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PUBLIC POLICY ISSUES IN NUCLEAR WASTE MANAGEMENT

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Prepared under contract EW-78-C-06-1076

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CHAPTER 1: INTRODUCTION

In the next few years important decisions will be made about the management and disposal of waste from commercial nuclear power production. These decisions, when finally implemented, will have consequences and outcomes both now and in the long term future. A decision to proceed with a certain technical approach to waste disposal on a certain time scale will likely have different consequences than a decision to proceed with a different approach and time scale. It is these potentially different consequences and disagreement and contention about them that forms the core of this exploration of public issues in nuclear waste management.

While nuclear waste management decisions involve economic and social factors, they will no doubt rely heavily on a base of technical data generated by traditional scientific methods, e.g., the leach rates of various types of glass-like substances which might be used to package wastes for disposal, the vulnerability to accidental breaching during transport of various waste canister and cask designs, and the rate of transport via ground water of nuclear waste isotopes in various geologic media. Portions of this data base will probably attain the status of "scientific fact" by virtue of near universal agreement about their validity in the scientific community. Other portions will be the subject of continuing scientific controversy and will point up uncertainties. In other cases, empirical methods by their nature are not very powerful tools for acquiring information needed to make nuclear waste management decisions. For instance, a pilot repository can be built and pilot tested for months, years, or decades, but there are no readily apparent methods for determining that it will not be breached for centuries or millennia. In other words, uncertainties will remain, as in every technical area, despite the best efforts of technologists. The exercise of careful <u>scientific judgment</u> will be required in making decisions where <u>scientific facts</u> are unavailable or insufficient.

It is because the outcomes of alternative waste management decisions will have differential effects or impacts on the public that makes these alternative decisions <u>public</u> issues. Since society, present and future, will bear the impacts of nuclear waste management and disposal outcomes, it would appear useful to incorporate public judgments into the nuclear waste decision making process. The public's judgments are evaluative judgments. The public should indicate its relative preferences among the outcomes expected from alternative decisions or approaches. In other words, the public must render a judgment on the extent to which various outcomes are consonant with public values. This evaluative judgment incorporates individual and collective perceptions of what is right and equitable, what ought to be done, as well as what is feared and ought to be avoided.

These public judgments are not technical judgments but must be based in part on technical judgments. Technical judgments must come from scientists/engineers who by training and experience are familiar with waste management technology. As previously mentioned, technical judgments should be based to the extent possible on scientific facts. Careful scientific judgments must be rendered when scientific facts are unavailable. These judgments are refined by scientific review and continued scrutiny.

Technical judgments thus define the set of available technical options. They describe what can be done, on what time schedule, at what economic cost, and with what probable impact on public health and safety and the physical and social environment. While technical experts may have their own value preferences and thus also make evaluative judgments, the final evaluation of the predicted outcomes of waste management options is a broadly shared public responsibility. Public officials charged with making nuclear waste decisions in the broad public interest must weigh technical, economic and social considerations including the public's evaluative judgments about the desirability of projected decision outcomes.

Before proceeding with this analysis of public issues it may be helpful to distinguish "issues" from "problems." Nuclear waste disposal, like any complex technical activity, presents many problems. By problems we mean acknowledged difficulties. A problem is a challenge to solution; a candidate for thought; an occasion for research, experimentation, and scientific analysis. A problem represents a difficulty in achieving a goal. It may involve a blockage of progress, a delay, or increased cost or hazard in reaching the goal. Some problems may not be solved by the time action is judged necessary. In these cases a decision is necessary on whether the difficulty is bearable or on whether the goal is worth the risk.

Problems, as mentioned above, give rise to issues. If issues are in the public domain or affect the general public, they become public issues. The term "issue" suggests discussion, opposing views, disagreement, contention, and argument or debate. Issues are not "solved" like problems; issues are resolved. Resolution may be furthered by the accumulation of facts which convince all parties to follow a common course. Where issues involve the values of the parties in the disagreement, more facts may not help issue resolution. Perhaps compromise is the only way to resolve the issue. In other cases, an alternative goal of equal value to all parties or an alternative path that doesn't involve the troublesome issue may bring resolution.

This paper involves an analysis of nuclear waste public issues. The term analysis is used loosely here to include a statement of and exploration of the issues or points of disagreement over waste disposal problems. Disagreements (issues) can take several forms including (a) disagreement over the existence of a problem or over its severity, e.g., some feel the inability of future generations to participate in present waste disposal decisions is a severe problem; others feel this is not a problem and argue that virtually all societal decisions have extended future consequences; (b) disagreement over the benefits and costs of achieving a goal, e.g., some feel continued economic growth is desirable, some do not; and (c) disagreement over the desirability of benefits and costs/hazards attendant to alternative paths to a goal or different ways of overcoming a problem, e.g., some feel existing nuclear wastes should be placed in geologic isolation, some feel they should be disposed of in space.

What follows then is an attempt to present in outline format the more important public issues of nuclear waste management. The intent is to gather together in a common format and grouped into common clusters an extensive set of nuclear waste issues. The objective is to raise and discuss issues rather than resolve them. This may cause frustration in some readers, but issue resolution must be left to the political process (broadly defined). We hope the process of issue resolution will be assisted by the present analysis, but it surely will not be accomplished by it. We do attempt to state the more common points of view or sides of some issues, and we do point out the major factors that have become associated with issues. These points of view constitute possible forms that resolution of issues might take. We also, in some places, indicate the direction that in our view issue resolution appears to be moving. Background and clarifying statements are made in sections headed "Comment." Comment sections are also used to point up some of the interrelations among issues in different sections.

ISSUE SOURCES

Most of the issues raised here are raised elsewhere. Several documents list and discuss in varying detail a dozen or more major issues (Hébert, Rankin, Brown, Schuller, Smith, Goodnight and Lippek, 1977; Bishop, 1976; Abrahamson, 1976). Other authors focus on only a few issues, providing extended discussion (Rochlin, 1976; Skolnikoff, 1976) or raise implied issues of a broader nature (Sharefkin, 1976).

Although we feel the issues discussed in this paper deserve public airing, many have received little public discussion except among a set of "expert insiders" to the technology and problems of nuclear waste. We have drawn heavily for our material from several public meetings including the Conference on Public Policy Issues in Nuclear Waste Management held in Chicago in October 1976 and the two Environmental Protection Agency conferences on this topic held in Reston, Virginia and Albuquerque, New Mexico in February and April 1977. Other published sources are listed in the accompanying bibliography. A few sources that provide a variety of perspectives on a given cluster of issues are briefly annotated in a section at the end of the bibliography and keyed to sections of the analysis. Unpublished papers, correspondence and conversations with technical and nontechnical observers of nuclear waste management round out our sources.

ISSUE IMPORTANCE

In this analysis we rarely make judgments about the relative importance of issues. Such judgments are usually value judgments not resolvable by recourse to scientific data or appeals to authority. Of course we were forced to make some judgments about issue importance in deciding where to draw the line between those issues we discussed and those which fall within our content limits (to be defined later) but were judged not important enough to discuss.

Many writers do make judgments about the relative importance of issues. Importance has a variety of meanings. Some use importance to refer to the magnitude of possible consequences--major versus minor. Some use importance to refer to issues they feel to have overriding moral or ethical content. Others feel issues where there is frequent or wide discrepancy between the positions taken are the more important issues. In still other cases importance is used to refer to the apparent difficulty of solving the problems that give rise to the issues in question.

It is clear that some issues are raised more frequently in the literature and are thus more familiar than others. For instance, the assertion that waste disposal involves a "Faustian bargain" (Kneese, 1973) in which benefits of nuclear power are enjoyed in the present and costs/risks are incurred in the future is one of the more frequently mentioned themes. Frequency of mention may or may not indicate issue importance.

