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The Karma of Kerma: Nuclear Wastes and Natural Rights

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Abstract

The disposal of radioactive substances in a manner that anticipates their eventual partial release into the human environment imposes a health burden upon future generations that cannot be justified by any moral or legal rationale. Like an irresistible force meeting an immovable object, the concept of the greater good for the many in the present generation runs against the concept of the inalienable rights of each individual in future eras. At present, in matters involving nuclear power, our governmental agencies have taken the side of the irresistible force. But when federal agencies venture to tread beyond of the scope of the foundation principles with which the federal government was fashioned, they endanger more than human lives. At risk in the nuclear waste debate are long-held concepts of ordered liberty.

Nuclear energy is not alone among the rapidly advancing technologies which challenge the ways we think about ourselves and our relationships with the Earth, with our culture, and with future generations, but it has seemed to cross more previously sacrosanct boundaries more quickly and more openly than many other technologies.

There are at least three distributional injustices in the public health impacts of nuclear energy: medical, spatial and temporal. The medical inequality relates to the varying abilities of different persons to withstand exposure to radiation. We can never know the specific circumstances of every human exposure: the amount and rate of radiation; the type (gamma, beta, alpha, neutron, low-LET, high-LET) of radiation received; the physical and biological pathways; the duration and frequency of the exposures; the age, sex, and health of the individual; the influence of other environmental carcinogens; the genetic predisposition; and the synergistic and multiplicative effects of other risk factors. Because of these and other uncertainties, we will not be able to say for certain in most individual cases whether the effects suffered by particular persons are traceable to any discrete source, or even to ionizing radiation generally.

The unfair spatial distribution is related to the NIMBY ("Not In My Back Yard") reaction, something governmental regulators almost invariably encounter when trying to site a potentially polluting facility. With few exceptions, the NIMBY syndrome brings about a selection of sites with the lowest human population, resulting in an inequitable burden of risk that falls most heavily on those who live farthest from population centers and have the least political visibility.1

Temporal inequalities are those arising from the transfer of health effects, economic costs, and various other risks to future generations. This article is primarily concerned with the temporal inequalities of radiation on human health, which I've termed the karma of kerma. "Karma" is meant primarily to denote

the cause and effect aspect of the physical universe, although it carries a spiritual connotation which is equally apt in the present context. "Kerma," an acronym for Kinetic Energy Released in Material, refers to a known quantum of radiation exposure based upon release rates, shielding and other factors, or more simply, dose. That all kerma carries karma is a truism. This article will explore some of the karma that our generation is creating for the generations which come after us.

Microphysics

In nature, energy is regularly cast off from unstable atomic structures in the form of gamma waves, free electrons (beta rays), or proton-neutron pairs (alpha particles). When these particles or energies leave their previous residences and radiate outward, they are capable of imparting an electrical charge to other matter they encounter, and so are called "ionizing radiation." Such radiation can be, and is, quite damaging to biological structures. As physicist John Gofman describes it:

[W]ith ionizing radiation, electrons are removed from their atoms, and endowed with energies huge compared to those in ordinary chemical reactions. Such electrons maraud for great distances (compared with atomic dimensions in angstroms) and have the chemical capability to break any kind of bond one might care to visualize. In biochemical systems, reactions are carefully controlled, often by special geometric juxtaposition of the reactants. A marauding high-speed electron simply does not notice this all this elegant juxtaposition‹it can break anything, anywhere. And once it has ripped an electron out of an atom in a molecule, that molecule is itself at such a high-energy level that it can produce all kinds of chemical reactions that would never have been possible without the ionizing radiation.2

The karma of kerma is therefore a slightly accelerated entropy of biological systems.

In the human cell, certain chemical bonds are crucial to the integrity of the genetic code and breaking just a few of these bonds may endow the code with a permanent alteration.3 When a mutated gene is responsible for regulating normal cell growth, an uncontrolled proliferation of damaged cells, or cancer, can develop. When mutation occurs in the procreative cells or in the developing embryo, birth defects can result. When mutation occurs in the blood-forming tissue, impairment of the immune response system can result, and this can increase susceptibility to an entire spectrum of human disease. Radiation is therefore said to be mutagenic (cell-mutating), carcinogenic (cancer-causing), teratogenic (birth-defect inducing), and immuno-suppressing (resistance-impairing). All of these effects, which begin at a submicroscopic level, remain invisible for extended periods of time until they reach observable proportions. The latent period may be decades in the case of an incipient cancer, or it may be centuries in the case of a genetic effect. Another aspect of the karma of kerma, then, is human (and other sentient beings') suffering, ill health and death, over very long periods of time.

Non-accidental Emissions

Transgenerational ecological torts pose a serious challenge to American jurisprudence. At the core of our legal system is the ancient maxim of res inter alias acta alteri nocere non debet ‹no one ought to suffer because of what others have done. Yet, if our predictive powers are correct, the man-made radionuclides released into the environment from the waste products of the 20th Century nuclear fuel cycle, even barring large or catastrophic releases, will produce very sizeable numbers of diseases and deaths in the human population over the course of the next several hundred millennia. The toxic materials produced by the fission of uranium emanate radiation that is invisible to the human senses. These materials will persist in radioactive forms for millions of years. Many are nearly impossible to contain. Releases to the human environment are certain. These releases are inexorably under way even as you read this and will continue, even if all nuclear power generation were stopped this afternoon.

Some of those who have examined this problem, such as the Committee on Science and Public Policy of the National Academy of Sciences, have resigned themselves to the inevitability that releases will occur, but are convinced that the effects should not be of great concern because the rate of release‹and corresponding injuries‹can be kept within some acceptable range.

> In none of the cases so far studied in the literature have alarmingly high values been estimated for the time-integrated population dose that people in the future might receive if buried wastes were to be leached by groundwater into the surface environment. Thus, while many authorities have called attention to gaps in our knowledge about some of the factors that bear on the probability and time scale of

> such eventual leaching, it is not necessary to strive for absolute assurance against escape. One can pursue the much more attainable goal of finding disposal sites for which the product of probability of escape by the consequences if escape occurs can be reasonably small 4

The fact that non-accidental (planned) emissions of radioactive wastes are expected to injure persons in the general population over extended time frames has been reported by standard-setting and advisory bodies in the United States atomic energy community for more than three decades. In 1981, the Nuclear Regulatory Commission published a notice in the Federal Register confirming that:

> ... the Commission's own estimates of nuclear power health impacts include a number of radiologically induced cancer deaths among present and future populations.5

In the estimates accompanying that statement, NRC calculated that a design performance fuel cycle6 required to support the production of 800 megawatts per year (one reference reactor-year) will result in an upperbound dose in the general population of 710 person-rem over the first 100-year period following the releases.7 When the NRC dose estimate was multiplied by the NRC cancer coefficient, NRC arrived at a figure of 0.1 lethal cancers and 0.2 genetic effects per reactor year.8 The Commission then estimated that 652 lethal cancers and 1,155 genetic effects per century would result from the wastes produced by normal operations of reactors now operating.9 Owing to uncertainties in the mathematical model used by NRC<due to the gaps in our knowledge<some authorities10 have suggested this figure could understate the full impact by 3 or more orders of magnitude (1,000 times).11

The Gaps in Our Knowledge

Some 240 radionuclides are considered to be significant by-products of the use of uranium fuel in fission reactors. Some of these isotopes, like radium-226 and uranium-238, have been studied for almost a century. Others have been studied very little. Much of what we would like to know for a reliable risk analysis is not merely unknown but, at least for the present, unknowable.

