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RADIOACTIVE WASTE MANAGEMENT CRITERIA

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INTRODUCTION

This report proposes fundamental criteria for nuclear waste management and analyzes the basis for their development. The criteria proposed are goals whose achievement should be the function of a waste disposal program. Adoption of these criteria prior to commencement of that program is essential to assure that the program is designed to meet those goals rather than having the goals designed to meet the program.

The fundamental criteria related to the disposal of radioactive wastes are those that limit the release of the radionuclides to the biosphere and hence limit the induction by radiation of biological effects in the population. By limiting the dosage, they limit the induction of cancer and genetic damage in the population. Other specific criteria related to technical aspects of the disposal system and site would be derived from these fundamental criteria.

Because many of the radionuclides have very long half-lives, they will be capable of irradiating populations for hundreds and thousands of years into the future. Thus, while the effects on one generation might be small, the cumulative effects over many generations would be substantial. Thus, the fundamental criteria for radioactive waste disposal must include consideration of this intergenerational irradiation and effects.

Proposed nuclear waste disposal criteria are presented in the final section of this report. The first three sections of the report present the rationale and basis for the proposed criteria.

In the first section of this report, the role of mechanisms of individual decision-making and general social choice, as developed in the science of distributive economics, is discussed. This discussion reviews the fundamental principles limiting the applications of methodologies like cost/ benefit and risk/benefit analysis to problems of social choice, and shows how a failure to confront difficult tasks has resulted in the misapplication of these methodologies in nuclear waste programming. Appropriate application of the concepts of distributive economics to the nuclear waste problem demonstrates that the radioactive waste disposal criteria should present a posture of neutrality towards future generations. The second section of the report discusses the ethical perspective offered by religious groups and shows this to be consistent with this neutral posture. The third section discusses the interaction of the public at large with the government relative to previous nuclear and environmental decisions. Here again it is shown that this neutral posture (nondegradation of the environment) represents the only acceptable waste disposal criterion. It is also shown that it has been a frequent practice of the government when establishing protective standards in the nuclear area to set them at the level which can be achieved and not necessarily at the level that is required. The proposed criteria in the final section are responsive both to the goal of neutrality and, if adopted now, to the goal of setting criteria for the program to meet, rather than _vice versa_.

II. DECISION MAKING AND DISTRIBUTIVE ECONOMICS

Criteria for nuclear waste management should involve formal notions of decision-making and social choice. The following discussion examines how nuclear waste management criteria can be deduced from such notions. Arguments center not on maximizing the efficiency of power production for the present, but on questions of social choice between allocations of benefits and hazards over time. If the economic aspects of the issue were those treated in classical theories of micro-economics, there would be no issue at all: hazards from nuclear wastes dumped into the environment and left for future generations would be externalities and would be ignored by behavioral units such as firms and consumers.

Modern decision analytic science tries to "prescribe how an individual who is faced with a problem of choice under uncertainty should go about choosing a course of action that is consistent with his personal basic judgments and preferences."[1/] In order to use the procedures and techniques developed by decision analysts, the individual need only be rational, and satisfy a few consistency conditions. The essence of the rationality standard is that if the individual is presented with a number of possible outcomes of his decision, he must be able to express his preferences by making

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1/ Howard Raiffa, "Decision Analysis - Introductory Lectures on Choices Under Uncertainty," Addison-Wesley, Reading, Mass. 1970.

statements like "I prefer outcome A to outcome B," or "I am indifferent between outcome A and outcome B." The essential consistency condition is that the individual must be transitive in his preferences. If he prefers outcome A to outcome B, and prefers outcome B to outcome C, then he should prefer outcome A to outcome C.

The rationality and consistency constraints are imposed not to produce an analysis which suggests action along a recommended ideal but to allow an analysis to occur. They state merely that the individual can express how he feels about outcomes and would like to be consistent with those feelings. When these standards apply, formal decision analysis can be used to analyze a problem, and, via a long interactive process between analyst and decision maker, "solve" it in a way that is perfectly consistent with the decision maker's feelings.