ISSUE INTERRELATIONS

As will become clear, nuclear waste issues are numerous, complex and frequently interrelated. Decision makers could easily fail to consider them all adequately. One of our purposes, therefore, was to gather them together in one document so they may be jointly considered. We have commented on interrelationships when these were particularly salient, but have not yet formally mapped them. This effort is currently under way and will be the topic of a subsequent report.

In order to assist readers who may wish to consider issue interrelationships, there appear to be several common forms including (a) hierarchical relationships--some issues are sub-issues or elements of broader issues; (b) contiguous relationships--some issues tend frequently to be mentioned together and may share common hierarchical relationships to a broader issue; (c) causal relationships--at a decision point in waste management, different decisions will give rise to different issues, that is, decisions on a given issue affect the occurrence or non-occurrence of other issues; and (d) mutually exclusive--the existence of certain issues implies a decision that prevents the occurrence of certain other issues, e.g., issues associated with the risks and benefits of nuclear waste retrievability do not occur if there is a decision to use a method of disposal that prevents retrievability.

LIMITATIONS

As technically qualified readers will quickly note, this analysis is not intended to be a technical evaluation of nuclear waste alternatives. That is beyond our scope and competence. We do make some assumptions about technical feasibility based on our understanding of nuclear waste technology at time of writing. These limited assumptions are necessary to avoid extended discussion of issues not likely to arise and to help keep the discussion generally on track. For instance, we do not discuss issues related primarily to transmutation technologies since there appears to be no immediate prospect of their being available. In the same vein, much more attention is given to issues associated with geological disposal on land than to extra-terrestrial disposal or sea bottom disposal.

This analysis is limited primarily to high level waste from civilian light water reactors operated to produce electricity. Our definition of high level waste is a nontechnical one that simply means nuclear waste, whether from a reprocessing plant or in the form of unreprocessed spent fuel that involves intense and damaging radiation. We do not discuss transuranium contaminated waste, gaseous emissions from nuclear facilities, mine and mill tailings or decommissioning of nuclear facilities. There are many issues connected with the management of these other waste forms, and many of the issues we discuss could be applied to them, but our treatment, like public concern (Bartlett, 1976; Bishop, 1976) is centered more on high level waste from nuclear reactors.

While many of the issues we discuss may apply to both civilian and military waste, our treatment is limited to civilian waste. This point is particularly important to keep in mind during the ensuing discussion of benefits associated with nuclear waste issues. Technological issues often take the form, when viewed from the public perspective, of a rough cost/benefit assessment. Aside from the possible recovery of scarce elements such as those in the platinum group and the potential for recovering nuclear fuel by reprocessing, there are few direct benefits of nuclear waste, per se.

The benefits are related to the use of the electricity generated by nuclear means. Thus we explore these benefits and their role in nuclear waste issues. The benefits (national security) associated with military waste are quite different and generally beyond the scope of our discussion.

Our treatment is limited generally to wastes from light water reactors. We have not attempted to deal in detail with issues that may arise in connection with specific alternative fuel cycles. There is limited discussion of issues associated with whether or not to reprocess waste to remove uranium and/or plutonium. And, to a limited extent, the plutonium-fueled breeder is also discussed in connection with reprocessing issues.

The brevity of our discussion of alternative fuel cycles, reprocessing and the fast breeder are regretable because the issues involved are gaining in public salience. However, to do these topics justice it would be necessary to project specific scenarios involving various combinations of fuel cycle options, reprocessing and mixes of breeders and more conventional LWR's. Moreover, the timing of these scenarios has important effects on the calculation of benefits and risks. One could easily construct several dozen hypothetical combinations of possibilities. To attempt treatment of the issues specific to each combination would be an arduous and speculative task. A similar problem is encountered in dealing with alternative modes of nuclear waste disposal, i.e., geologic, extraterrestrial, etc. Given the current state of decision flexibility, the possible combinations of disposal mode, fuel cycle, timing, etc. are too numerous to explore individually. As mentioned above, we have given more detailed attention to the most likely technical approach (geologic disposal on land) and the present nuclear power reactors (uranium fueled LWR's). As time passes and nuclear waste management decisions are made or changed, some combinations of specific system elements will become irrelevant. Others will become salient and demand a more focused analysis of the issues associated with them. Readers are invited to think through the system combinations or scenarios of special interest to them and explore issues that may be unique to those particular combinations.

Finally, to state one more limitation, we deal with nuclear waste issues from the perspective of the United States with little attention to the many international issues such as multinationally operated reprocessing plants, return of spent fuel from abroad for storage or disposal in the United States, and international agreements to pursue fuel cycles that inhibit nuclear weapons proliferation. When, and if, these possibilities take on more substance it will be necessary to explore more specifically the issues involved. For now, we have given them only brief mention.

NUCLEAR POWER DEVELOPMENT

One more point seems worth making before moving on to the issue outline. It involves the relation between nuclear waste management issues and the future development of nuclear power. As pointed out above, there are few apparent benefits of nuclear waste, per se. Nuclear waste results from the production of nuclear power which in turn is perceived by the majority of the U.S. public as beneficial (see Melber, Nealey, Hammersla and Rankin, 1977, for an extensive review of public attitudes about nuclear power). Moreover, as the amount of nuclear power produced increases, so does the amount of nuclear waste. We have approached the analysis of nuclear waste issues from a rough benefit/cost perspective. Electricity produced by nuclear means represents the benefit, and nuclear waste management represents the cost and risk. It would be convenient if nuclear waste issues could be clearly separated from the question of further nuclear power development. Committed advocates of nuclear power appear to be arguing for this. They say, in effect, "We already have nuclear waste, we have several promising alternatives for disposing of it, let's proceed to do so and show that the problem can be solved." Committed opponents, by contrast, focus on the perils of proceeding to produce more waste before it has been demonstrated conclusively that nuclear waste management and disposal can be successfully carried out.

Of course, not all nuclear waste issues are related to the question of further nuclear power development. Many issues are related to how waste management should be carried out and require resolution in order to deal with the current waste inventory even if a decision were made today to produce no new waste. We have tried to point up those issues that appear highly related to the question of continued nuclear power development and those independent of it. As nuclear power development continues, the amount of waste will increase. Several sections in this analysis deal with the issues related to amount of waste. These sections address directly the issues linked to continued nuclear power development. We hope this effort will help bring clarity to this difficult problem for nuclear waste issue resolution.

ORGANIZATION OF ISSUE CLUSTERS

Nuclear waste issues have been clustered in this report into four main sections which are referred to as issue clusters or issue branches. Chapter 2 deals with temporal equity issues--issues associated with present benefits and risks/costs versus future benefits and risks/costs. Chapter 3 deals with issues associated with the distribution of benefits and risks/costs over geographic areas and socioeconomic groups. Chapter 4 covers a variety of issues associated with implementing waste management and disposal systems--organizations needed to manage wastes, regulation and inspection, financial arrangements and monitoring in the near and far term future. Finally, Chapter 5 considers public involvement issues--issues associated with how and to what extent the public should be involved in nuclear waste management decisions. Issues arising from the question of public involvement in nuclear waste management decisions are a specific subset of the broader issues of public involvement in policy decisions involving technology. Chapter 5 deals with the process of issue resolution while chapters 2, 3 and 4 deal with the content of nuclear waste management issues.

The ordering of these chapters is not very important. In fact, each chapter is designed to stand more or less alone, and readers primarily interested in only certain clusters of issues could give only brief attention to the others.

There are also many possible ways of clustering issues. For instance, uncertainties of various kinds give rise to issues throughout the four sections. It would have been possible to pull together all the instances of uncertainty into one major section and discuss how they affect temporal equity, geographic equity, etc. Readers are invited to employ any conceptual device they find useful for clustering issues. The analysis is organized, where possible, to facilitate this by parallelism of issue treatment. For instance, most major issues have subsections that deal separately with benefits and risks/costs; and certain considerations like amount of waste, alternative fuel cycles, uncertainty, irreversibility of actions, and alternative modes of disposal are raised in each of the three substantive chapters (2, 3 and 4).