The biological response to some forms of radiation is not assessable down to the level at which damage is assumed to occur. Our knowledge of radionuclide environmental pathways is weak and our knowledge of biological migrations incomplete, giving us only a small picture of the much larger effect once radionuclides are released. The transport mechanisms between waste site and water or waste site and atmosphere, atmosphere and soil, soil and plant, plant and animal, and animal and human depend greatly on the characteristics of different isotopes, carrier molecules, geological constraints, hydrology, climates, seasons, soil varieties, plant and animal species, population demographics and diet, very few combinations of which have ever been examined. Deposition rates depend on air concentrations, but air concentration measurements are not accurate to the required degree of sensitivity, so filter efficiency or decontamination factors are usually calculated and air concentrations are extrapolated using a computer model. Even filter efficiency is not taken from actual experience, but rather from the efficiency of a comparable filter in trapping comparable materials for relatively short time spans, and filter efficiency varies to a large extent as a function of wear and burden. In the case of engineered geological barriers and synthetic waste mediums, laboratory tests are inconclusive and the vast time spans involved make in-situ testing impractical.

As Amory Lovins has observed, an error factor of 2 at each stage over a 20-step methodology results in a millionfold mistake.12 Once radioactive waste is placed into the environment and released from our control, we simply do not know what the level of human exposure will be over the long term.

Unknowable Effects

If the rate of exposure is unknown, so is the full potential for impact on human health. On the positive side,

> ... even if low level radiation can induce cancer and genetic effects, future discoveries in prevention and cure of cancer, and genetically related diseases and genetic engineering may negate many of these effects.13

Although predicting the course of scientific discoveries thousands of years into the future is indeed impossible, we mere mortals may nonetheless make educated guesses based upon known physics. There being no practical means in nature to prevent one electron from colliding with another, there will always be

radiation-induced cellular and genetic damage in the human population. True, the means may be found to eradicate cancer cells from the body and to repair immune system damage caused by radiation of the blood-forming tissues. However, when molecular damage is sustained in the procreative cells or in the developing embryo, birth defects or latent genetic damage may still result. For a great many, if not most, of the 943 dominant and 783 recessive diseases now known to be caused by radiation,14 there is no prospective "cure" for this effect, apart from induced abortion before birth, which may not be a desirable alternative to every prospective parent. Indeed, most genetic "abnormalities" are very subtle differences between one individual and another. The same abnormality may turn out to be something abnormally good or abnormally bad, depending on infinitiely variable and completely unpredictable influences. Still, most effects will be so common as to be indistingishable from the normal human condition, as the National Academy of Sciences observed in its 1972 BEIR Report:

> There is a danger that ... by concentrating only on fairly well-defined genetically associated diseases, we have dealt with only the tip of the iceberg. What about the rest of human illness? It, too, has some degree of genetic determination.
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> A genetic death may be the death of an embryo so early that no one ever knows about it, or it may simply be the failure to reproduce. On the other hand, it may be a lingering, painful death in early adult life that causes great distress to the person and his entire family.
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> We remind all those who use our estimates as a basis for policy decisions that these estimates are an attempt to take into account only known, tangible effects of radiation, and that there may well be intangible effects in addition, whose cumulative impact may be appreciable, although not novel.15

Most predictive models also make the assumption that the exposed population is homogeneous. In fact, there are subgroupings for susceptibility in the population, and equal radiation exposure can increase disease by five to ten times in the more susceptible groups over the less susceptible.16 All men are not created equal, and the burden of environmental radioactivity will fall more heavily on some than on others, depending on their genes. As the Nuclear Regulatory Commission has acknowledged,

> Because our present state of knowledge precludes all possible meaningful quantifications of the relative radiosensitivity of a given individual, it is true that persons are not necessarily equally "protected" by current federal regulations designed to protect the general population as a whole.17

Various Justifications

This failure of our regulatory scheme to equally protect all citizens is not considered, at least by the NRC, to be a constitutionally suspect defect, owing to the randomness of the injury:

> The protection of life in the Fifth and Fourteenth Amendments has been applied by the courts to proscribe government action taken with the overt purpose of depriving particular individuals of life. ... The Fifth Amendment does not proscribe all government activity which includes loss of life among its foreseeable effects.18

The Nuclear Regulatory Commission has been repeatedly placed in the unenviable position of having to justify the inequities of the federal nuclear program.19 In determining what level of harm to public health is

acceptable, the NRC has, like the National Academy of Sciences, at times suggested that cancer deaths that fall within the normal range of variation would be acceptable because they would be unobservable.
The 1979 population within 50 miles of a plant ranges from 7,700 to 17.5 million. The average (mean) is 1.7 million. Ninety percent of the plant sites have populations less than 4.1 million within 50 miles; half the sites (median) have populations less than 950,000 within 50 miles.
From the mean population figure of 1.7 million, the average number of cancer fatalities per year from non-nuclear causes is predicted to be approximately 3,200. For the average plant, the numerical guidelines permitting a 0.1 percent increase in delayed fatalities would allow no more than an additional 3.2 estimated fatalities. Thus, this guideline value is small with respect to the average number of predicted cancer fatalities per year for a population of 1.7 million. It is also small with respect to the geographic variation in cancer death rates. When applied to the mean population within a 50-mile radius of a power plant site, the annual cancer rate for Rhode Island (2.5 per 1000) would correspond to 4,300 cancer deaths per year, and the annual cancer rate for Virginia (1.6 per 1000) would correspond to 2,700 cancer deaths. Thus, the average number of 3.2 additional estimated deaths is small in comparison to a regional variation of 1,600 (i.e., 4,300 - 2,700) cancer deaths.20
This rationale underscores the inability of radiation victims to be compensated directly for individual claims. In a background of 4,300 cancer deaths annually, the 3.2 victims of nuclear radiation vanish in a tide of human suffering.
Another approach frequently used by NRC is comparative risk analysis:

> . . other risks are apparently acceptable, perhaps fatalistically, in that lives lost in construction accidents, transportation accidents, mine accidents, etc., which result in much greater numbers of real and immediate deaths than the latent potential cancer deaths due to radiation are relatively unprotested.

This approach is gaining greater use in many areas of regulation. In its various forms, it suggests that if we can tolerate 50,000 highway deaths annually, we should be willing to tolerate catastrophes of comparable magnitude less frequently, or that if you drink two glasses of wine per year, smoke three cigarettes, own a canoe or cross the street against the light, you have no business protesting a toxic waste dump. The methodology often fails to distinguish between voluntary assumption of risk and involuntary risk, between governmental imposition of risk and private risk-taking, or between those things which people choose to protest and those which they merely quietly resent or never consider.
Our governmental agencies have on occasion placed much reliance on these philosophical shortcuts. However, future peoples may well not wish to be limited to the levels of risk which 20th Century Washingtonians endured, any more than one of us might wish to live with the levels of pollution endured in 19th Century Pittsburgh or 18th Century London.
An important threshold question that comparative risk assessment does not address is whether the health of individuals can or should be subordinated to the needs of the society as a whole. The Department of Justice and the Nuclear Regulatory Commission have argued that the issue is already settled as a matter of law:

> [I]f a single person exposed to a slight risk along with the rest of the community could insist as a matter of right on being spared that risk, then "the spectacle would be presented of the welfare and safety of an entire population being subordinated to the notions of a single individual who chooses to remain a part of that population." It seems fair to argue that [a right] asserted under the guise of constitutional due process [is] a right to subordinate to [an individual's] wishes the entire nuclear power program, otherwise duly established by Congress and intended to confer major benefits on the public at large. The Supreme Court in Jacobson refused to hold that such right existed. The Commission's similar conclusion seems every bit as soundly based.21

Challenged on the issue of the inalienability of the right to life, the Commission drew a distinction between the constitutional rights of particular individuals subjected to purposive deprivation and the environmental poisoning of people in general:

> The Commission would readily accept the proposition that [the Fifth Amendment] forbids the federal government to authorize or carry out without due process of law an activity which has the purpose of taking the lives of persons under the protection of the laws of the United States. The nuclear power program, however, is not such an activity. The purposeful taking of life has no part in the licensing of nuclear fuel cycle facilities. Any resulting harm is an entirely unwanted side effect to be minimized or eliminated where practicable, and the risks are distributed more or less uniformly among the public at large rather than directed by State action at particular pre-selected individuals or groups.22

These distinctions are the kinds of gymnastic sophistry that make people hate bureaucrats. The trouble is, as the late Lon Fuller once said, "in human affairs, what men mistakenly accept as real, tends, by the very act of their acceptance, to become real."23

The Challenge to Our Thinking

Imagine for a moment that you are a tender child born a few centuries from now and you were born missing a piece of your anatomy. By means of amniocentesis, your mother's obstetrician knew well in advance that you would have this defect, but your mother insisted that your birth was warranted despite the difficulty you would have in life. To be sure, a bionic prosthesis will mitigate your suffering, but somehow, it's just not as good as the natural part. Then one day, through the wonders of science, you learn that your deformity can be traced to your mother's inhalation of a microscopic plutonium compound which is known to emanate from only one source: an ancient 20th Century nuclear waste repository.