If possible, it would be desirable to produce some sort of procedure by which a society can go about making decisions which are rational and consistent in a way analagous to the standards of individual decision-making. The study of such procedures is the domain of distributive economics. In particular, this science tries to develop procedures for societal decision-making which promote fairness and justice. Defining exactly what constitutes justice is part of the problem before distributive economists.

One measure of how just is a societal decision-making process is how accurately the process aggregates individual preferences into an overall expression, called a societal preference function. Decisions produced by society as a whole might relate to allocations of benefits and costs (such as wealth and hours spent working at a particular job) among members, or could relate to other societal actions conferring intangible benefits like budget allocations for research which might save lives in the future.

Procedures which society might use to make decisions could be various market mechanisms, government controls wielded by administrators, voting pricedures, or any other processes which result, implicitly or explicitly, in a decision being made. Distributive economists approach the problem in a general way, and try to infer general principles. Much theoretical work has been done to see if individuals' preferences can be aggregated to form an overall societal preference expression.[2,3,4]

A very general expression of this problem of finding a just way for society to reach decisions was produced by Kenneth Arrow.[3] Arrow assembled a simple set of assumptions which essentially stated that a group of individuals needed to choose among outcomes possible from the group's decision

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2/ Ralph L. Keeney and Howard Raiffa, "Decisions with Multiple Objectives: Preferences and Value Tradeoffs," John Wiley & Sons, New York, New York, 1976.

3/ Kenneth J. Arrow, "Social Choice and Individual Values," 1st Ed., 2nd Ed., Yale University Press, New Haven, Conn., 1951, 1963.

4/ Amartya K. Sen, "Collective Choice and Social Welfare," Holden-Day, Inc., San Francisco, 1970.

and wished to utilize a procedure incorporating in a rational and consistent way how each individual felt about the possible outcomes of the decision before the group. The assumptions allowed only procedures other than those where a single individual was dictator and imposed his preferences on the society. Arrow proved no such procudure exists, the result being known as Arrow's Impossibility Theorem.

Although Arrow's theorem seems to be a difficult obstacle to get around, modern analysis has extended theory in some interesting directions. It might be that Arrow's very fundamental consistency requirements are too strong, but Sen [4/] has shown there is no procedure for quantifying a group's preferences that does not include interpersonal comparison of preferences of the group's individuals [paraphrased from Reference 2]. It can be shown that interpersonal comparison of preferences requires some means of going to each individual in the society and quantifying his feelings about possible outcomes of society's decision in an expression which allows comparison with other people's feelings. These general results imply that if you want a decision to be fair to all affected by it, you must at a minimum have access to everyone's feelings about the outcomes. A fair allocation of risks and benefits between present and future generations would be one which would be picked by a group preference function which consistently reflected the preferences of all the members of the group, in this case, composed of people living in the present and in the future.

The theoretical conclusions apply to any methodology used to make decisions, including cost/benefit analysis, voting by individuals, market mechanisms, and so on. Their implication is that there is no way through which formal analysis or decision-making processes of any sort can certify that any course of action allocating hazards to the future will be seen as fair or agreeable by future generations. Fundamentally, this is because there is no way to consult anyone from future generations about his feelings on preferences of outcomes and risks.

Most people, however, would intuitively agree that there is some distribution of current and future risks and benefits which would be acceptable to present and future generations, if all parties could be consulted. At the same time, most people would also agree that there are many unacceptable distributions; considering the complexity of nuclear waste matters, a fair guess would be that there are many more unacceptable combinations loading risks into the future than acceptable ones. Talbot Page[5/] has suggested as much in his discussion of current uses of natural resources and the environment.