The issue analysis is structured within each chapter into a few broad "primary" issues with a number of "dependent" issues under each primary issue. A formal outline format is employed to bring order and help clarify the hierarchical structure of the issues. Issues are stated in the grammatical form of questions. The most detailed elements of the outline take either the form of a description of the opposing points of view on the question or constitute a listing of the major factors to be considered in resolving the question.

Finally, in a content area like nuclear waste issues where opposing issue positions are so often rooted in value judgments, it may appear that we are taking certain value positions that bias the discussion. We have tried to avoid actually doing this because we see our task as collecting, reporting on, and exploring nuclear waste public issues raised in the many and diverse sources we mentioned earlier. Our own views on these issues are not germane to this task. We do not speak for any group or government agency, nor should positions we may appear to take be attributed to any particular group or government agency.

CHAPTER 2: TEMPORAL EQUITY ISSUES

INTRODUCTION

A major problem with nuclear waste is the long-term radiation hazard of waste materials. To oversimplify somewhat, there are two time periods of concern associated with the waste components. The fission products account for very high levels of radiation initially. This hazard progressively decreases over the 500-1000 years following removal from the reactor. The actinides present a slowly decreasing hazard for up to 500,000 years. It is clear that potential harm to future generations will exist for a long period of time after direct benefits in the form of electrical power cease.

This situation has given rise to a cluster of issues that are widely considered to be highly important. In the Battelle study "Public Values Associated with Nuclear Waste Disposal" (Maynard, Nealey, Hébert and Lindell, 1976) long-term safety was judged by most respondents to be more important than the three other waste management criteria considered--short-term safety, cost, and accident detection and recovery. This problem of the temporal dislocation of costs and benefits was the topic of extended discussion and wide concern among participants in the Chicago conference on "Public Policy Issues in Nuclear Waste Management" in October 1976. From these and many other sources listed in our bibliography it is clear that long-term safety is a problem judged to be of great importance and that a cluster of issues center on the question of equity over time.

Risk/benefit analysis in this case is complicated by a number of factors. Some of the more important of these are: uncertainty associated with benefits and risks (especially over very long time periods), the extent to which nuclear waste disposal involves irreversible actions, the extent to which actions that increase short-term safety may decrease long-term safety and vice versa, and the role that future generations might play in both monitoring waste and becoming exposed to waste through accidental or volitional acts.

In this chapter we take up the many issues that have been linked to the temporal distribution of the benefits of nuclear power and the risks/ costs of nuclear waste disposal. Most of these issues would not exist but for the very long time periods over which nuclear waste materials must be isolated from the biosphere. In other words, if all the benefits and risks/ costs of nuclear power and nuclear waste disposal occurred in the period during which nuclear power is produced and consumed, temporal equity issues would not exist.

SUMMARY OF PRIMARY AND DEPENDENT ISSUES

Primary Issues:

1. Is the distribution of benefits from nuclear power and risks/costs from nuclear waste disposal over time (involving many generations) acceptable?
2. Is the inability of future generations to participate in waste disposal decisions that will affect them an important problem?

Dependent Issues:

1.1. How is the acceptability of the distribution of benefits and risks/ costs over time affected by the amount of waste requiring disposal?

1.2. How is the acceptability of the distribution of benefits and risks/ costs over time affected by alternative fuel cycles?

1.3. How is the acceptability of the distribution of benefits and risks/ costs over time affected by uncertainty associated with the calculation of benefits and risks/costs over time?

1.4. How is the acceptability of the distribution of benefits and risks/ costs over time affected by irreversibility of waste disposal actions?

1.5. How is the acceptability of the distribution of benefits and risks/ costs over time affected by alternative modes of nuclear waste disposal?

2.1. How does amount of waste requiring disposal affect the importance of allowing future generations decision flexibility?

2.2. Can waste management decisions be postponed to avoid disenfranchisement of future generations?

2.3. Should we strive to preserve flexibility for future generations to make decisions about nuclear waste?

ISSUE OUTLINE

1. Is the distribution of benefits from nuclear power and risks/costs from nuclear waste disposal over time (involving many generations) acceptable?

Comment: This issue is taken up first because it is related to the important question of whether and at what level to continue the production of nuclear power, and thus the production of nuclear waste. If nuclear power were to stop immediately, the amount of commercial nuclear waste would consist of the present inventory which is estimated at 2,500 metric tons. On the other hand, if nuclear power production were increased significantly, say to 500-700 operating light water reactors by the year 2000, the amount of nuclear waste would be a minimum of 125,000 tons, a significantly greater volume than at present ("The Radioactive Waste Inventory, 1977").

We are using a nontechnical definition of amount of waste to refer to the physical volume and intensity of dangerously radioactive material removed from reactors. The thermal radiation intensity per cubic unit of repository space will depend on the period of decay before disposal, on whether or not reprocessing removes uranium and/or plutonium, on the ratio of waste material to fixing medium in waste canisters, on canister size and density of placement in the repository, and other factors. A more precise definition of amount of waste seems not to be required here. The point of this issue is whether as waste amount increases (and nuclear power production increases) there is an effect on the temporal distribution of benefits and risks/costs.

Variations in the nuclear fuel cycle also affect waste amount as we have defined it, and waste disposal mode variations can have significant effects on the amount of waste which could threaten future generations and thus raise temporal equity issues. For instance, extraterrestrial disposal, if successful, could permanently remove some nuclear waste materials from concern. For each combination of nuclear fuel cycle and disposal mode, the four possibilities under 1.1 below should be considered.

1.1. How is the acceptability of the distribution of benefits and risks/costs over time affected by the amount of waste requiring disposal?

1.1.1. Creating more waste will increase the risks/costs to both present and future generations. However, continuing the development of nuclear power will increase the benefit to present and near term future generations, but will not increase the benefits to far term future generations.

1.1.2. Creating more waste will increase the risks/costs and the benefits to both present and future generations. (Far term future generations will enjoy the secondary benefits of resource conservation and reduction in long-term negative impact on the environment from expanded fossil fuel extraction and burning.)

1.1.3. Creating more waste will increase the short-term risks/costs from disposal actions but will not significantly increase the long-term risks/costs because most waste release scenarios are sensitive to event probabilities rather than waste amount. That is, the risks/costs borne by future generations may be only slightly affected by the amount of waste produced. Benefits will increase in the short term but not in the far term.

1.1.4. Risks/costs will increase in the short term but not in the long term, while benefits will increase in both the short and long term.

Comment: To summarize, the above possible outcomes of increased waste amount differ only in their long term impact. That is, all involve increases in both short term risks and benefits, while long term risks and/or costs are increased in three of the four outcomes. To the extent that increasing risk to far term future generations without commensurate benefits is an important issue, the four cases might affect a decision to continue nuclear power development (and waste production) in the following fashion: 1.1.1. Stop nuclear power; 1.1.2. Continue nuclear power if the long term benefits outweigh the long term costs; 1.1.3. Stop or continue based on short term risk/benefit considerations; 1.1.4. Continue nuclear power.

The above discussion does not deal with economic costs of nuclear waste disposal. It is taken for granted that costs of waste disposal will be borne by the users of the nuclear generated power.

Of course, as the amount of waste increases, so will the cost of waste disposal. However, if current and foreseeable short term future costs, e.g., for repository monitoring, are paid by current power users, economic costs would not appear to be an important temporal equity issue. In this chapter, economic cost will therefore be given only cursory treatment. Financial arrangements are discussed at more length in Chapter 4, issue 3.1.

1.2. How is the acceptability of the distribution of benefits and risks/ costs over time affected by alternative fuel cycles?

Comment: Given the large number of potential fuel cycle variations and the variety of technical and policy considerations that will affect choices among them, it does not seem fruitful to attempt to explore the implications of specific fuel cycle variations at this time. Rather, the general benefit and risk issues associated with a choice among fuel cycles are explored below.

1.2.1. What near term benefits are associated with fuel cycle variations?

1.2.1.1. The technical feasibility of various fuel cycles varies in the near term. Therefore, the amount of power that can be generated in the near term depends to some extent on the choice of fuel cycle.