How do we in this generation go about compensating those in future generations whom we know we shall, in the fullness of time, grievously wrong? To what expense of present peoples are we willing to go to protect those for whom actual existence is not yet established? Should we discount the value of their lives, which are not real, in relation to the value of our lives, which are real?24 Should we appreciate the value of future lives?

What are they then? They lack the individuality that we often associate with the sacredness of life, and may at first thought seem to have only a shadowy, mass existence. Where are they? Are they to be pictured lined up in a sort of fore-life, waiting to get into life? Or should we regard them as nothing more than a pinch of chemicals in our reproductive organs, toward which we need feel no special obligations? What standing should they have among us? How much should their needs count in competition with ours? How far should the living go in trying to secure their advantage, their happiness, their existence?25

When we contemplate the rights of future peoples, it may not be sufficient to confine our thinking to the limited framework of our present laws. Rather than struggling to project all possible future legal constructs, however, we can examine just a few of the common threads that bind all of our civil relations, in the hopes of finding those things which are sufficiently objective and absolute as to likely form a basis for future social constructs.

Morality

If a person becomes outraged that nuclear waste is creeping into their own or their child's body or has given their child a birth defect which was anticipated, that outrage first takes the form of moral indignation. "It's immoral!" they cry. But is that a valid argument?

Moral authority derives from the concept that humans can agree that certain modes of conduct are right or wrong. The Ten Commandments were a codification of moral authority. In modern thought there is a divergence between those who believe moral codes are matters of fact and those who relegate morality to questions of opinion. Authority carries very little authority when it arises solely from opinions. Moral authority does not. It is by its very nature, absolute.26

Our society was founded on faith in the absolute quality of moral authority. The basis for our social contract is that each of us desires something that we by nature need and in order to obtain it for ourselves, we are willing to accord to others the same entitlement. If we can agree to the premise that humans generally recognize their individual existences and seek to preserve and prolong those existences, we can

all agree that individual self-preservation is a commonly recognized and verifiable higher good. As Mortimer Adler observes,

If all goods were merely apparent, having the aspect of the good only because this or that individual happens to want them, we could not avoid the relativism that would reduce moral judgments to mere opinion. Having no hold on any truth about what is right and wrong, we would be left exposed to the harsh doctrine that might makes right.27

Adler, after Aristotle, says that those things which are really good are all things to which we have a natural right. Our natural rights are therefore rights to the things that we need to live healthy, useful, happy lives. But Adler cautions us to separate true happiness from merely psychological or momentary states of contentment.

> With happiness conceived as contentment, its transient and shifting character, changing from day to day with changes in an individual's wants and shifting from wants that are satisfied to wants that are frustrated, makes happiness so variable and impermanent a goal that no government could possibly aid and abet the pursuit of happiness for all its people. Nor could it pledge to promote the pursuit of happiness for everyone on those terms, since the conflicting wants of different individuals would make it impossible to enable all to satisfy their wants.
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> The pursuit of happiness, thus conceived, consists in the effort to discharge our moral obligation to seek whatever is really good for us and nothing else unless it is something, such as an innocuous apparent good, that does not interfere with our obtaining all the real goods we need.28

Electricity is excluded from the universe of rights to which we are naturally entitled, but not because Aristotle was off the grid. Electricity is a mere conduit for our pursuit of happiness, and no more.29 It is something that elevates our contentment, but is not truly necessary for a healthy, happy, moral and useful life. It is not something that we by nature need, but rather it is one means by which those real needs are met. Would you not still read this by candlelight if electricity were not available?

Natural Rights

The conception of natural rights, then, is an essential thread in the cross-generational legal fabric. At the first Continental Congress in 1774, the delegates adopted a declaration proclaiming to the world that:

> ...the inhabitants of the English colonies of North America, by the immutable laws of nature, the principles of the English Constitution, and the several charters or compacts, have the following rights: ... That they are entitled to life, liberty, and property, and that they never ceded to any power whatever, a right to dispose of either without their consent.30

When they met again two years later, the delegates affirmed that the basis of their ideal government, and indeed, any government, was mutual consent.

> We take these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain inalienable Rights, that among these are Life, Liberty, and the pursuit of Happiness.‹That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed,‹That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most like to effect their Safety and Happiness.31

Consent is a thorny problem when we speak of the rights of future peoples. Even if we discard any notion that future people may have statutory or constitutional rights, we are, by our heritage and the moral basis at our foundation, obligated to recognize their natural rights.

There are acts which the federal or state legislature cannot do, without exceeding their authority. There are certain vital principles in our free republican governments, which will determine and overrule an apparent and flagrant abuse of legislative power; as to authorize manifest injustice by positive law; to take away that security for personal liberty, or private property, for the protection whereof the government was established. An act of the legislature (for I cannot call it law), contrary to the first great principles of the social compact, cannot be considered a rightful exercise of the legislative authority....32

How then do we obtain the consent of future peoples to bear the burdens<be they health, economic, weapon-related or other<of the nuclear wastes we are generating? Clearly we cannot. We have not left the world as wholesome as it was before we split the atom.33 The karma of kerma is an enduring diminution of natural rights.

Compensation

At public hearings on these issues, it has frequently been suggested both by members of the public and by public officials that some suitable compensation to future peoples might make their unwanted burden more acceptable.34 The idea of somehow contracting with future peoples on terms we would find mutually agreeable would strike many as rather arrogant. As Professor Bruce Ackerman has observed,

I do not see any good reason to be bound by deals that might be reached by somebody who wasn't me; and calling the deal a "social contract" only serves to obscure the fact that no flesh-and-blood creature could ever in fact have bargained his way to the "contract"35

Setting aside the inability of general social indemnifications to adequately compensate individual victims, what benefits would we propose to confer in exchange for the costs we intend to impose? Some commentators have suggested that the benefits brought about by the generation of nuclear electricity ultimately inure to the interest of future generations.36 This is a risky proposition, because the economic and social benefits of the technology are yet unproven and over the long term any or all of them may prove to impose a net deficit. Moreover, a number of little understood concomitants to nuclear power, such as the proliferation of nuclear weapons technology, a tightening of state security, and heightened state secrecy, pose substantial potential costs to future peoples. The benefits are largely devoured within the second they are produced. The tangential advancements in science and engineering would probably have been achieved anyway, although perhaps more slowly (and that might even have been better).

Many commentators have advocated a simple cost-risk-benefit calculus that assigns a set worth both to the risks, in terms of lives lost or shortened, and to the benefits, in terms of power generated, leverage gained, science advanced, and detriments foregone (e.g.: acid rain, global warming, loss of species habitat). This approach was in general use by most federal agencies and many state governments even before it was federally mandated by President Reagan in 1981.37

The overwhelming deficiency of the cost-benefit analysis approach is its reliance on utilitarianism to the exclusion of all other value systems. As one state regulator has observed:

The underlying assumption of utilitarianism is that an option should be chosen that creates the greatest happiness for the greatest number of people. Since an efficient market maximizes happiness by satisfying the greatest number of individual preferences, the economist usually asserts that the option which maximizes the efficiency of the market place is the "optimal" solution. This is a utilitarian formulation of the good. It is a different formulation than other ethical formulations, and to the extent that the value assumption is not identified and remains hidden, the ethical basis for the final decision is never exposed, and other viable approaches are completely ignored.