Since there are more unacceptable distributions than acceptable ones, a random guess on how the future might feel about a particular allocation would be more likely to saddle

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5/ Talbot Page, "Conservation and Economic Efficiency," Johns Hopkins University Press, Baltimore, 1977.

future generations with hazards they would prefer not to incur. Current analyses are no better than random guesses at how future generations might feel. Perhaps an analyst might convince himself that his ideas about future generations' feelings are accurate and non-random over 100 years, but is is unlikely that even an exceptionally arrogant analyst would feel the same about projections for 1000 years down the road.

By adopting a waste management program explicitly allowing releases in the future (thus exposing future generations to some hazards), it is more likely future generations will be wedged into a bargain they will dislike than one they will appreciate. To be fair to future generations, it is necessary that they be allowed to make their own decisions about safety. This means that allocations of benefits and hazards should be confined to the present generation, where at least those who are imposed upon by risk are available for comment.

It would appear that the above has gone through much theoretical discussion to reach a common sense conclusion. After all, most people accept that it is in general unfair to expose other people to risks without consulting them first. For example, a societal decision-making procedure for establishing automobile insurance coverage consisting of a single man being drawn at random and his insurance coverage being uniformly established for all individuals would be labeled unfair. Instead of this procedure, our society uses one trying to incorporate how individuals feel: a minimum level of insurance is established by elected representatives beyond which any person can contract for whatever level of insurance makes him comfortable.

The theoretical conclusions thus far reached are essential to understanding why some representations made by public officials on the acceptability of nuclear waste risks are false at the very core. For example, the Environmental Protection Agency (EPA) has suggested that levels of danger which may be imposed on future generations can be defined by referring to the acceptability of risks exclusively among the present generation.[6/] The EPA tried to justify this recommendation as fair by referring to social choice concepts, yet the EPA conclusion is obviously wrong because fundamental precepts of rationality and consistence require the incorporation of every involved individual's feelings into a group's decision if that decision is to be fair. Similarly, while the Nuclear Regulatory Commission (NRC) uses $1,000/man-rem as a value placed on human life, this in no way can be represented as a fair and reasonable measure of our society's group opinion. This figure's use in government programming demonstrates the bureaucracy's willingness to use any expedient value judgment, regardless of society's opinion

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6/ See, for example, Environmental Protection Agency (EPA), "Criteria for Radioactive Wastes, Recommendation for Federal Radiation Guidance," Federal Register, p. 53262, part IX, Nov. 15, 1978.

of its morality, if it may be concealed in implicit decision-making assumptions.

The conclusions of distributive economists give us an ideal goal for our radioactive waste programming: a totally neutral allocation of benefits and risks. This ideal result finds practical application in refuting the arguments that a present commitment to nuclear power is fair because investments in a technological society now via nuclear power will benefit the future as a result of an enhanced society more than they hurt as a result of waste hazards. From the results of formal reasoning, it can be seen that this argument requires weighing benefits now versus costs later to make an allocation which is known to be unfair. The ideal may be unattainable, but it is essential to minimize unfairness by the closest possible approach to neutrality with the future.

The practical result of distributive economists' impossibility conclusions is that society should strive toward making nuclear waste disposal neutral to future generations, in order to be as fair as possible. This is the underlying basis for the criteria developed in this report (pp.28-31). This posture is the most fair (or least unfair) goal for nuclear programming, and it results from a fundamental incapacity to fairly choose "right" allocations other than neutral ones.

III. RELIGIOUS PERSPECTIVES

A posture of neutrality was derived in the previous section by the introduction of justice and equity into the procedures of distributive economics. The concepts of justice and equity derive their meaning and significance from our religious heritage. In the discussion that follows, it will be shown that the posture of neutrality toward future generations is a minimum criterion that is consistent with this religious perspective. This discussion draws heavily upon materials prepared for or by the World Council of Churches and the National Council of Churches of Christ in the USA, two ecumenical groups that are currently examining Christian issues related to nuclear energy.

