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CRITERIA FOR RISK ACCEPTANCE: A HEALTH PHYSICIST'S VIEW*

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1. INTRODUCTION

A controversy over the safety of nuclear energy has grown in the United States since about 1970 and has now spread to near worldwide proportions. This controversy has been fueled by a variety of issues. Initially in the U.S. the most prominent issue concerned the degree of hazard of low level radiation, in particular that associated with the nuclear fuel cycle. Since then attention has shifted successively to the reliability of emergency core cooling systems, the longevity of nuclear wastes, the possible misuse of radioactivity by terrorists and the potential for diversion of nuclear power produced plutonium to weapons fabrication. Underlying each of these issues has been the implication that the employment of nuclear power will entail an unacceptable risk to the public.

Seemingly, the public interest would be served by an agreement upon some very elementary yardsticks for risk acceptance. In common with others engaged in occupational and public health protection activities, health physicists must apply some operational criteria for the acceptability of risk. Their essence are contained in the statement of the objectives and purposes of the Health Physics Society. They are suggested as a useful model for a general approach.

2. CRITERIA FOR RISK ACCEPTANCE

The stated primary objective of the Health Physics Society is "the development of scientific knowledge and practical means for the protection of man and his environment from the harmful effects of radiation, while encouraging its optimum utilization for the benefit of mankind" (1). This statement embodies or implies some very common sense criteria for risk acceptance. 1) All human activities, including the utilization of radiation, entail some risk. 2) The development of "knowledge and means" facilitates the minimization of risk. 3) The acceptance of risk should be evaluated in the context of offsetting benefits. It follows that no risk should be accepted for which there is not an apparent benefit. 4) An agent or activity that entails some risk should be utilized so that it offers an optimum benefit. It follows that it should not be utilized if a lower risk agent or activity offering the same benefit is available.

Given that each of us has an individual set of preferences and values, and that none of us has a right to force our set on another, the ICRP's philosophy of keeping risks from radiation less than or equal to risks "regularly accepted in everyday life" (2), seems the only available objective basis for societal judgements about risk acceptance. Any other approach risks ideological strife, as documented by the quasi religious overtone of much of the current argument about the acceptability of nuclear power (3). Thus a pragmatic secular approach to risk acceptance involves three simple questions: 1) What are the benefits? 2) What are the risks? How do the risks compare with those of alternatives? With regard to nuclear power, the

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benefits (electricity) are the same, regardless of fuel. So the principal remaining issue is the comparative risks of the alternative cycles.

3. RISK COMPARISONS

For a large scale employment of nuclear power by the year 2000, an associated average individual dose to the U.S. population of 0.0005 rem/yr has been projected by the Environmental Protection Agency (EPA)(4). This is compared to other significant radiation sources in Table 1. It is evident that the "other environment" dose, principally from the nuclear fuel cycle, is expected to remain small compared to natural and medical radiations, and to be comparable to that from such miscellaneous sources as color television, luminous time pieces and air transportation (the benefits of which seem somewhat less than having an assured supply of electricity).

Radiation source	Year 1960	1970	1980	1990	2000
	(mrem/yr)				
Environmental					
Natural	130	130	130	130	130
Fallout	5.5	4.0	4.6	4.7	5.0
Other*	0.08	0.06	0.09	0.22	0.47
Subtotal	135.6	134.1	134.7	134.9	135.5
Medical					
Diagnostic	72.3	72.3	72.3	72.3	72.3
Pharmaceuticals	0.3	2.0	13.9	14.2	15.6
Subtotals	72.6	74.3	86.2	86.5	87.9
Occupational	0.8	0.8	0.8	0.9	0.9
Miscellaneous	1.9	2.7	2.2	1.2	1.1
Total	211	212	224	224	225

TABLE 1 Average Annual Radiation Doses in the United States--1960 to 2000**

*Principally the nuclear fuel cycle.
**Adapted from A. W. Klement, et al. (4).

If not satisfied at this point that nuclear power is acceptable, one may ask, "How do its risks compare with those posed by the alternatives?" From the dose-effect estimates made by the National Academy of Sciences-National Research Council Committee on the Biological Effects of Ionizing Radiation (BEIR)(5), an "extra" risk of fatal cancer of about 1/10,000,000 may be calculated for an individual exposed to 0.0005 rem/yr (from nuclear power in the year 2000). The U.S. Nuclear Regulatory Commission's (NRC) Reactor Safety Study (6) leads to a "most probable" risk (for low dose rate radiation) of 2/100,000,000, with a lower bound which does not exclude zero. The integrated risk of immediate fatal effect to the average individual in the U.S. from nuclear malfunctions, as given by the Reactor Safety Study, is for the 100 postulated reactors, only about 5/1,000,000,000 per yr, so that it adds little to the above estimate.