1.2.1.2. The choice of fuel cycles affects, and is affected by, nuclear fuel supply and the desire to conserve nuclear fuel.

1.2.2. What near term risks and costs are associated with fuel cycle variations?

1.2.2.1. Risks and costs of waste processing, transportation, emplacement, and monitoring, as well as those associated with mining and mills, are expected to vary by fuel cycle.

1.2.2.2. The potential for the international proliferation of nuclear weapons, diversion of strategic materials, and terrorism varies by fuel cycle.

1.2.2.3. The use of some fuel cycles will result in the burial of potentially needed nuclear materials, and thus may affect retrieval policy and the likelihood of retrieval. Retrieval operations are potentially risky.

1.2.3. What <u>long term benefits</u> are associated with fuel cycle variations?

1.2.3.1. Since variations in fuel cycle will affect near term nuclear power supply and nuclear fuel consumption, the long term supply of nuclear fuel will also vary with fuel cycle.

1.2.3.2. As near term choice of fuel cycle affects use of fossil fuel, it may also affect the long term availability of fossil fuel.

1.2.4. What <u>long term risks</u> and <u>costs</u> are associated with fuel cycle variations?

1.2.4.1. Should a release event occur in the long term, the radionuclide inventory existing in the repository at the time will affect the risk of radiation exposure, genetic damage, and economic costs to future generations. This long term radionuclide inventory varies by fuel cycle. For instance, the burial of unreprocessed spent fuel will result in substantially higher amounts of plutonium in repositories in the long term (and thus a higher radionuclide inventory) than might be the case with the breeder fuel cycle in which plutonium is taken out of the waste stream by reprocessing.

1.2.4.2. The near term choice of nuclear fuel cycle will affect the long term environmental impact of fossil fuel burning.

1.3. How is <u>the acceptability of the distribution</u> of benefits and risks/costs over time affected by <u>uncertainty</u> associated with the calculation of benefits and risks/costs over time?

<u>Comment</u>: If the decision is to stop nuclear power and thus produce no more waste, the calculation of near term future and far term future benefits becomes trivial and issues 1.3.1 and 1.3.2 below do not occur. If nuclear power continues and more waste is produced, these issues do occur. Moreover, they interact with the 1.1 issue branch because benefits increase with amount of nuclear power produced

in the short term and amount of nuclear power produced in the short term may affect long term benefits. Uncertainty exists over the type and amount of these benefits.

1.3.1. What are the major types of uncertainty involved with the calculation of near term future benefits?

1.3.1.1. The benefits of nuclear power in the present is a subject of controversy, but this is probably a function of value differences rather than uncertainty. The calculation of near term future benefits is hampered by uncertainty over the need for more power in the future (although values also affect the perception of this need).

1.3.1.2. Uncertainty also exists over the efficacy of conservation efforts and the speed with which alternative technologies could replace nuclear power if there are increased power demands.

1.3.2. What are the major types of uncertainty associated with the calculation of far term future benefits?

1.3.2.1. Uncertainty exists over the amount of fossil fuel conservation that might occur in the near term, with and without nuclear power, and over the value to future generations of this conservation if it occurs.

1.3.2.2. Uncertainty exists over the amount of the reduction in long term negative environmental impact that might be avoided by reduced fossil fuel burning if nuclear power is further developed and the value to future generations of this reduced environmental impact.

1.3.3. What are the major types of uncertainty associated with the calculation of near term future risks?

1.3.3.1. Uncertainty exists over the severity of risks associated with preparation of wastes for disposal, transportation of wastes, and disposal operations.

<u>Comment</u>: Near term uncertainty would appear less with geologic disposal since the mining and engineering operations are familiar and use present technology.

1.3.3.2. Uncertainty exists over the risks that might be incurred if wastes, once emplaced in a repository, should have to be retrieved. Uncertainty is related to whether or not there will be a need to retrieve and to risks of retrieval should it be necessary.

1.3.3.3. Uncertainty exists over risks from near term release of wastes due to natural causes, e.g., earthquake, flood, etc.

Comment: This source of uncertainty appears small in the near term future, since siting criteria will address natural events. However, should a release event occur in the near term, the wastes would still be highly toxic.

1.3.3.4. Uncertainty exists over risks from terrorism prior to waste disposal. Risks of this kind after disposal appear small.

1.3.4. What are the major types of uncertainty associated with the calculation of far term future risks?

1.3.4.1. Uncertainty exists over the probability of geologic event, e.g., earthquake, volcanic uplift; and erosion or meteorite hit that might permit waste release via aquifer transport or gas venting.

1.3.4.2. Uncertainty exists over man-caused events (a) of an accidental nature, e.g., drilling for minerals in the vicinity of the repository without knowledge of its existence, and (b) of an intentional nature with knowledge of repository existence, e.g., to recover valued nuclear resources.

Comment: Providing adequate information about the repository is preserved into the future, the risks from intentional intrusion would presumably be counterbalanced by expected benefits.

1.3.4.3. Uncertainty exists over the nature and costs of the environmental, health-safety, and genetic consequences should release occur by natural or man-caused events. Components of this uncertainty are: (a) whether consequences would be catastrophic (large areas rendered uninhabitable or large numbers of deaths in a short period) or circumscribed, and (b) whether release takes place over very long time periods or is sudden. "Sudden" geologic events (earthquake, volcano) might be catastrophic while most other natural events and all man-caused events would probably have circumscribed consequences. The possibility that effective cures for radiation effects may be developed also affects these consequences.

1.3.4.4. Uncertainty exists over the effectiveness and costs of monitoring/detection and protective reaction activities in the far term. Issue 4 in Chapter 5 provides a detailed discussion of monitoring and protective reaction.

1.3.4.5. Uncertainty exists over whether or not near term genetic alterations might carry over, with long term genetic effects.

1.4. How is the acceptability of the distribution of benefits and risks/costs over time affected by irreversibility of waste disposal actions?

Comment: In theory most waste disposal actions could be reversed although some, such as waste retrieval from deep geologic media long after repository closure, would be difficult, costly and hazardous. By "irreversibility" we mean actions that would be very difficult to reverse. Irreversibility appears not to impact benefits either in the near or far term, except that a decision to irretrievably dispose of unreprocessed spent fuel would make unavailable nuclear fuel resources that could be used to produce more electricity. The impact of irreversibility on the acceptability of risks and costs seems strongly related to uncertainty issues 1.3.3 and 1.3.4 above. The combination of uncertainty of risks and costs (especially in the far term) and irreversibility may be important in deciding on waste disposal system characteristics, particularly the provisions made for retrievability of waste and the time period over which "easy" retrievability is maintained. As noted previously, uncertainty is expected to be somewhat less in the near term (see subissues of 1.3.3) than in the far term. Uncertainty over the consequences of irreversible actions has received much discussion and appears to weigh heavily on judgments of acceptability.

1.4.1. How does irreversibility of waste disposal affect near term risks?

1.4.1.1. When the period of easy retrievability ends (when backfilling occurs, when waste canisters lose their integrity, or when and if the geologic structures adjacent to canisters are deformed) irreversibility may increase risks from sudden release events.

1.4.1.2. Should a release event occur, detection and protective reaction capabilities become more important. "Difficult" retrieval and its obvious risks is also a possibility depending on the nature of the release event.

1.4.1.3. Irreversibility <u>and</u> reduction in the period over which "easy" retrievability is maintained may significantly <u>reduce</u> near term risks to the extent that it is associated with repository integrity and to the extent that the existence of retrievability as an option could lead to ill-considered retrieval actions and attendant risks.

1.4.2. How does irreversibility of waste disposal affect far-term risks?

1.4.2.1. Detection and protective reaction are the prime risk limiting considerations in the far term when easy retrievability will certainly be impossible. (See related issue 1.3.4.4.)