Roger L. Shinn in a discussion of decision-making in public policy issues where science plays a role, emphasized that every decision has two aspects: the objective, and the normative.[7/] The objective part of every decision relates to the body of scientific fact which exists independently of the ethical or ideological perspective of the decision maker. Shinn insists that the factual basis of problems must be ascertained before normative inputs are applied to make a decision:

> "Ethical decisions about energy, if they are scientifically uninformed, are likely to be foolish and irresponsible." 8/

7/ Shinn, Roger L. "Faith, Ideology and Science in Ethical Decision - Theological Reflections on the Nuclear Debate." Second WCC Consultation on Ecumenical Concerns in Relation to Nuclear Energy, Ecumenical Institutes, May 2-7, 1978, Celigny, Switzerland.

8/ Ibid., p. 2.

Shinn argues that the facts themselves do not make a decision; individuals or a society must apply their beliefs in reviewing the facts to come up with a decision. He warns against relying on factual or merely technological manipulation as a means of avoiding confrontations with ethical issues implicit in decisions:

> "This faith warns [Christians] against idolatries, including the idolatry of the "technical fix" as a solution to deep human problems." 9/

Shinn, applying Christian ideas, offers guidance relevant to the nuclear waste issue:

> "To jeopardize people and values for the sake of domination and greed is sin. To put others at risk, without their consent, for our own benefit is sinful." 10/

"The Ethical Implications of Energy Production and Use," a Study Document of the National Council of Churches (NCC) 11/ stresses in many places the need to consider the rights and participation of all people affected by a decision:

> "Human responsibility for future generations cannot be adequately met with an ethic that deals only with the rights of human beings who are presently alive." 12/

9/ Ibid., p. 9.

10/ Ibid. p. 6.

11/ D.S.C. Unit Committee, "The Ethical Implications of Energy Production and Use," Sept. 6-7, 1978, National Council of Churches Study Document.

12/ Ibid., p. 12.

> "An ethic of participation points to a guiding principle: the views of those who will be affected by a particular action ought to be considered." 13/

> "Participation includes representation of the interests of future generations." 14/

This same Study Document discusses another general criterion for decision-making applicable to nuclear matters - sustainability, which "refers to the earth's limited capacity to provide and to absorb the pollution."

It asserts:

> "Sustainability requires that biological and social systems which nurture and support life be neither depleted nor poisoned." 15/

This Christian perspective on nuclear energy issues argues for the inclusion in decision-making of all parties exposed to harm. It also implies non-degradation of the environment.

Of course, Christian ethics are not represented as being the only perspective religious thought has to offer in this matter, but the Golden Rule notion of doing unto your neighbor as you would have him do unto you is common to most religions in the world. Since most people would rather not be exposed to risk involuntarily, the Golden Rule also argues for the inclusion in decision-making of all parties exposed to harm.

13/ Ibid., p. 23.

14/ Ibid., p. 23.

15/ Ibid., p. 14.

Christian ethics as discussed by World Council of Churches and National Council of Churches documents and the Golden Rule, an imperative common to many religions, all argue for an ethic of participation in making decisions which are meant to be fair. The implication of this ethic in matters ranging over many generations is that each generation should strive to make its decisions as neutral to the future as possible, and not attempt to extend allocations of hazards and benefits which it may itself find acceptable onto future generations. This concept implicitly suggests non-degradation of the environment as a fundamental goal, and this goal is explicitly suggested in the National Council of Churches Study Document.

IV. CITIZEN CONCERNS AND GOVERNMENTAL ACTION

The EPA and NRC, both presently developing waste disposal criteria, recognize that currently codified radiation protection standards cannot adequately guide radioactive waste disposal. Since their inception, radiation exposure standards have been steadily evolving and changing. Reviewing this evolution assists in recognizing where we are today and how we got here, and points the way to acceptable waste disposal criteria.

History shows that the major changes in the protection standards have resulted from active public participation in the decision-making process. Not surprisingly, it also demonstrates the public's attitude is consistent with a posture of neutrality toward future generations and with non-degradation of the environment.