The utilitarian approach raises additional ethical problems that cannot easily be answered from within a utilitarian system. A utilitarian, for instance, must decide what alternatives will be entertained in the utilitarian calculus, which consequences of a given action will be considered, whose assessments of harms and benefits will be allowed, and what time scale will be used in assessing those consequences. 38

Concepts of rights, mercy, justice, wisdom, openness, and due process, which have traditionally been regarded as fundamental components of public policy, have little or no relevance in the calculus of the risk analyst, who is concerned with isolating objective facts and making mathematically consistent proofs. In the nuclear risk sciences, these analysts tend to be inbred with a sense of higher purpose which causes them to discount public protest as irrational and emotional, or at best, outweighable. Even the term "risk" reveals

a bias, because it confuses actual deaths or injury to real living people with slight threats to a much larger population at "risk."

What Value Life?

The inadequacy of the utilitarian analysis is readily apparent when looking at the efforts to assign a dollar value to one human life. The Nuclear Regulatory Commission has been doing this tentatively since 1975, when it adopted Appendix I to 10 CFR Part 50. That guideline provided that the benefit of any design change in a licensed nuclear facility should be compared with the associated costs on the basis of $1,000 per man-rem averted. According to the NRC:

> ... $1,000 per man/rem would be equivalent to $10,000,000 per life saved, on the assumption that a 10,000 man-rem exposure results in one (statistical) fatality. ... If the population outside the 50-mile zone is included, the proposed guideline would typically be equivalent to a little less than $5,000,000 per life saved. This value is higher than values calculated for actual and proposed life-saving activities in other (non-nuclear) regulatory contexts (e.g., highway and automobile safety, air pollution, carcinogens in drinking water), where the estimated costs per life saved were found to range from zero to as much as a few hundred million dollars, with most values below $200,000 per life saved.39

Actually, the $10,000,000 per life figure is at one end of the range of possible mathematical outcomes, depending on what values are assigned to cancer-risk per person-rem, dose conversion coefficients, and other factors which are the subject of scientific controversy.40 At the other end of the possible range, the dollar value per life could be just that one dollar.

The problem is, who among us would take any amount of money for their life? By what authority is it taken away? Like an irresistible force meeting an immovable object, the concept of the greater good for the many runs smack into the concept of the inalienable rights of each individual. At present, in matters involving nuclear power, our governmental agencies take the side of the irresistible force.

> This Commission does not sit as an arbiter of any national morality alleged to exist apart from the Constitution and the laws of Congress, which each Commissioner is sworn to uphold. Nor does any other Commission. Nor does any Court. While the Commission brings its best judgment to the task of applying the phrases "adequate protection" or "no undue risk" to individual cases, we do not do so in a vacuum.
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> The benefit provided by nuclear power, generation of electricity, is clearly of great value to society. Although the program is not free of hazards, the risks to any individual are slight. The number of deaths estimated to result from the nuclear power program is extremely small compared to the number of persons benefitted, and it may be expected that all reasonable means to reduce the health impacts still further will be taken as they are discovered. 41

We could just say that what we are doing is killing people<let history judge us. To imbue it with psuedoscientific mumbo jumbo is nonsense. Cost-risk-benefit analysis simply should not be applied where human lives are concerned. Human lives are beyond value.42

The contemporary bureaucratic adherence to utilitarian values may run contrary to the values which have currency in future centuries. One need only look back a few centuries to see the contrast, as in Virginia's Constitution of 1776:

That all men are by nature equally free and independent, and have certain inherent rights, of which, when they enter into a state of society, they cannot by any compact deprive or divest their posterity; namely, the

enjoyment of life and liberty, with the means of acquiring and possessing property, and pursuing and obtaining happiness and safety.
Or when Thomas Paine wrote:

> Every age and generation must be as free to act for itself in all cases as the ages and generations which preceded it. The vanity and presumption of governing beyond the grave is the most ridiculous and insolent of all tyrannies. Man has no property in man; neither has any generation property in the generations which are to follow.43

Edmund Burke viewed the fundamental liberties as

> ... an entailed inheritance derived to us from our forefathers, and to be transmitted to our posterity; as an estate specially belonging to the people of this kingdom, without any reference to any more general or prior right.
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> [T]he temporary possessors and life renters ... should not think it among their rights to cut off the entail, or commit waste on the inheritance ... [lest they] leave to those who come after them a ruin instead of a habitation.44

Premises considered, logic would dictate that the government of the United States departed from its foundation principles when it embarked upon the nuclear electricity enterprise.45 Successor administrations are now saddled with the unhappy chore of randomly administering potentially lethal doses of radiation to future members of the global human population over the course of untold millennia. The federal government regains a measure of moral authority by engaging in efforts to reduce these effects as best it can. But whenever it balances those ennobling efforts against the real world constraints of the national treasury, the press for a political solution, or the retarding influence of its cost-benefit calculus, it hazards what little moral authority it has left. The karma of kerma is an erosion of fundamental tenets<the moral force of our legal system. The danger of this should not be underestimated.

> The continued existence of a free and democratic society depends upon the recognition of the concept that justice is based upon the rule of law grounded in respect for the dignity of the individual and his capacity through reason for enlightened self-government. Law so grounded makes justice possible, for only through such law does the dignity of the individual attain respect and protection. Without it, individual rights become subject to unrestrained power, respect for the law is destroyed, and rational self-government is impossible.
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> The possible loss of that respect and confidence is the ultimate sanction. So long as its practitioners are guided by these principles, the law will continue to be a noble profession. This is its greatness and its strength, which permit of no compromise.46

Solutions

Cost-benefit analysis may have its place when we are comparing one machine with another but falls short when we try to debate the relative worth of present and future values. Frank P. Grad gives the more practical example of letting cost-benefit analysts choose between seat belts and air bags, but urges that any scientific analysis be challenged when it goes beyond its limits. He recommends that concerned parties employ expert testimony to contest agency calculations that threaten to impose a tyranny of numbers.47

Donald A. Brown would concur with Grad that citizens must assert their rights to participate and to oppose the narrow utilitarian calculus of agency decisions. Brown goes on to urge:

> Experts and concerned citizens must realize that crucial policy choices concerning environmental pollution, nuclear power, and toxic chemicals are value judgments, matters of morality, social and political judgments. In a democracy these judgments should not be made by "experts," but rather by the people and their elected representatives.48

The problem with both of these approaches<participation in rulemaking and votingis that they have met with very little success in relation to the nuclear debate. For example, the deficiencies in applying cost-benefit approaches to value judgments which dispose of lives of present and future peoples were identified and raised by Jeannine Honicker in her comprehensive rulemaking petition to the Nuclear Regulatory Commission in 1978.49 Mrs. Honicker argued:

> It is known that the nuclear fuel cycle as a means to generate electricity produces enormous quantities of long lived ionizing radiation, much of which cannot be, and is not, isolated from the biosphere which mankind inhabits. Life threatening experimentation on citizens without their 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. 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.50

After an extended procedural battle that went before some 24 federal judges, including en banc hearings in two circuits, and four trips to the United States Supreme Court, Mrs. Honicker was informed that:

> For the reasons we have discussed, some deaths from activities with the scope and value of nuclear power are "acceptable," at least in the sense that the Congress, the Executive, and the Judiciary know about them and accept them.51

The same concerns raised by Mrs. Honicker have been raised by citizens in rulemakings on radiation protection standards (10 CFR 19),52 deregulation of consumer products made from smelted alloys containing radioactive wastes, and the NRC's safety goal.53 They have been raised in numerous intervention proceedings54 and at public forums on radioactive waste management. 55 The usual administrative response to these concerns, when there is any, has been to deem them outside the scope of agency consideration.56

There is a presumption in law that favors agency determinations when the agency is being challenged in an area of its special expertise.57 Unless a federal agency has acted clearly beyond the bounds of reason, this presumption serves to insulate agency determinations in matters of a complex, technical nature. Because of the complexity of nuclear science, this presumption is particularly strong where judicial review of decisions by the Nuclear Regulatory Commission and the Department of Energy are sought. This was the fate shared by Mrs. Honicker and many of the others who have brought court challenges to the imposition of a federal utilitarian ethic.58

A frequent response of the agencies is to defer to experts, such as the National Academy of Sciences. At an Academy forum on radiation risks, I posed the following question:

What is the process, what is the mechanism, for assessing the acceptability of risks? Is this process scientific or political, and is it democratic? Considering that you are giving risks to persons in future eras, is that ethical?