<u>Comment</u>: Estimation of far term risk is the subject of intense technical activity at present. These studies will, of course, impact the selection of the waste disposal systems chosen for demonstration.

1.5. How is the acceptability of the distribution of benefits and risks/ costs over time affected by alternative modes of nuclear waste disposal?

Comment: As with alternative fuel cycles (see issue 1.2), there are a number of alternative potential modes of nuclear waste disposal. These include: (a) dispersal on land or in water with the intention of diluting wastes to acceptable levels, (b) transmutation, (c) geologic disposal in deep media on land or under the ocean floor, (d) disposal in polar ice, and (e) extraterrestrial disposal by solar impact, solar orbit or earth orbit. In addition, waste storage for various periods and by various means prior to ultimate disposal has been discussed. These modes vary in technical feasibility, cost, involvement with international issues, estimated risks, and degree of uncertainty associated with estimated risks.

To explore the temporal equity implications of specific nuclear waste disposal modes is beyond the scope of this analysis. However, the heart of the question of the relative acceptability of waste disposal modes would seem to be the relation (positive or negative) between short and long term benefits and risks/costs. That is, some modes may increase near term risk in the interest of decreasing far term risk. Extraterrestrial disposal is an example. Such modes involve a negative relation between near and far term risk. Some modes may involve less risk in both the near and far term than other modes (a positive relation of near and far term risk).

1.5.1. If a choice among waste disposal modes involves a positive relation between near and far term risks, the choice will be relatively easy. The most acceptable modes will be those that minimize risk in both periods.

1.5.2. If a choice among waste disposal modes involves a negative relation between near and far term risks, a more difficult choice involving a trade-off of risks/costs over time must be made.

1.5.2.1. What factors impact this trade-off?

1.5.2.1.1. Health and safety.

1.5.2.1.2. Possibility of genetic damage.

1.5.2.1.3. Monetary cost in the present and future.

1.5.2.1.4. Necessity for long-term monitoring.

1.5.2.2. What discount function concerning future risks/costs is most acceptable?

1.5.2.2.1. Far term risks and costs may be considered less important than present and near term risks and costs. (Positive discount function.)

1.5.2.2.2. Far term risks and costs may be considered more important than present and near term risks and costs. (Negative discount function.)

Comment: While it has been suggested that our obligation, or even ability, to plan for uncertain events in the remote future is questionable and that the amelioration of known risks and costs in the present and near term is the first priority (Golding, 1968), the results from Maynard et al. (1976) indicate that most segments of the public feel the discount function should be negative, i.e., far-term risks are more important than near-term risks. Most participants at the Chicago conference appeared to agree.

1.5.3. What benefit trade-offs over time are associated with nuclear waste disposal modes?

1.5.3.1. Some modes preclude retrieval of nuclear resources that may be of value in the future (e.g., dispersal modes, transmutation and extraterrestrial disposal), whereas others maximize the potential for recovery (e.g., "temporary" storage).

1.5.4. What risk trade-offs over time are associated with nuclear waste disposal modes?

Comment: The answer to this question is the topic of thousands of pages of technical materials. The generic categories of concern are listed briefly under issue 1.5.2.1 above.

2. Is the inability of future generations to participate in waste disposal decisions that will affect them an important problem?

Comment: Some observers feel the answer to this question is "no." After all, they argue, a vast number of current societal decisions involves impacts on future generations that are irreversible or reversible only over long periods of time (examples are use of non-renewable resources and major land use decisions). Decisions involving nuclear waste may not be different in nature from many other similar decisions and perhaps should be decided in the same way (by making a careful cost/benefit judgment considering the time period over which the decision will have effect). No "special" provisions to maintain the decision flexibility of future generations may be necessary or appropriate. However, the following dependent issues should be considered.

2.1. How does amount of waste requiring disposal affect the importance of allowing future generations decision flexibility?

2.1.1. Amount of waste may have little effect on the importance of this issue.

2.1.2. As amount of waste increases, the costs/risks and benefits to future generations change (see issues 1.1.1-4). Therefore, as waste increases (as we continue using nuclear power), some feel there is more and more need to consider how future generations can join in decisions affecting them.

2.2. Can waste management decisions be postponed to avoid disenfranchisement of future generations? (Three positions are explored below.)

2.2.1. Yes, to some extent. We can continue present storage of spent rods for a limited period of time.

2.2.2. Yes, to a large extent. We can develop a longer term storage system that will maintain decision flexibility for decades and perhaps hundreds of years if provision is made for "hands on" system maintenance.

2.2.3. No. The above answers are deficient. Any decision, including no decision, involves risk and that risk inevitably spreads to future generations. Postponing decisions will serve to increase risks to near-term future generations because they will have to service the system and ultimately dispose of the waste anyway. Besides, we have no assurance that better disposal options will be available in the future than are available now, or that technological development will somehow render nuclear waste less harmful.

2.3. Should we strive to preserve flexibility for future generations to make decisions about nuclear waste? (Three differing positions on this issue are explored below under 2.3.1, 2.3.2, and 2.3.3).

2.3.1. We should make irreversible decisions now using the best information available and should <u>not</u> leave decisions for future generations to make.

2.3.1.1. How might this be accomplished?

2.3.1.1.1. The location of the repository might be kept secret.

2.3.1.1.2. Waste might be committed to the repository in such a way as to maximize irreversibility.

2.3.1.1.3. Engineered and natural barriers might be used to decrease the chances that future generations could be exposed to the waste either accidentally or through efforts to recover the waste.

2.3.1.1.4. Waste systems which maximize irreversibility such as extraterrestrial disposal, ocean burial, transmutation, and dispersal might be considered.

2.3.1.2. What might be the advantages of this approach?

2.3.1.2.1. It reduces or removes the need for future monitoring and its attendant costs.

2.3.1.2.2. It may reduce the need for information transfer to future generations.

2.3.1.2.3. It reduces the dependence on institutional stability over long time periods.

2.3.1.2.4. It requires no assumptions about the state of future technology.

2.3.1.3. What are the disadvantages of this approach?

2.3.1.3.1. Attempts to hide the repository may fail and curiosity might increase the chances of intentional breaching of containment (lack of information about the dangers would increase the risks).

2.3.1.3.2. Tends to preclude the possibility that future generations may wish to recover waste for its resource value. Thus any possible direct benefit to future generations would be lost. However, secondary benefits discussed in issue 1.1.2 would still remain.

2.3.1.3.3. In the event of waste release, protective reaction would be made more difficult without information about waste and without warning of impending release gained from monitoring.

2.3.2. Although many decisions must be made now and some of these decisions will have long term consequences, we should leave as much decision flexibility to future generations as possible.

2.3.2.1. How can this be accomplished?

2.3.2.1.1. Information about the disposal system could be passed on at least for a number of generations into the future.

2.3.2.1.2. The repository could be so constructed as to maintain easy retrievability for a considerable period and to enhance the ease of retrieval in the long term.

2.3.2.1.3. Waste systems that maximize irreversibility could be rejected.

2.3.2.1.4. Provision for monitoring the repository for a considerable period of time could be made.

2.3.2.2. What are the advantages of this approach?

2.3.2.2.1. Future generations could make more choices about the waste system--whether to continue monitoring, whether to retrieve for processing and better disposal if available, whether to retrieve for resource recovery, etc.

2.3.2.2.2. Monitoring might provide useful warning of impending waste release and information about waste and the waste system might make informed protective response possible.

2.3.2.2.3. Potentially vital resources would be maintained in a recoverable form for an extended period, thus making possible some direct benefit to future generations.

2.3.2.3. What are the disadvantages of this approach?

2.3.2.3.1. Developing and maintaining an adequate information system would have present and future costs.

2.3.2.3.2. Monitoring would have present and future costs.

2.3.2.3.3. Both information transfer and monitoring require assumptions about institutional stability over long time periods.

2.3.2.3.4. Maximizing the decision flexibility of future generations requires the assumption that future technology is equal or better than present technology.