A. Historical Background[16/]

At inception, radiation protection standards were associated with professional societies and organizations. The standards guided only exposure of individuals occupationally associated with radium and x-ray utilization. These early standards were based upon the concept of a safe or threshold dose of radiation; they gave no consideration to genetic effects. In 1934, the International Commission on

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16/ Taylor, L.S. Radiation Protection Standards, CEC Press, 1971. This is a review of the pre-1970 history of radiation protection standards prepared by a member of the establishment standard setters.

Radiological Protection (ICRP) recommended a dose limit of 0.2 R/day and the National Committee on Radiation Protection (NCRP) recommended a limit of 0.1 R/day.

Nuclear Weapon Tests

In the late 1940's the general public first learned of the biological effects of radiation. The knowledge triggered a public debate over the hazards associated with the testing of nuclear weapons in the atmosphere, which led first to the moratorium on atmospheric tests and then to the Atmospheric Test Ban Treaty. A major public concern in this debate was the genetic effects of radiation.

As a result of public interest in this matter, the National Academy of Sciences Committee on Biological Effects of Atomic Radiation (BEAR Committee) reviewed the existing data on the biological effects of radiation with particular emphasis on genetic effects. The BEAR Committee report was significant in several ways:

- For the first time, the genetic effects were considered.
- It concluded that, so far as genetic effects are concerned, there is no safe limit or tolerance.
- It urged, therefore, "Keep the dose as low as you can."
- It recommended a reduction in occupational exposure limits.
- For the first time, it recommended an exposure limit for the general population.

These recommendations were adopted by the NRCP in 1958 when they recommended an occupational exposure limit of 5 rem/yr and, for the first time, an exposure limit for the general public of 0.5 rem/yr.

It is important to note that the federal government had no significant regulations for radiation exposure at this time, since the Atomic Energy Commission (AEC) was then in the process of preparing the first set of such federal regulations. The AEC included these recommendations in their regulations which were finally promulgated in 1960. The recommendations still stand as the principal standards in the present day Nuclear Regulatory Commission (NRC) regulations, and contain the admonition that the actual exposure should be kept "as low as practicable" (ALAP), recognizing that there is no safe level of radiation exposure [The wording was subsequently changed to "as low as reasonably achievable" (ALARA)].

It is important to note at this point that these pre-1960 events represent the start of a common thread in the history of radiation standards which persists to the present day. This common thread is a process where standards are proposed by individuals or agencies with a strong interest in radiation producing activities, are adopted by government as law, and are finally revised to more stringent standards under pressure from an informed public.

Clearly, it requires nonaligned scientists to inform the public of the hazards of radiation. An example of this process is how an informed public brought an end to the atmospheric tests and forced a reconsideration of the radiation protection standards with due acknowledgement of genetic effects. As a consequence of this reconsideration, more restrictive exposure standards were established.

But these new exposure standards were still set in accord with the industry bias of the regulators. Before making its recommendations, the BEAR Committee consulted the AEC to determine if these more restrictive standards could be met.[17/] Concerning its recommentations, the ICRP states:[18/]

> (83) Because of the need for guidance in this regard, the Commission in its 1958 Recommendations suggested a provisional limit of 5 rems per generation for the genetic dose to the whole population, from all sources additional to natural background radiation and to medical exposures. <u>The Commission believes that this level provides reasonable latitude for the expansion of atomic energy programs in the foreseeable future.</u> It should be emphasized that the limit may not in fact represent a proper balance between possible harm and probable benefit, because of the uncertainty in assessing the risks and the benefits that would justify the exposure.
> (Emphasis added)

17/ *Ibid.*, p. 47.

18/ ICRP Publication 9, 1966, p. 15.

Examination of the 1959 report of the ICRP, which gives the 1958 recommendation, reveals the convuluted logic used in the attempt to justify these industry biased recommendations.[19/]

Although the public debate related to the biological effects of radiation subsided with the advent of the Atmospheric Test Ban Treaty, the public concern over these effects did not. Instead, much to the surprise of the nuclear industry, the industrial bias in the new exposure standards was recognized by the general public. Because of the lingering public concern over the effects of radiation and the bias in the regulations, a new debate surfaced in the late 1960's. This debate centered around the adequacy of these exposure standards and was directly concerned with the Plowshare Program for the peaceful uses of nuclear explosives and with the developing nuclear power industry. It is reasonable to state that this public debate (similar to the debate stopping atmospheric tests) resulted in the virtual elimination of the Plowshare Program.

