. average of +3.4% for this period.
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> On the other hand, cancer mortality rates actually declined during this same period most strongly in the four states having no nuclear facilities at all: Alaska, -10.6%; Montana, -4.4%; New Hampshire, -2.0%; and Hawaii, -1.5%.[22]

These figures are powerful supporting data for those who claim that the effects of low-level radiation are greater than has been estimated in the past.

The study at Denver, Colorado, by Dr. Carl Johnson was released in 1979 and showed that plutonium contamination from the Rocky Flats plant was affecting the surrounding population. The results found by Dr. Johnson confirm Dr. Sternglass's results: contamination was spread more thinly as he moved away from the plant, and the cancer rate got correspondingly lower.[23]

Radiation contamination at low levels has also been associated with a general speeding of the aging process and an increase in arteriosclerotic heart disease.[24]

But, in the long run, the most startling danger from low-level radiation is its ability to cause genetic mutations in humans, other animals, and plants. Recent studies have highlighted that danger.

The 1979 Interagency Task Force summed up the most recent findings on genetic damage. Increased chromosome breakage has been found in several populations exposed to more than the usual background radiation. In addition:

> Experimental studies in short-lived animal species demonstrate clearly that ionizing radiation produces gene mutations which can result in heritable abnormalities in later generations. .... While such risk values are difficult to translate into actual health effects, the 1972 BEIR report has estimated that a cumulative dose of 5 rem per generation (the current allowable population limit of 0.17 rem per year times 30 years) might be expected in the United States to produce between 60 and 1,000 genetically determined illnesses of various sorts per one million live births.[25]

As the BEIR report is now considered to have underestimated the effects of low-level radiation, the actual genetic damage can be expected to be higher. The cumulative effects of gene mutation over the long period of time that radiation remains active in the environment could be staggering, expecially if the nuclear industry continues to expand. The damage was summed up by one author: "Particle for particle, radionuclides may be 100 million times more toxic to developing embryos than thalidomide."[26]

The end result of current research on low-level radiation has been a large increase in the estimation of the danger posed by radiation under 5 rems to human health and the biosphere. Dr. Bross, using statistical analysis, showed that there is no "threshold dose" below which radiation is harmless and that, in fact, the response of organisms to radiation doses probably increases for low-level contact, compared to high-level exposure.[27] This is the opposite of the long-held assumption that the lower the dose of radiation, the lower the likelihood that an organism would be effected. Instead, recent studies show that:

> ...the most serious of all radiation exposures are not brief medical x-ray diagnostic isotope tests for the adult, but prolonged environmental exposures to fallout accumulating in the body from nuclear bomb-testing and releases from nuclear facilities acting slowly on the infant in utero, the young child and the oldest individuals in our society.[28]

CONCLUSION

Natural background radiation has long been known to affect the inhabitants of the planet. The additional radiation from the nuclear fuel and weapons cycle, even if no further mining or development is undertaken, has made and will make a

difference in the history of the area now known as the United States. The Nuclear Regulatory Commission's estimate is the 100 deaths will occur for each day that fuel is produced--from uranium milling alone.[28] That estimate does not include any deaths after 1,000 years, the rest of the nuclear cycle, or the illness and mutations that do not cause death.

The people of the United States are, essentially, being allowed to take in increased doses of radiation by the failure to curb the nuclear fuel cycle. As the petitioner in Honicker v. Hendrie said to the Nuclear Regulatory Commission:

> Citizens of the United States have well established rights to prevent life-threatening harm from damaging themselves or their children. .... Life-threatening experimentation on individual citizens without their informed, individual consent, and willful causing of disease, death, and deformity within a large number of people over a long period of time are crimes against humanity of the most heinous degree and inimical to American and international concepts of justice under the laws. It can never be maintained that sound public policy would permit government or non-governmental agencies to deprive human beings of their lives in order to obtain energy for other human beings.[30]

These are the stakes in the use of nuclear power.