Dr. Arthur C. Upton, Director of the National Cancer Institute, replied:

I think that the issue as to how one determines what is an acceptable situation must be a public issue, and the public must have as much information as objectively presented as possible, so that it can decide for itself what it will and will not accept.

To which the moderator, Daniel E. Koshland, Jr., Chairman of the General Advisory Committee of the National Academy, added:

The ultimate power in a democracy rests with the people and that is going to be the final decision ... The Nuclear Regulatory Commission cannot impose something that the voters don't want.59
In this instance, the experts deferred to the informed judgment of the voters, which meant, for all practical purposes, to the judgment of their elected representatives in Congress. The agencies also like to point to Congress, frequently finding justification for their independent value judgments in a Congressional authorizing statute, even when the phrases most often relied upon are couched in vague terms.60 For its part, Congress often prefers to rely on the developing expertise of the federal agencies and of the National Academy of Sciences. We are left with a vision of a cluster of monkeys, sitting in a circle scratching each other's backs, and pointing their fingers in each other's direction.
Even the courts, when not deferring to the judgment of the agencies, are frequently inclined to defer to the wisdom of Congress, as Justice Rehnquist did in Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council :

> Nuclear energy may some day be a cheap, safe, source of power or it may not. But Congress has made a choice to at least try nuclear energy, establishing a reasonable review process in which courts are to play only a limited role. The fundamental policy questions appropriately resolved in Congress and in the state legislatures are not subject to reexamination in the federal courts under the guise of judicial review of agency action. Time may prove wrong the decision to develop nuclear energy, but it is Congress or the States within their appropriate agencies which must eventually make that judgment.61

Under the U.S. Constitution, the legislative branch does bear primary responsibility for protection of the public health and welfare. Unfortunately, at the time Congress made its fundamental determination to go forward with commercial-scale nuclear energy, very little was known about the invisible, latent effects of radiation.62 The Joint Committee on Atomic Energy reported:

> Operation of atomic reactors, whether for power or for fissionable material production, involves some degree of hazard from radioactivity. One of the questions explored briefly during the hearings was how these hazards might be minimized and the practices of the industry with regard to them regulated. * * * With the normal operation of any of the designs now in sight, the problem of safety of the operators or the nearby people is entirely one of shielding, which is a straightforward engineering problem.63

Since that time, the die has been cast. Congress has never debated the propriety of depriving future citizens of their lives in order to produce electricity for those now living.64 The installment plan has already been rung up on the register of time. But even if Congress were to take up this debate, is it the proper forum? Congress is governed, in the final analysis, by majority rule. Future generations do not send representatives to Congress. They do not vote. They are truly a silent majority.
As William Blackstone said, "civil liberty, rightly understood, consists in protecting the rights of individuals by the united force of society." The genius of the American Bill of Rights was the protection of the individual from the will of the majority. Congress may not be the proper vehicle for that great pure effort. As the President's Nuclear Safety Oversight Committee reported after the accident at Three Mile Island:

> Nuclear power plants' threat of mortalities and morbidities to unidentified individuals in a larger population ... may be specified precisely in terms of expected deaths and injuries per unit of electricity generated‹a task straightforward in logic, though difficult in application.
>
> * * *
>
> Behind [vague] legislation lies a realistic assessment of the risk to a politician of responsibility for a threat that could become a reality. In bureaucracy, the

> congressional instinct for avoiding blame is compounded by the necessity to have rules that can be applied in a uniform fashion. As a consequence, the recent history of regulation has frequently been a saga of stalemate. In few areas is this more evident than in the regulation of nuclear power.65

Getting Out of the Loop

If you were to ask the Framers of the Constitution into whose bailiwick this thorny problem goes, they would undoubtedly be inclined to view the protection of individual rights as the proper province of the Judiciary. Alexander Hamilton wrote:

> It is not otherwise to be supposed that the Constitution could intend to enable the representatives of the people to substitute their will for that of their constituents. It is far more rational to suppose that courts were designed to be an intermediate body between the people and the legislature in order, among other things, to keep the latter within the limits assigned to their authority.
>
> * * *
>
> This independence of the judges is equally requisite to guard the Constitution and the rights of individuals from the effects of those ill humors which the arts of designing men, or the influence of particular conjunctures, sometimes disseminate among the people themselves, and which, though they speedily give place to better information, and more deliberate reflection, have a tendency, in the meantime, to occasion dangerous innovations in the government, and serious oppressions of the minor party in the community.66

Hamilton saw the judicial role in much broader terms than did Justice Rehnquist in the Vermont Yankee decision. It was Hamilton's view that limitations on federal power to restrict the natural and inalienable rights of the individual were guarded only by a resolute Judiciary:

Limitations of this kind can be preserved in practice no other way than through the medium of courts of justice, whose duty it must be to declare all acts contrary to the manifest tenor of the Constitution void. Without this, all the reservations of particular rights or privileges would amount to nothing.67

Conclusion

The reality that intrudes upon our reverence for our rights is that we have generated vast amounts of deadly nuclear waste and have to do something with it. A point which I want to be sparing with is that we are still generating it as if we had solved the problem or were confident that there was a technical or engineering solution when we now must truly recognize there is not and never will be. As a matter of fundamental equity, we must try to do the best we can by a bad situation. And that doesn't mean a balancing test, necessarily. We may have to go all out. Having recognized the fundamental unfairness of inflicting injury upon the innocent and unrepresented peoples of the future, we can only, in fairness, strive to limit the damage to the full extent of our national abilities.

As our nation rests in its momentary hiatus from issuing new nuclear plant construction permits, it would be an appropriate time to rethink more than just the design of the light water reactor. We should also consider imposing a new, albeit traditional, test upon all future applications for federal authority to engender random human injury in the public interest.

Where rights to be protected are clearly enumerated, are "so rooted in the traditions and conscience of the nation as to be ranked as fundamental,"68 or are "implicit in the concept of ordered liberty,"69 so that failure to protect them would mark a departure from first principles, the grant of a federal license should be conditioned upon the demonstration of an overriding interest of compelling importance,70 the absence of less damaging alternatives for meeting that interest,71 and some method of limiting or restricting the scope of the excursion and redressing the injustice created.

Technological hazards arise as a consequence of endeavors to satisfy societal needs and wants. Such hazards can sometimes be reduced by changing societal wants, by choosing a different technology to satisfy the wants, or by improving the technology to eliminate the hazard. We should force ourselves to thoroughly examine such alternatives in the future before embarking upon any new governmental endeavors, or putting new wrinkles on old endeavors, which carry transgenerational health impacts. The effects which we have identified as irreducible and irremediable will not be without some countervailing benefit to future peoples if we seize upon them as unfortunate steps to a lesson learned and modify our behavior accordingly.