2.3.2.3.5. Maintaining retrievability may increase near term risks as discussed in issue 1.4.1.3.

2.3.2.3.6. Maintaining retrievability may increase the near term risk from terrorism or strategic materials diversion and the attendant threat to civil liberties from attempts to limit these risks.

Comment: Issues involving resource value and terrorism/safeguards are related to fuel cycle variations, especially if reprocessing to recover plutonium is involved. Also, the retrievability issues are similar to those discussed under branch 1.4 (irreversibility) and like the irreversibility issues are related to uncertainty issues 1.3.3 and 1.3.4.

CHAPTER 3: GEOGRAPHIC AND SOCIOECONOMIC EQUITY ISSUES

INTRODUCTION

Any sizable facility constructed to provide public services, answer public needs and supply public benefits can be expected to detrimentally affect some in its immediate vicinity. For example, a dam may be constructed to provide flood control, water storage for irrigation, hydroelectric power and recreational facilities--outcomes generally considered public benefits. However, in the area to be covered by the reservoir, farm land, homes, wildlife cover, and perhaps sites of historical significance will be flooded. Residents near the construction site can expect an influx of construction workers and disruption of service facilities such as transportation routes and schools. Residents downstream may gain flood control security but could be devastated in the event of dam failure. Similar scenarios could be sketched for highways, energy production facilities, mining operations, airports, military bases, etc.

The point is that the benefits of these facilities are geographically wide, perhaps national in scope, while the social costs and risks are often concentrated.

Similarly, sizable public or private sector facilities with obvious undesirable side effects may be disproportionately located in areas of socioeconomic deprivation. The promise of jobs, increased tax base and improved social services may make such facilities attractive in areas where jobs, tax base and services are deficient, while more affluent areas may reject such facilities. In other words, short term improvements may offset the short term disruption, but long term hazards or inconvenience may remain. It may also be that such facilities tend to be located in socioeconomically deprived areas because such areas may lack the political influence to resist them. Situations like these raise socioeconomic equity issues.

In this chapter we discuss geographic and socioeconomic equity issues that have been raised in connection with the siting and operation of nuclear waste management facilities. The focus will be primarily on the near term because these issues commonly become salient at the time prospective sites are evaluated. Of course, some effects, both benefits and risks, will extend far into the future. Therefore, questions of long term geographic and socioeconomic equity are also raised.

For convenience, waste management activities have been divided roughly into four classes: waste processing activities (processing spent fuel into a form suitable for disposal), transportation (moving spent fuel to the waste processing facility and from there to the waste disposal site--although processing and disposal activities may be co-located), waste emplacement (placing processed waste into the final disposal position), and short term monitoring (monitoring the performance of the waste emplacement system and the performance of the repository during the pilot phase and the period of "easy" retrievability). If a waste management system that involves temporary waste storage is implemented, this would constitute an additional class of activities. Each of these activities (including transportation) involves geographic equity issues. Each of these activities would also seem to involve socioeconomic equity issues. Those activities requiring construction of facilities will also involve local short term construction impacts. In the discussion of the issues to follow, these waste management activities will not be dealt with separately except where one activity or another seems particularly salient. Therefore, the discussion of the geographic and socioeconomic equity issues is intended to apply to all classes of waste management activities.

SUMMARY OF PRIMARY AND DEPENDENT ISSUES

Primary Issues:

1. What factors affect the acceptability of the geographic distribution of benefits and risks/costs from nuclear waste management?
2. What factors affect the acceptability of the distribution across socioeconomic groups of benefits and risks/costs from nuclear waste management?

Dependent Issues:

- 1.1. How is the acceptability of the geographic distribution of benefits and risks/costs affected by the amount of waste requiring disposal?
- 1.2. How is the acceptability of the geographic distribution of benefits and risks/costs affected by alternative nuclear fuel cycles and disposal modes?

1.3. How is the acceptability of the geographic distribution of benefits and risks/costs affected by uncertainty over their calculation?

1.4. How is the acceptability of the geographic distribution of benefits and risks/costs affected by the maintenance of retrievability?

1.5. How does the geographic distribution of benefits and risks/costs affect local willingness to accept waste management facilities?

1.6. Is the geographic distribution of benefits and risks/costs an important long-term issue?

2.1. Is the socioeconomic distribution of benefits and risks/costs an important issue?

2.2. What benefits and risks/costs are related to socioeconomic differences?

ISSUE OUTLINE

1. What factors affect the acceptability of the geographic distribution of benefits and risks/costs from nuclear waste management?

   1.1. How is the acceptability of the geographic distribution of benefits and risks/costs affected by the amount of waste requiring disposal?

      1.1.1. As the amount of waste produced increases, it may be necessary to increase the number of waste processing and disposal sites. The number of waste shipments increases directly with the amount of waste, although multiple sites, geographically dispersed in several regions, would shorten the length of waste shipments. This would tend to reduce the transportation risks per unit of waste volume. In general, as the number and geographic dispersal of waste sites increases, the major geographic equity issue of widely dispersed benefits of nuclear power and narrowly site specific risks of waste disposal decreases. Increasing the number of sites, beyond those considered optimal from a technical standpoint, has been suggested by some as a way of reducing geographic inequity.

      1.1.2. As the amount of waste stored in each site increases, the severity of the geographic equity issue increases.

      1.1.3. The economic costs of nuclear waste management are related to the amount of waste. However, there is wide agreement (and federal policy) that the costs of waste management will be borne by the users of nuclear power rather than fall disproportionately on residents near waste management sites. Therefore, economic cost, given the continuation of present policy, is not a geographic equity issue. (See Issue 3 in Chapter 4 for a fuller discussion of economic cost.)

1.2. How is the acceptability of the geographic distribution of benefits and risks/costs affected by alternative nuclear fuel cycles and disposal modes?

1.2.1. How do fuel cycle variations affect geographic equity?

1.2.1.1. How do fuel cycle variations affect the geographic distribution of benefits?

1.2.1.1.1. The benefits of nuclear power are related to fuel cycles in that some may be cheaper or more technically feasible and thus more available for use. Benefits of such power are widely distributed but more valuable in regions where alternative sources of power are limited or expensive.

1.2.1.1.2. Some fuel cycles involve fuel reprocessing and more extensive waste processing and thus offer greater potential for natural benefits such as employment and economic growth.

1.2.1.1.3. Fuel cycle variations requiring international cooperation may provide important economic benefits for developing countries as they may be selected as the site of a multinational facility or receive technical support and resources.

1.2.1.2. How do fuel cycle variations affect the geographic distribution of risks/costs?

1.2.1.2.1. To the extent that risks associated with waste processing, transportation, waste emplacement and monitoring vary by fuel cycle they will affect geographic equity.

1.2.1.2.2. To the extent that fuel cycle variations affect nuclear safeguards, terrorism and associated threats to civil liberties they will impact on geographic equity.

1.2.1.2.3. Fuel cycle variations may affect the likelihood of waste retrieval and its attendant risks and thus may impact on geographic equity.

Comment: The above issues are also mentioned as near-term benefits and risks under Issue 1.1. in Chapter 2, the temporal equity chapter.

1.2.1.2.4. Some fuel cycle variations may result in higher electricity costs than others and thus affect geographic equity.

1.2.1.2.5. A decision to implement or exclusively pursue a fuel cycle which entails higher costs, is less available or technically underdeveloped, will impact the present and near term economic development nationally, increasing the cost of living over time, while competing with geographic regions or nations using more available and less costly fuel cycles. Consequently, fuel cycle variations may impact the relative economic well-being of geographic areas.

1.2.1.2.6. Fuel cycle variations involving international cooperation between nuclear supplier and consumer nations may affect cost and availability of reprocessing and waste management activities; increase risk by extending nuclear technology into developing countries with inadequate technical expertise and facilities; and increase political tension between nations with conflicting objectives in their alliance.