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FOOTNOTES

1 Subcommittee on Energy and the Environment, United States House of Representatives, Proceedings of a Congressional Seminar on Low-Level Ionizing Radiation, Environmental Policy Institute: Washington, D.C., 1977, p. 16. (Hereinafter "Seminar I")

2 Congressional Environmental Study Conference, Environmental Policy Institute, and Atomic Industrial Forum, Radiation Standards and Public Health: Proceedings of a Second Congressional Seminar on Low-Level Ionizing Radiation, Congressional Environmental Study Conference, Environmental Policy Institute, and Atomic Industrial Forum: Washington, D.C., 1978, pp. 138-139. (Hereinafter "Seminar II")

3 Interagency Task Force on the Health Effects of Ionizing Radiation, Report of the Work Group on Science, Department of Health, Education and Welfare: Washington, D.C.: 1979, p. 22. (Hereinafter "Work Group on Science")

4 Environmental Action Reprint Service, "Nuclear Power?", Environmental Action Reprint Service: Denver, p. 2.

5 Metzger, The Atomic Establishment, 1974, p. 126.

6 Advisory Committee on the Biological Effects of Ionizing Radiation, National Academy of Sciences, Considerations of Health Benefit-Cost Analysis for Activities Involving Ionizing Radiation Exposure and Alternatives, National Academy of Sciences, 1977, pp. 7-9.

7 Interagency Task Force on the Health Effects of Ionizing Radiation, Public Comments on the Work Group Reports, Department of Health, Education and Welfare: Washington, D.C., 1979, Letter of Stephen J. McDougall and R.V. Durham, Safety and Health Department, International Brotherhood of Teamsters, Chauffers, Warehousemen and Helpers of America, March 20, 1979, pp. 4-5. (Hereinafter "Public Comments." NOTE on the use of this volume: the book pages are not numbered, so all quotes will be attributed to the page of the individual letter or report.)

8 Public Comments, Letter of Robert Alvarez and Craig Swick, Radiation Health Information Project, Environmental Policy Institute, March 26, 1979, p. 2.

9 Public Comments, Memo by Rosalie Bertell, Ph.D., G.N.S.H., Ministry of Concern for Public Health, April 2, 1979, p. 3.

10 Public Comments, Irwin D. J. Bross, Ph.D., Roswell Park Memorial Institute, "U.S. Civilian Casualties of Cold War Radiation Weapons and Myths: Must There be Another Million?", March 6, 1979, pp. 6, 2.

11 Seminar I, p. 9.

12 Interagency Task Force on the Health Effects of Ionizing Radiation, Report of the Work Group on Exposure Reduction, Department of Health, Education and Welfare: Washington, D.C., 1979, p. 26. (Hereinafter "Work Group on Exposure Reduction")

13 Work Group on Exposure Reduction, p. 137.

14 Work Group on Exposure Reduction, pp. 138-139.

15 Honicker v. Hendrie, The Book Publishing Company: Summertown, Tennessee, 1978, p. 99.

16 Seminar II, p. 57.

17 Seminar II, Dr. Ernest Sternglass, "Cancer Mortality Changes Around Nuclear Facilities in Connecticut," p. 176.

18 Ibid., p. 177.

19 Work Group on Science, p. 5.

20 Seminar II, Dr. Sternglass, p. 81.

21 Ibid., pp. 82-83.

22 Ibid., pp. 179-180.

23 Public Comments, Carl J. Johnson, M.D., M.P.H., "Epidemiological Evaluation of Cancer Incidence Rates for the Period 1969-1971 in Areas of Census Tracts with Measured Concentrations of Plutonium Soil Contamination Downwind from the Rocky Flats Plant," 1979, "Summary," p. i.

24 Seminar I, p. 13.

25 Work Group on Science, pp. 5-6.

26 Honicker v. Hendrie, p. 36.

27 Seminar II, pp. 250-251, 254.

28 Seminar II, Dr. Sternglass, p. 178.

29 Honicker v. Hendrie, p. 126.

30 Ibid., "Abstract," p. 1.