Footnotes

1 Prior to 1966, Atomic Energy Commission guidelines did not permit siting a nuclear reactor within 25 miles of a population center of 25,000 or more people. See: AEC/TID 14844 (1962). In 1966, the AEC discarded this rule in order to site Consolidated Edison's Indian Point, New York reactor. However, spatial inequities are subject to some individual mitigation, as the NRC staff noted in 1979: "... in a real sense, there is some choice regarding the risk of nuclear power, since an individual can select his living location so as to be in a lower risk group than those living near a power plant." Responses to Questions to Staff Relevant to the Honicker Petition, September 1979.

2 Gofman, J.W., Radiation and Human Health (San Francisco: Sierra Club Books, 1981), 23.

3 One concept of the genetic mutation process put forward by the National Academy of Sciences in the 1972 BEIR Report (infra note 14) employed a line of nucleoproteins in a normal sequence something like this: AGT-AGT-AGT-AGT-AGT-AGT-AGT.... In this model the DNA code is read and transmitted in groups of three proteins. Consider what happens if the sequence is disturbed, such as when a speeding electron destroys one protein in the chain. The entire sequence is thrown off until two counterbalancing breaks occur that throw it back into correct order. Until then it is read: AG-TAG-TAG-TAG-TAG-TAG-TAG.... Suppose the AGT sequence was for brain cells, but the TAG sequence was for stomach muscles. You could get something pretty weird happening. It may have been from mutations such as these that all of us evolved. As a species, we arrived at our present form by selection of favorable mutations and elimination of unfavorable mutations, which is not to say it was a pleasant process for those individuals with the unfavorable mutations. The rate of genetic translocations in humans caused by ionizing radiation and estimated in the current the scientific literature ranges from 24 to 1,330 translocations per rad per million live births per generation. See Gofman, supra, note 2, at page 844. Gofman also observes that it could take on the order of 100 generations to eliminate each unfavorable mutation from the human genetic pool. Biostatistician Rosalie Bertell has therefore suggested that elevation of the background level of mutagens in combination with mutations which interfere with normal reproduction could result in sudden species extinction, which we could be powerless to counter. Bertell, R., No Immediate Danger (Summertown, Tenn: The Book Publishing Company, 1986), 44.

4 National Academy of Sciences, Risks Associated with Nuclear Power: A Critical Review of the Literature, Summary and Synthesis Chapter (Washington: Academy Press: 1979), at 148.

5 46 Federal Register 39573, 37579, col 1. (August 4, 1981).

6 "Fuel Cycle" refers to the mining and milling of fissionable ores, the fabrication of fuel, the fission of the fuel in reactors, the disposal of the effluents and waste, and the transportation, storage and handling processes that accompany each of these stages.

7 Nuclear Regulatory Commission, SECY-78-560 (1978), at 14. However, as a number of analysts have observed, the estimate of man-rems per RRY is fraught with controversy. See, e.g.: Gofman, Radiation and Human Health, supra note 2; and Bertell, R. Handbook for Estimating Health Effects from Exposure to Ionizing Radiation 2nd Ed. Revised (Toronto: Inst. of Concern for Public Health, 1986).

8 The NRC's 1976 coefficient of 135 cancer deaths per million person rem (NUREG-0002) lies toward the lower end of a range of estimates used by scientists of from 100 (United Nations Scientific Committee on the Effects of Atomic Radiation [UNSCEAR] Report, 1977) to 7,500 (Mancuso, T.E., Stewart, A., and Kneale, G., Radiation exposures of Hanford workers dying from cancer and other causes, Health Physics 33:369, 1977) cancer deaths per million person rem. This author prefers to rely on the full range of estimates appearing in the current scientific literature to express the potential for harm, although,

admittedly, if error bands were assigned, the range might have to be expanded by another order of magnitude. Commonly applied values in the range of estimated cancer effects are:

Cancer deaths per million person-rem

Source	Yr of Publication	Range
UNSCEAR	1977	75-175
NRC	1982	100
NRC	1976	135
BEIR I	1972	177-353
BEIR III	1983	359-719
ICRP	1984	600
Morgan	1981	900
Bertell	1982, 1986	549-1648
Gofman	1981	3333-4255
Mancuso	1977	7500

From the lower end of the range to the top end of the range is a span of 2 orders of magnitude (100 times), which reflects considerable scientific uncertainty.

9 Nuclear Regulatory Commission, Final Generic Environmental Statement of the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Reactors (GESMO), NUREG-0002 (1976). See too: 46 Fed. Reg. 15167. By "wastes," I mean to refer to all solid, liquid, and gaseous effluents placed into the environment by all commercial nuclear fuel cycle facilities in the United States.

10 These authorities were reviewed at length in the Honicker Petition for Emergency and Remedial Action on file with the Nuclear Regulatory Commission and published in book form as Honicker v. Hendrie: A Lawsuit to End Atomic Power (Summertown: Book Publishing Company, 1978). However, the staff of the Nuclear Regulatory Commission, responding to the Honicker petition, noted: "If the same assumptions used by the staff in treating long-lived radioactive trace metals were applied, the stable trace metals would remain in the biosphere forever, with calculated health effects approaching infinity. Clearly, such calculations have little meaning and only serve to obscure real problems in need of solution today." It is not my intention to exclude stable metals from consideration, but rather to focus this article on the radioactive component of the wastestream. I am, nonetheless, equally concerned with our cultural decision to bequeath many non-radioactive environmental hazards to future peoples.

11 See: Bates, A., Shutdown: Nuclear Power on Trial, 2d Ed. (Summertown: The Book Publishing Company, 1979). I would suggest that the figure could be as high as 1,500,000 deaths per century when uncertainties, not including catastrophic accidents, are taken into account. As of January, 1988, the U.S. had generated 3.5 quadrillion watt hours of nuclear electricity, the equivalent of 500 reference reactor years. There are 109 nuclear power plants presently licensed for commercial U.S. operation or undergoing power-up. My estimate is based on the operation of these facilities alone.

12 "What appears to be a solid wall of meticulously verified empirical bricks proves on closer inspection to be a facade of holes strung together with bits of mortar." Lovins, A. Cost-risk-benefit Assessments in Energy Policy, 45 George Washington Law Review S:911 (1977).