1.2.2. How do alternative disposal modes affect geographic equity?

1.2.2.1. Disposal mode variations are not expected to have major impact on the production of nuclear power and thus should not impact benefits directly. However, should a policy decision result in the choice of a disposal mode that requires an extended period of technical development, power production may be delayed and regions more dependent on nuclear power would suffer most.

1.2.2.2. Alternative disposal modes may have important impact on the geographic distribution of risks. For instance, dispersal on land would presumably spread the risk geographically, while dispersal in water would place at risk those in the proximity of the body of water chosen. Choice of a geologic media that occurs in only a few places would also contribute to geographic inequity. Extraterrestrial disposal might inequitably place at risk those living in the launch area.

Comment: This issue is the subject of extensive research and development activity. A full discussion of risks associated with specific disposal modes is beyond the scope of this analysis. In general, to the extent that various disposal modes affect site specific risks, geographic equity issues are involved.

1.3. How is the acceptability of the geographic distribution of benefits and risks/costs affected by uncertainty over their calculation?

Comment: This issue is somewhat parallel to issues 1.3.1 and 1.3.3 in Chapter 2. The effect of uncertainty on the calculation of present and near term benefits and risks was discussed there. That discussion will be supplemented below by geographic considerations.

1.3.1. The calculation of benefits from nuclear power by region depends to some extent on the present and near term availability of alternative means of generating electric power. Coal is more available in some regions than others and offers a near term alternative. Opportunities for solar conversion to electricity also vary by region. Uncertainties in the calculation of benefits involve (a) national policy decisions, e.g., import restrictions on oil, strip mining, permissible emissions from coal generation, mandated conservation actions, and (b) technical uncertainties, e.g., speed of solar development and technical advances in conservation. These uncertainties affect regions of the country differentially as a function of the differential availability of alternatives in various regions.

1.3.2. The calculation of present and near term risks and economic costs of nuclear waste management by region would appear to be little affected by uncertainty. That is, the uncertainties described under 1.3.3 in Chapter 2 would appear to apply equally to regions.

Comment: The above tentative conclusion assumes that technical criteria for waste management facility siting will be applied evenly throughout the country. This latter assumption runs counter to the suggestions of some that nuclear waste be disposed of in the vicinity where the power is used. While this might appear to lessen problems of geographic inequity, it may actually increase them since some regions may possess no sites that meet acceptable technical criteria. Placing waste in these regions would impose inequitable risks on power users in these areas.

1.3.3. The calculations of present and near term costs and risks of waste management are affected by uncertainty over the effectiveness of international arrangements to reduce proliferation of nuclear weapons risk and safely provide nuclear technology to developing countries. To the extent that location of reprocessing and waste facilities are determined by political concerns in such an international effort, rather than technological criteria, geographic inequity may occur.

1.4. How is the acceptability of the geographic distribution of benefits and risks/costs affected by the maintenance of retrievability?

1.4.1. The relation of retrievability to near term risks is discussed in issue 1.4.1 in Chapter 2. To that discussion might be added one point of significance to geographic equity: if monitoring reveals that a repository is failing or if superior modes of disposal should be discovered, the maintenance of retrievability would permit remedies and thus might avoid geographically inequitable consequences. Retrievability may thus be a partial hedge against geographic inequities (and may as a consequence increase the acceptability of the repository to the local citizens). Of course, retrieval implies additional waste processing, transportation, and disposal elsewhere which may simply shift risks elsewhere, but should not substantially increase geographic inequity.

1.5. How does the geographic distribution of benefits and risks/costs affect local willingness to accept waste management facilities?

1.5.1. What <u>local</u> benefits and risks/costs should be considered in evaluating the seriousness of geographic inequity due to nuclear waste disposal activities?

<u>Comment</u>: A full answer to this question is obviously beyond the scope of the current issues analysis and will involve both generic and site specific environmental impact statements. The following list is merely illustrative of the factors that need to be considered.

1.5.1.1. Local benefit categories for consideration.

1.5.1.1.1. Employment during RD&D stage, construction stage, operational stage and monitoring period.

1.5.1.1.2. Economic development both directly and indirectly resulting from the above stages.

1.5.1.1.3. Benefits resulting from "special compensation" (if any).

1.5.1.2. Local cost/risk categories for consideration.

1.5.1.2.1. Threat to health and safety from accidents.

1.5.1.2.2. Environmental pollution threat from material mined to construct the repository, e.g., salt.

1.5.1.2.3. Threat to social structure and quality of life arising from the possibility of terrorist acts and threats to civil liberties as a result of actions to prevent such acts.

1.5.1.2.4. Opportunity costs to local economic development resulting from land use restrictions and possible need to maintain low population density.

1.5.1.2.5. Disruption of the existing way of life for pre-existing residents.

Comment: Again local direct economic costs have not been considered on the assumption that disproportionate costs would not be borne by the local residents.

1.5.2. How much weight should be placed on local willingness to accept nuclear waste management facilities? (Two contrasting positions are discussed below.)

1.5.2.1. Very great weight. Local willingness is the crux of the geographic equity issue. If the locals in several areas will accept facilities, the problem is solved.

1.5.2.2. Little weight. Responsibility for sound and balanced siting decisions is national. While local desire for or opposition to facilities can't be ignored, geologic and technical criteria are much more important siting considerations.

1.5.2.3. What factors affect a decision on the relative importance of local willingness to accept waste management facilities?

1.5.2.3.1. The extent to which geologic and other technical siting criteria are standardized and applied uniformly to all prospective sites.

1.5.2.3.2. The extent to which geologic and other technical siting criteria can be met by many as opposed to only a few prospective sites.

1.5.2.3.3. The extent to which national policy decisions dictate that siting responsibility is a national (federal) function with pre-emptive authority over state and local siting decisions.

1.5.3. Should "special compensation" be given to a locality to increase local willingness to accept waste management facilities? (Two contrasting positions are discussed.)

1.5.3.1. No. Waste management facilities must be located somewhere. The optimal sites should be chosen on grounds other than local willingness. Special compensation is inappropriate just as it is with siting national defense facilities or other essential facilities in the broad public interest.

1.5.3.2. Yes. Waste management facilities are a special case because of the general lack of "natural" benefits such as employment and the prospect of economic development and because location of waste management facilities may curtail other local development opportunities. The local risks will so outweigh the local benefits that local acceptance will be impossible to obtain without special compensation.

1.5.3.2.1. What form might special compensation take?

Comment: Many forms are conceivable. Examples might include provision of local services that will greatly improve the quality of life compared to other comparable locations without a waste facility, colocation of highly desirable federal facilities, and direct money payments to state and local governments or even to individuals.

1.5.4. To what extent might siting of nuclear waste management facilities based on local willingness affect the risks and benefits borne by other localities?

1.5.4.1. Siting of facilities in certain localities may greatly increase the transportation risks borne by many other localities.

Comment: Much of the discussion of issue 1.5 is primarily relevant to repository siting, but risks from waste processing facilities and waste transportation also present problems of geographic equity. If local willingness to accept a repository becomes a dominant siting consideration, it raises the possibility of increasing geographic inequity due to increased risks from waste transportation. Geographic inequity from waste transportation would seem to be of less importance than geographic inequity due to waste processing and repository facility siting since waste will be transported in many areas of the country with consequent geographic spreading of risk. However, it should be noted that "natural" compensating benefits such as employment and economic development would seem to be almost completely absent along the waste transportation routes.

1.6. Is the geographic distribution of benefits and risks/costs an important long term issue?

Comment: In the long term, people living near a repository may incur greater risk than those living far away. Uncertainty exists over the need to maintain retrievability and active monitoring and the period over which these activities may be sustained. However, unless the location and nature of repositories are hidden, future generations could presumably evaluate the risks and make voluntary decisions about living near them. Should the repository site be perceived in the long term as an undesirable area, there is a possibility that disadvantaged socioeconomic groups would locate there, thus constituting geographic and socioeconomic inequity in the long term. (See issue 2.1 below for a discussion of socio-economic inequity.) The long term benefits of nuclear power involve fossil fuel conservation and the avoidance of possible long term environmental impacts of alternative technologies (see issue 1.3.2 in Chapter 2). These benefits are probably less location-specific in the long term than in the short term, and thus do not impact the geographical equity issues very directly. On balance, the long term issues of geographic and socioeconomic equity seem somewhat less important than those in the present and near term. Given these considerations, no further aspects of this issue will be discussed.