The attention currently being devoted to risk reduction in the NRC Appendix I regulations and EPA nuclear fuel cycle standard, seems out of proportion to its contribution to the overall current or prospective exposure to the public. Terrill has estimated that monies spent on improved x-ray equipment would accomplish from 1000 to 6000 times as much exposure reduction as the same amount spent on reactor waste treatment systems (7). Something needs re-examination when the driving forces in the debate about the merits of nuclear energy produce such a misallocation of resources to the reduction of already trivial risks.

Several estimates of the health risks of the fossil fuel cycles have appeared recently in the literature (8-10). From them it appears that the associated average risk of premature fatal effect to individuals in the U.S. public is in the order of 2/100,000/yr, or about 200 times the "upper limit" nuclear risk. Additionally, there is epidemiological evidence in which cancer rates are positively correlated with urbanization and more pertinent to this consideration, with air pollution, much of which is associated with fossil power effluents (11,12). There appears to be a negative correlation with background radiation levels (13,14). From these indications the utilization of nuclear power would provide a net benefit to public health, and thus be not only "acceptable" but "desirable."

4. CONCLUSION

While the currently available information is insufficient to establish numerical risk estimates for nuclear wastes, terrorism or diversion, the probable consequences do not appear as severe as suggested by some critics (15-18). Finally, in deciding on the acceptability of risk from nuclear power, one may ask "How do the national resources currently being allocated to still further reducing the 1/10,000,000 or so yearly hypothetical prospective risk from nuclear power compare with those resources being devoted to the overall prevention of premature death?" Some common risks are shown in Table 2.

Cause	Annual Risk	Cause	Annual Risk
All causes	8.96×10^{-3}	Influenza	2.70×10^{-4}
Diseases of heart	3.39×10^{-3}	Diabetes	1.68×10^{-4}
Malignant neoplasms	1.74×10^{-3}	Cirrhosis of liver	1.51×10^{-4}
Cerebrovascular disease	9.18×10^{-4}	Arteriosclerosis	1.37×10^{-4}
Accident (total)	4.81×10^{-4}	Mortality in early infancy	1.28×10^{-4}
Motor vehicle	2.09×10^{-4}	Suicide	1.26×10^{-4}
Falls	7.20×10^{-5}	Bronchitis	1.19×10^{-4}
Drowning	3.80×10^{-5}	Homicide	1.02×10^{-4}
Fire	3.00×10^{-5}	Congenital abnormalities	6.70×10^{-5}
Poisoning (solids and liquids)	1.90×10^{-5}	Nephritis and nephrosis	3.90×10^{-5}
Suffocation	1.50×10^{-5}	Peptic ulcer	3.20×10^{-5}
Firearms	2.50×10^{-5}		
Poisoning (gases)	1.60×10^{-5}		
Natural phenomenon	3.10×10^{-6}		
Electrocution	2.50×10^{-6}		

TABLE 2 Annual Death Risk from Leading Causes, United States*

*From Monthly Vital Statistics Report, Annual Summary for the United States, 1975, (HRA)-76-1120 24: 13 (6/30/76) except estimates of subcategory of accident from U.S. National Safety Council, Accidents Facts, 1976 edition.

It seems obvious that we cannot solve every health problem simultaneously both for lack of sufficient monies and sufficient knowledge. The determination of the priorities for their address and the determination of acceptable risk from each seems a matter of public policy. In terms of its relative risk, nuclear power appears to be more than "acceptable."

Beyond making these kind of comparisons, it may be suggested that the public would benefit from some kind of consensus about negligible nonzero levels of probable risk which would be deemed generally acceptable. A reasonable perspective in this regard, suggested by Starr (19) is a yearly risk of 1×10^{-6}, the level of natural hazards (such as earthquakes, floods, hurricanes, and tornados). A similar "cut off," with regard to major accidents and their consequences has recently been advocated by Farmer (20) on the basis of existing social decisions (i.e. flood defenses) and the lack of experience to justify a lower level. Following a satisfactory demonstration of its achievement, hopefully the nuclear argument could be terminated. Society could then move on to the real issues affecting energy, population and quality of life.

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