Public concerns over radiation effects in the late 1960's also raised serious questions on radioactive emissions from nuclear power plants. Confronted with an informed public, the AEC in June, 1971, proposed new guidelines for the emissions from light water reactors (LWR's) which were the center of the controversy. These new guidelines were eventually

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19/ ICRP Publication 1, 1959, p. 7.

included in the regulations as Appendix I of 10 C.F.R. 20. Essentially, these regulations reduced the allowable dose to the general population from the 500 mrem/yr 20/ primary standard to 5 mrem/yr - a 100 fold reduction.

These new regulations were stated to be in response to the ALAP or ALARA portion of the earlier regulations, and contained a procedure for determining what is ALARA. This procedure involves balancing the cost of additional emission control equipment against the cost of the health effects produced by the radiation. They used a health effects cost of $1000/person rem. 21/ This approach was included in the regulation although it was admitted that because of the intangibles associated with health effects, the approach did not include consideration of "overriding moral values that cannot be quantified." 22/

Here again we can see the common thread. The public had to force a reluctant AEC to prepare these emission standards. The AEC, in testimony before Congress in 1969, indicated that they did not want to establish these emission standards until they determined what the actual re-

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20/ A mrem is 1/1000 rem, hence 0.5 rem is 500 mrem.

21/ The person rem is determined by summing the dose over the exposed population. A dose of 1 rem to 1000 people is 1000 person rem. A dose of 0.1 rem to 10,000 people is also 1000 person rem.

22/ US AEC, Final Environment Statement Concerning Proposed Rule Making Action. WASH-1258, July 1973, Vol. 1, p. 8-2.

leases would be.[23/] The AEC did not want to challenge the nuclear industry - - they wanted to accommodate it. AEC Commissioner, Wilfrid Johnson, for example, testified:

> "If we were too rigid, we would have nothing but boiling water and pressurized water reactors from now on. If we get to liquid metal cooled fast breeders, the effluent problem will be different. Hopefully, they will be better, but we know they will be different. We need flexibility for these reasons." (Emphasis added) [24/]

To accommodate the industry, the Appendix I guidelines (guidelines that were predetermined to be no challenge) were meant to apply only to light water reactors, not to reprocessing plants or breeder reactors. With obvious industry bias, the AEC wanted to wait to see what the emissions from these plants would be before setting guidelines. A continuing intent to accommodate radiation producing programs has also marked government response to questions raised by a worried public on radioactive waste disposal.

The Tailing Piles

Radionuclides emitted from a reactor can irradiate the population for thousands of years into the future. This

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23/ "Environmental Effects of Producing Electrical Power." Hearings before the Joint Committee on Atomic Energy, 91st Congress, 1st Session, held Oct. 28-31, Nov. 4-7, 1969, Washington, D.C.. U.S. Government Printing Office, 1969, pp/ 203-209.

24/ Ibid., p. 209.

factor was a major aspect of the debate over atmospheric testing. Carbon-14 with its 5000 year half life was an important argument in that debate. Nevertheless, the method for the determination of ALARA in Appendix I ignores the half life of the radionuclides and is based only upon the annual dose. The first official recognition of the significance of the half life of radionuclides occured in an EPA assessment of the effects of the nuclear power fuel cycle.[25/] Here EPA determined the dose and hence effects from selected nuclides for 100 years into the future.

While this 100 year period would seem adequate for Cesium-137 with its 30 year half life, it has an arbitrary appearance compared to the 5000 year half life of Carbon-14. Again, because of public debate and participation in reactor licensing proceedings, the significance of the half life of radionuclides has become a major issue. This debate has centered around the radon emission from the tailing piles at uranium mills. The radon results fromthe decay of Thorium-230 which has a half life of 80,000 years.