13 Nuclear Regulatory Commission, Office of General Counsel, SECY-79-180 (1980).

14 National Academy of Sciences, National Research Council, Committee on the Biological Effects of Ionizing Radiations (BEIR-I), The Effects on Populations of Exposure to Low Levels of Ionizing Radiation (Washington: Academy Press, 1972), citing McKusick, V.A., Mendelian Inheritance in Man (Baltimore: Johns Hopkins Press, 1971).
15 Id. at 56-58.
16 Bross, I.D.J., and N. Natarajan, Leukemia from low level radiation; identification of susceptible children. New England Journal of Medicine 287:107 (1972); Bross, I.D.J., and N. Natarajan, Genetic damage from diagnostic radiation. Journal of the American Medical Ass'n 237:22-2399 (1977); Bross, I.D.J., and N. Natarajan, Cumulative genetic damage in children exposed to preconception and intrauterine radiation. Investigative Radiology 15:1 (1980).
17 SECY-78-560 at 47.
18 Nuclear Regulatory Commission, Denial of Petition for Revoking Nuclear Plant Licenses, 46 Federal Register 149:39573,39579 (August 4, 1981).
19 It is an unwanted role, as former Commissioner Gilinsky observed: "We shrink from making measurements in terms of an acceptable number of deaths per year. Yet we must have some kind of overall standard or goal; without it each nuclear safety problem is unique, each calls for a handwringing return to square one." Speech at Brown University, November 15, 1979. Former Commissioner Peter Bradford observed: "I know of no other area on this front between risk and technological capability where so many are involved so strongly as in nuclear power, nuclear waste management, and the relevant energy alternatives. It is an area which, handled correctly, will tell us much about what we believe in as a society and how those beliefs can be translated into governmental and technological decisions. Handled less well, it will be a signpost on a road to a level of alienation and frustration and governmental distance from the governed that no truly democratic society can survive for very long." Bradford, "How a Regulatory View of Nuclear Waste Management is Like a Horse's Eye View of the Cart" November 15, 1978.
20 Nuclear Regulatory Commission, Office of Policy Evaluation, Safety Goals for Nuclear Power Plants: A Discussion Paper, NUREG-0880, February 1982, p. 24.
21 Honicker v. United States, (D.C. Cir. No. 80-2006) Appellees Brief at 25, quoting Jacobson v. Massachusetts, 197 U.S. 11 (1905) (compulsory vaccination cases).
22 46 Fed. Reg. 39579.
23 Quoted in: R.S. Summers, Lon L. Fuller (Stanford: Stanford Univ. Press, 1984), 154.
24 For a discussion of discounting, see: Ramsey W., and M. Russell, "Time Adjusted Health Impacts from Electricity Generation," Harvard Journal of Public Policy 26-3: 387-403 (Summer, 1978).
25 Schell, J., The Fate of the Earth (New York: Alfred A. Knopf, 1982), 116.
26 Mortimer Adler, with much greater attention then I can devote here, draws upon John Locke, Thomas Aquinas, David Hume, Immanuel Kant, Epicurus, John Stuart Mill, Benedict de Spinoza, A.J. Ayer, Bertrand Russell and Aristotle before arriving at this conclusion. Adler, M.J., Ten Philosophical Mistakes (New York: MacMillan, 1985).
27 Adler, Id., 127.
28 Id. 134-135.
29 Adler also made this observation in a filmed seminar at the Aspen Institute in 1982. Moyers and Ewing, Six Great Ideas, (New York: WNET, 1982) Show #3, transcript at 12. Acknowledging Locke's second essay on civil government, Adler goes on to conclude that "Any action on [an individual's] part that injures the welfare of the community or another person is an illicit action, it is‹should be in some sense‹criminal action, and therefore prohibited. Id., Show #4, transcript at 5.
30 Declaration of Rights, First Continental Congress, Philadelphia, October 14, 1774.
31 Declaration of Independence, Second Continental Congress, Philadelphia, July 4, 1776.
32 Calder v. Bull, 3 U.S. (3 Dall) 386, 1 L.Ed. 648. See too: A. Hamilton, The Federalist, No. 78 (1788).
33 By the same logic, the world may have become less wholesome when we entered the Age of Industrialization, the Age of Modern Chemistry, or split the gene. Most of us would acknowledge that all of these developments have prolonged and enhanced human life generally, although some, such as the Old Order Amish and the Hopi elders, may disagree. My distinction here is between social benefits, which are consentual, and individual rights, which should not require consent. Insofar as other scientific advances have created transgenerational health injuries, they are equally subject to criticism.
34 See generally: Environmental Protection Agency, Proceedings of a Public Forum on Environmental Protection Criteria for Radioactive Wastes 30 March - 1 April, 1978, Denver, Colorado, EPA CRP/CSD-78-2 (May 1978); Nuclear Regulatory Commission, Workshop on Frameworks for Developing a Safety

Goal Held at Palo Alto, California April 1-3, 1981, NUREG/CP-0018 BNL-NUREG-51419 (June 1981); and Nuclear Regulatory Commission, Workshop on a Proposed Safety Goal Held at Harpers Ferry, West Virginia, July 23-24, 1981, NUREG/CP-0020 (Sept 1981).

35 B.A. Ackerman, Foreword: Talking and Trading 85 Columbia Law Review 5:899, 901-902 (1985).

36 Id. See too: S.L. DelSesto, Conflicting Ideologies of Nuclear Power: Congressional Testimony on Nuclear Reactor Safety, 28 Harvard J. of Public Policy 1:39-70 (1980).

37 Executive Order 12291.

38 Donald A. Brown, Ethics, Science and Environmental Regulation, 1987. Environmental Ethics 9:4: 331 at 337.

39 U.S. Nuclear Regulatory Commission, Office of Policy Evaluation, Safety Goals for Nuclear Power Plants: A Discussion Paper, NUREG-0880, February 1982, p 25-26, referencing: J.D. Graham and J.W. Vaupel, "Value of a Life: What Difference Does it Make?" Risk Analysis, 1:89-95 (1981).

40 Applying the full range of cancer risks from the table in footnote 8 to the calculation used in NUREG-0880, we derive this range for possible value per life:

Cancer deaths per million person-rem and Dollars per life

Source	Yr of Publication	Coefficient Used	Life Value in Dollars
NRC	1982	100	5,000,000-10,000,000
NRC	1976	135	3,703,703-7,407,407
UNSCEAR	1977	75-175	2,857,142-13,333,333
BEIR I	1972	177-353	1,416,430-5,649,717
BEIR III	1983	359-719	695,410-2,785,515
ICRP	1984	600	833,333-1,666,666
Morgan	1981	900	555,555-1,111,111
Bertell	1982	549-1648	303,398-1,821,493
Gofman	1981	3333-4255	117,508-300,030
Mancuso	1977	7500	66,666-133,333

However, the inexact cancer/radiation ratio is only one step in a very long chain of uncertain assumptions which might increase or decrease the values computed.

41 Nuclear Regulatory Commission, Denial of Petition for Revoking Nuclear Plant Licenses, 46 Federal Register 39573, 39580 (August 4, 1981).

42 Similarly, where the possibility of human extinction is raised, as it is with regard to the cumulative effects of genetic injury (see note 3), there can be no realistic counter-benefit raised. The act of self-extinction, unlike an individual act of suicide, renders all previous acts and events meaningless, there being no one left to endow any meaning. There can be no worth in any human effort which leaves no human remaining to derive that worth.

43 Thomas Paine, The Rights of Man, 1791.

44 Edmund Burke, 1803-27. Works, (16 Vols., London: Rivington Edition) V, 78.

45 There can be no doubt that in the United States, nuclear electricity is a governmental activity, despite the creation, in 1954, of our system of licensing public corporations to use fissionable materials commercially. All fissionable materials, patents, and ultimate control originated and still reside with the United States. The federal government likewise retains actual or reversionary ownership of all high-level nuclear waste