This debate forced the NRC to set aside the validity of its S-3 Table, which had the purpose of evaluating the radiological impact of the uranium fuel cycle in the environmental impact statements of nuclear power reactors. As a consequence, reactor licensing proceedings had to be reopened

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25/ US EPA, Environmental Analysis Of The Uranium Fuel Cycle, EPA-520/9-73-003, 3 Volumes, October 1973.

on this issue. In these proceedings the NRC Staff is suggesting that perhaps the population dosage and the effects should be determined over a period of 1000 years. Moreover, they do not use the ALARA cost analysis approach that is part of Appendix I. Instead they simply compare the dosage with that of natural background radiation. One licensing board appears to accept the NRC Staff approach.[26/]

Neither that licensing board nor the staff indicate how small is small enough in this comparison with natural background radiation. Moreover, they do not indicate why it is better to kill or maim 1 million persons at a rate of 10 persons per year for 100,000 years as opposed to killing or maiming a million persons in a single year. The Commissioners of the NRC have yet to rule on these issues. Clearly these issues are paramount in the selection of waste disposal criteria.

Again, that common thread in the federal radiation "protection" program can be seen. The public had to force the NRC to consider the long-lived radionuclides and to address them in relation to the mill tailings issue. The response of the NRC, typical of its industry bias, was an attempt to minimize the problem by discounting future generations.

26/ Atomic Safety and Licensing Board, Partial Initial Decision, Environmental Consequences Of The Uranium Fuel Cycle, In The Matter of Duke Power Co., Perkins Nuclear Station, Docket Nos. STN 50-488, 50-489, 50-490, dated July 14, 1978.

Enter EPA

The Environmental Protection Agency has the lead responsibility in establishing radiation protection criteria for waste disposal. This agency was created by the Congress in response to the public's concern over its deteriorating environment. In other words, the EPA itself is the result of the actions and demands of the general public. As a consequence, it should be anticipated that EPA would be responsive to the public's concern and not possessed with the industry bias of the other agencies. Unfortunately such is not the case.

Although EPA was the first to respond to the public's concern over long-lived radionuclides, it also chose to discount future generations by truncating its dose assessment at 100 years. However, EPA appears to be modifying this position. The EPA has recently published its "Criteria for Radioactive Wastes."[27/] Here they indicate that assessment out to 1000 years should be undertaken and that it is desirable to have some means for accounting for risks associated with longer time periods. This marginally more realistic effects assessment, however, is about the only concession to the public's concern made in the published criteria. The remainder of the criteria are designed more to provide latitude for the expansion of the nuclear power industry than to respond to the concern of the public.

27/ EPA, Criteria for Radioactive Wastes, Fed. Reg., Vol. 43, No. 221, Nov. 15, 1978, pp. 53262-53268.

The historical background on radiation standards presented above illustrates two aspects of the public's attitude toward radioactive contamination:

1. No amount of radioactive contamination is "acceptable." This was the public message that brought about the Atmospheric Test Ban Treaty and the demise of the Plowshare Program for the peaceful uses of nuclear explosives.

2. The effects of radiation on future generations are of prime importance and can not be discounted. This is illustrated not only by the ATB Treaty and Plowshare ban but also by the public concern over long lived nuclides and the tailing piles.

Both of these indicate that the public's attitude toward the environment is one of non-degradation. The National Environmental Policy Act (NEPA) which was brought about by public concern is also an expression of this attitude. In their published criteria, EPA states:

> Our responsibility to maintain environmental quality for future generations is well recognized. As enunciated in the National Environmental Policy Act of 1969 (NEPA), it is an important national goal to "fulfill the responsibilities of each generation as trustee of the environment for succeeding generations."28/

28/ Ibid., p. 53262.

The NEPA also states:

> (c) The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment.

Much the same statements can be found in the Clean Air Act and in the Federal Water Pollution Control Act as Amended by the Clean Water Act of 1977.

Thus the public's attitude and the actions it has caused to be taken by the Administration and the Congress demonstrate that the only acceptable criterion is one of non-degradation.

V. RECOMMENDED RADIOACTIVE WASTE DISPOSAL CRITERIA

The previous sections of this report demonstrate, whether approached from the standpoint of a rational, religious or public action perspective, that the only acceptable waste disposal criteria are those which, at a minimum, are neutral to future generations. Everything the present generation does has its impact on an unconsulted future and so is in some measure unfair to future generations; even more unfair, however, are those actions consciously promoting a policy which involves the distribution of benefits now and hazards later. The least unfair mode is one which tries to keep deliberate allocations of benefits and costs confined to a single generation, where those imposed upon by hazards are at least available for comment. The least unfair way of managing intertemporal relationships is for each generation to try to leave the earth as it was when they arrived. As a goal, the only acceptable distribution of hazards and benefits is the neutral allocation, where no pattern of benefits and hazards is imposed. Decisions striving for a neutral allocation are, therefore, the most acceptable.

Cost/benefit analysis, or any other analytic technique, alone cannot decide whether it is just or fair for the present to impose upon the future the burden of perpetual care for highly poisonous materials. Consequently, the foundation of any waste disposal criterion must be based on fundamental value judgments rather than on ad hoc modelling considerations, and be derived from a theory of justice. Conclusions from manipulations of numerical models must not be substituted for explicit confrontations with difficult value judgments. For example, if at a certain point our society wishes to stop being fair and reasonable because we do not wish to bear the monetary costs of justice, then we should explicitly acknowledge that we prefer being wealthy and evil to being poor and righteous and not try to justify our moral vacillation with a cloud of cost/benefit models.

All of these considerations lead to the first and the fundamental criterion that should be applied to the disposal of radioactive wastes.

Criterion #1

> Nuclear operation of all types (such as mining, milling, fuel processing, decommissioning, and waste isolation or disposal) should be conducted so the overall hazards to future generations are the same as those which would be presented by the original unmined ore bodies utilized in those operations. There should be high confidence that the cumulative risk to all future generations from radioactive waste should be less than, or (considering uncertainties in the calculation) comparable to, the cumulative risk to all future generations from the original uranium resources from which the radioactive wastes were derived, assuming these uranium resources were unmined.

The attempt here is to choose a criterion based on a theory of justice and equity. Waste criteria must be fair to future generations independent of the benefits this generation reaps from the use of nuclear power. The criterion above simply ignores the net benefits of using nuclear energy. Instead, it considers only the risks to future generations.

Criterion #2

> The geologic medium and site selected for geologic disposal should be selected to minimize the possibility of future human intrusion, particularly during periods after which the permanence of records can no longer be expected. Hence, the medium should not be located in an area where other valuable resources have been, or are likely to be mined. The geologic medium of choice should be a plentiful resource such that should it become a useful resource to future generations, its widespread availability will make it unlikely to be mined at the waste disposal site.

This criterion is designed to address the risk of release by human intervention rather than by geologic events. Arguably the risk of human intervention - after records of the repository are lost - is higher, or at least less predictable.

Criterion #3

> The radioactive waste should be stored in a retrievable manner for the period during which the repository is open, or until it can be assured with high confidence that all waste disposal criteria are met, whichever is the longer period.

The waste should be stored in a retrievable mode until there is clear evidence that we know what we are doing, and have high confidence that the desired goal will be achieved. Almost anything is retrievable at some cost. Here, retrievability implies something that can be economically retrieved.

These criteria should be the goals of our nuclear waste disposal program. Cost should be considered as only secondary in importance. A generation that is spending billions of dollars a year on nuclear weapons and on waste-producing nuclear power reactors should do no less with nuclear waste disposal. These criteria should not be relaxed simply to accommodate the new radioactive wastes being generated by the nuclear power industry.