and complete legal responsibility for its safe disposal. The full extent of federal control became readily apparent in 1979 during the Three Mile Island accident, when the NRC, acting at the direction of President Carter, took effective charge of the two-billion-dollar private facility without any of the legal difficulties faced by President Truman in his seizure of the steel mills more than 25 years earlier.
46 American Bar Association, Code of Professional Responsibility, Preamble (1974). See also: L. Fuller, The Morality of Law, Rev. Ed. (New Haven: Yale Univ Press, 1964, 1969), 39-40.
47 Grad, F.P., Risk assessment and the tyranny of numbers, Journal of Environmental Law and Litigation 1: 1 (1986), at 10.
48 Brown, supra note 38, at 349.
49 Reprinted as Honicker v. Hendrie, note 10.
50 Abstract of Honicker Petition, supre note 10, at 1.
51 46 Fed.Reg. 39573, 39580.
52 51 Fed. Reg. 6:1092 (January 9, 1986).
53 Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards, An Approach to Quantitative Safety Goals for Nuclear Power Plants, NUREG-0739, October 1980.
54 Mrs. Honicker raised them herself in the licensing hearings and other meetings for the Hartsville, Sequoyah, Watts Bar, Yellow Creek, Bellefont, Phipps Bend, Zimmer and Clinch River projects.
55 At a public forum in Denver, Colorado in 1978, Tennessee nurse Mary Hubbard commented: "I think it's unconstitutional and inhumane to expose anyone to radiation without their knowledge and consent. I don't think most people would want to accept the risk if given the choice." A Kansas grain farmer, Ferdinand Burmeister, said, "The intent of the founding fathers of our federal government and our state government of Kansas was that people and private establishments have a right to obtain, maintain and retain their property as long as this right did not interfere with the rights of others... [A]buse has occurred so often that society tends more and more to become unconcerned about the implications, particularly that segment of society which is not adversely affected. Nevertheless, might does not necessarily make right, and the wishes of the majority are not necessarily best for any society, and the rights of the minority must be protected." Environmental Protection Agency, Proceedings of a Public Forum on Environmental Protection Criteria for Radioactive Wastes, ORP/CSD-78-2 (May 1978), p.110.
56 See: 46 Fed.Reg. 39573, et seq.
57 E.g.: Ford Motor Credit Co. v. Milhollin, 444 U.S. 555, 566 (1980); Ft. Pierce Utilities Authority v. United States, 606 F.2d 986, 995 (D.C. Cir.), cert. denied, 444 U.S. 842 (1979).
58 Honicker v. Hendrie, 465 F.Supp 414, aff'd 605 F.2d 556 (6th Cir.), cert. denied 444 U.S. 1072, 100 S.Ct. 1015, 62 L.Ed 2d 753 (1980); Honicker v. NRC, 590 F.2d 1207, 192 U.S. App DC 91, reh. denied (D.C. Cir.), cert denied 441 U.S. 906, 99 S.Ct 1995, 60 L.Ed 2d 374 (1979); Honicker v. United States (unreported by order of the court, reh. denied, D.C. Cir. No. 81-2006), cert denied, 459 U.S. 945, 103 S.Ct 260, 74 L.Ed 2d 203 (1982).
59 National Academy of Sciences, Proceedings of an Academy Forum: Radiation, How Dangerous Is It? Sept. 27, 1979 (Washington D.C.: Academy Press 1980).
60 The phrase the NRC frequently falls back upon is the "reasonable assurance of no undue risk to public health and safety" language found in section 182(a) of the Atomic Energy Act (42 U.S.C.§ 2235) and reiterated in 10 CFR§50.35(a)(4)(ii). See, for instance, the testimony of Harold Denton to the President's Commission on the Accident at Three Mile Island on August 23, 1979. That standard has been substantially misconstrued by the NRC to suggest a balancing test to determine what is reasonably "due" and what is "undue." The phrase was actually meant to apply only during facility construction. The standard for facility operation is much more strict: " a reasonable assurance that the activities authorized by the operating license can be conducted without endangering the health and safety of the public." Sec. 185 and 10 CFR§50.35(c)(2). The confusion may have arisen in the Office of Reactor Regulation because most environmental challenges to facilities have come during hearings on the construction permit. The legislative intention is made clearer by examination of the 1946 Atomic Energy Act. Where the 1946 Act used the phrase, "as far as practicable" in Section 1's declaration of purpose to promote the pubic health and welfare, the 1954 version deleted the phrase in favor a simple, mandatory order. In only one section of the Act is "protection" modified by the word "adequate," implying a balancing of interests: in section 182(a), "License Applications‹Contents and Form." Upon this use of the word "adequate" alone, the Commission today hinges its entire argument for Congressional authorization to inflict civilian deaths in present and future centuries. Yet, the Senate Report 1699 makes clear that the word "adequate" in section 182(a) is meant only to modify license information, not the public's protection. See Legislative History, "Atomic

Energy Act of 1954," Senate Report No. 1699, 83rd Cong. 2d Sess., in U.S. Code Cong. & Admin. News 1954, at 3458. The expectation of the 83rd Congress was that public health could be completely protected by well-engineered design and sufficient shielding. Any assertion that Congress may authorize the intentional deprivation of innocent lives in the general population in the furtherance of other federal objectives, without a strong showing of overriding need, would be constitutionally suspect.

61 435 U.S. 519, 557-558, 98 S.Ct 1197, 55 L.Ed 2d 460,488 (1978).

62 Declassified reports from the Manhattan Project show that senior health physicists knew or suspected that: "... the genetic effect has no threshold and exposure is not only cumulative in the individual, but in succeeding generations. On this basis, there would be no tolerance dose, but rather an acceptable injury limit." (Parker, H.M. Instrumentation and Radiation Protection, Health Physics 38:957, 970, June 1980); and, "Even sub-tolerance radiations produce certain biological changes (cosmic rays are supposed to have some biological effects), and so tolerance radiation is not what one strives to get but the maximum permissible dose." (Morgan, K.Z., The Responsibilities of Health Physics, The Scientific Monthly, 93 , August 1946; reprinted in Health Physics 38:949-952, June 1980). While these views were held privately by many top scientists, the official position of the United States at the time was that there was a threshold or "safe" level of radiation exposure, below which no health damage was anticipated.

63 Joint Committee on Atomic Energy, Atomic Power and Private Enterprise, Summary of Hearing before the Joint Committee, 83rd Cong. 1st Sess., December 1953, p. 17.

64 Although from time to time the matter does come up, as it did in this exchange between Monte Canfield of the General Accounting Office and Congressman Robert Drinan at a hearing before the House Subcommittee on Environment, Energy and Natural Resources on September 12, 1977:

MR. CANFIELD: The issue is whether or not you can develop a sufficient amount of consensus that sufficient precautions have been taken and that the amount of risk is relatively low relative to other alternatives. The genie, after all, is out of the bottle. Something has to be done with it ... The issue is one of relative risk and safety.

REV. DRINAN: Would you concede that ultimately the Courts will have to decide that? ...

MR. CANFIELD: I think it is almost inevitable that there will be litigation. Congress may choose to make some statutory changes which would speed up the litigative process, but I think that litigation is inevitable.

REV. DRINAN: I keep wondering: What is the test that should be proposed? How safe is safe? And in a certain sense, since the risk is there for thousands of years, maybe any risk is unwarranted.

MR. CANFIELD: I agree, but ... I think the question is to weigh the relative risks and decide,...

65 Nuclear Safety Oversight Committee, Governance of Nuclear Power (September 1981), p. 39.

66 Publius (Alexander Hamilton), Federalist No. 78, June 14, 1788 (New York: New American Library, 1961) pp 464-472.

67 Id.

68 Snyder v. Massachusetts, 291 U.S. 97, 105; Rochin v. California, 342 U.S. 165.

69 Palko v. Connecticut, 302 U.S. 319.

70 See Justice Harlan's dissents in Poe v. Ullman, 367 U.S. 497, 554 and Shapiro v. Thompson, 394 U.S. 618.

71 As the Supreme Court said in Shelton v. Tucker, 364 U.S. 479, 488 and again in Aptheker v. Secretary of State, 378 U.S. 500, 508: "even though a governmental purpose be legitimate and substantial, that purpose cannot be pursued by means that broadly stifle fundamental personal liberties when the end can be more narrowly achieved. The breadth of legislative abridgment must be viewed in the light of less drastic means for achieving the same basic purposes." In the case of nuclear energy in the 21st Century, federal dollars spent developing just one alternative, superconducting electromagnets to replace those in existing electrical generators and motors, could obviate all need for additional sources of electricity for the remainder of that century and make many, if not most, electrical generation requirements capable of being met by more benign sources such as wind, photovoltaic arrays and rainfall. See: J. Gleick, Superconductor May Yield Strongest Magnets, New York Times (March 18, 1987), pp. 1,12; and C.P. Shea, Renewable Energy: Today's Contribution, Tomorrow's Promise, Worldwatch Paper 81 (Washington, DC: Worldwatch 1988). As economist Charles Komanoff has observed, "Efforts to exploit our Saudi-size reserves of inefficient energy use will provide the greatest payoff among our energy options." From 1978 to 1986, the U.S. gross national product grew 19% while energy consumption fell 5%. In 1985 and 1986, improvements in energy efficiency contributed the equivalent of 5.1 quads (quadrillion btu) compared with 0.7 new quads from coal and nuclear sources(a 7 to 1 ratio in favor of substitutes for generation of power. C. Komanoff, Increased Energy Efficiency, 1978-1986, Science 239:128 (1988).

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