2. What factors affect the acceptability of the socioeconomic distribution of benefits and risks/costs from nuclear waste management?

   2.1. Is the socioeconomic distribution of benefits and risks/costs an important issue? (Two contrasting positions are discussed.)

      2.1.1. The socioeconomic distribution of benefits, risks and costs is an important issue because using nuclear power to add to the current electrical supply benefits the affluent more than the disadvantaged, while risks from nuclear waste management will be borne disproportionately by certain occupational groups (miners and technicians) or by economically deprived areas where waste management facilities may be located.

      2.1.2. The socioeconomic distribution of benefits, risks and costs is not an important issue as it is not unique compared to benefits, risks and costs from other forms of industrial development or energy technology. Increasing the supply of electrical power is essential in order to improve the standard of living of the disadvantaged, and occupational groups voluntarily undertake risks with full awareness and compensation.

2.2. What benefits and risks/costs are related to socioeconomic differences?

2.2.1. Benefits related to socioeconomic differences.

Comment: The local benefit categories listed under issue 1.5.1.1 above do not seem to disproportionately benefit any one socioeconomic group. However, "special compensation" may, depending on its nature, e.g., special provisions for improving services to the poor.

2.2.1.1. The benefits of more electrical power may go primarily to the affluent.

2.2.1.2. The benefits of more electrical power may go primarily to the poor.

2.2.2. Risks related to socioeconomic differences.

Comment: None of the local risks listed under issue 1.5.1.2 above appear socioeconomically related.

2.2.2.1. Certain occupational groups will bear much of the risk of waste processing, transportation and disposal.

2.2.2.2. Waste disposal facilities may be more likely to be sited in economically deprived areas or states.

CHAPTER 4: ISSUES OF IMPLEMENTATION OF A NUCLEAR WASTE MANAGEMENT SYSTEM

INTRODUCTION

This chapter is concerned with how waste management systems will be implemented. The emphasis is on issues associated with actions that will need to be set in motion in the next few years: what kind of organizations should handle nuclear waste management activities? how should they be regulated? what financial arrangements are necessary? and what should be done about long term monitoring?

Waste management functions to be carried out include: (1) transportation of spent fuel rods to reprocessing facilities or to waste treatment facilities for packaging prior to disposal, (2) reprocessing to recover uranium and/or plutonium (if this option is decided on), (3) treatment and packaging of high level waste from the reprocessing facilities or treatment and packaging of spent fuel rods (if reprocessing is decided against), (4) transportation of waste to disposal or interim storage facilities, (5) construction and pilot testing of waste repository and/or interim storage facilities, (6) waste emplacement, (7) repository monitoring during the emplacement phase, (8) repository backfilling and closure, (9) information transfer, and (10) monitoring after repository closure.

"Implementation" implies a present and near term time frame but, as with so many issues in nuclear waste management, the long term perspective is highly relevant. That is, action will have to be taken to dispose of nuclear waste in the next few years and decades, but consideration must be given to how mechanisms such as financing and repository monitoring will remain viable and function effectively over the very long time periods of concern.

In this chapter we do not attempt to address the implementation issues specific to each alternative waste management system. As mentioned previously, a number of major waste management decisions remain to be made. These include: reprocessing, waste treatment, appropriate geologic media, repository design, provisions for interim storage, provisions for retrievability, periods over which "easy" retrievability will be maintained, and monitoring requirements in different time periods. Decisions must also be made about possible collaboration with other nations in managing nuclear wastes. Suggestions for multinationally operated fuel reprocessing facilities have been made but not yet carefully examined. Suggestions have also been made that the U.S. bring back spent fuel from U.S.-produced reactors abroad for storage, processing and/or disposal here. Multinational management of nuclear waste would raise a number of implementation issues which at this stage seem too speculative to attempt to cover here.

During the past ten years there have been several marked shifts in national waste management policy. It can be expected that as technical and political factors interact in the next few years there may be further shifts. In any case, as waste management system decisions are made they will impact implementation issues. Some will become more salient, others less so. At the same time, implementation or practicality questions affect waste management system decisions. Our treatment is intended to cover public issues common to many or all of the domestic waste management system alternatives currently under discussion.

SUMMARY OF PRIMARY AND DEPENDENT ISSUES

Primary Issues:

1. What organizational characteristics and organizational forms are necessary for the effective management of nuclear waste?
2. What regulatory and inspection functions are necessary to oversee the management of nuclear waste?
3. What financial arrangements are necessary to assure the management of nuclear waste in the near and far term?
4. What arrangements are necessary for the monitoring of nuclear waste and for taking protective reaction measures in the event of system failure after the period of active disposal has ended?

Dependent Issues:

- 1.1. What factors should be considered in choosing or designing waste management organizations?
- 1.2. Are unique or unusual organizational features desirable in nuclear waste management?

1.3. What type or types of organization(s) should be considered to carry out nuclear waste disposal?

1.4. What organizational problems are posed by the different requirements of the several temporal phases of nuclear waste disposal activity?

2.1. What factors should be considered in specifying arrangements for the regulation and inspection of nuclear waste management operations?

2.2. What jurisdictional considerations are involved with the regulation and inspection of nuclear waste management systems?

2.3. What factors need to be considered in carrying out regulatory and inspection functions?

3.1. What uncertainties affect the estimation of costs of nuclear waste management?

3.2. What are the broad policy options for nuclear waste cost estimating?

3.3. What long-term considerations affect financial planning?

4.1. What functions may be necessary in different time periods?

4.2. What provisions should be made for the long-term transfer of information about nuclear waste?

4.3. What factors are likely to affect nuclear waste monitoring functions over time?

4.4. What factors are likely to affect protective reaction capability in the event of system failure in various time periods?

ISSUE OUTLINE

1. What organizational characteristics and organizational forms are necessary for the effective management of nuclear waste?

1.1. What factors should be considered in choosing or designing waste management organizations?

1.1.1. Must performance standards for waste management organizations be extraordinarily high? Some argue the functions are exacting and that error consequences will be serious and long lasting. Others argue that waste management functions are no more difficult than many other high technology industrial processes.

1.1.2. Should there be provisions for very long-term organizational stability in order to assure effective performance? Some argue that such provisions would help guarantee stability of performance while others feel periodic consideration of new organizations would prevent complacency and help guarantee redundant capability to perform waste management functions.

1.1.3. In order to assure smooth interfacing between sequential waste management activities and clear lines of authority and accountability, some argue that waste management functions should be performed by a single vertically integrated organization. Others argue that vertical integration does not promote accountability or guarantee smooth interfacing between activities.

1.1.4. How important are economic efficiency and cost competitiveness as criteria for choosing waste management organizations? Some argue that cost is always an important consideration, while others feel that maximum safety should be sought without regard to cost.

1.1.5. Should there be provision for profit making in managing nuclear waste? Arguments that profit is often an incentive to better performance have been met with concern that profit maximization and cost cutting may take precedence over safe system performance.

1.1.6. Should organizational adaptability be considered a desirable characteristic? Some argue that waste management organizations must have the capability to adapt effectively to changed circumstances such as technical evolution, accidental events and shifts in waste management policy. Others emphasize consistency and invariance of performance and argue for buffering waste management organizations from policy fluctuations.

1.2. Are unique or unusual organizational features desirable in nuclear waste management? (Two positions are characterized.)

1.2.1. Governments have evolved procedures for carrying out long-term service functions for society, e.g., the defense system, postal system, the regulation of commerce, and the support of RD&D. The lessons learned should be carefully applied to choose organizational arrangements that have been effective in the past. In other words, we should not "experiment" with waste management.

1.2.2. The unique demands of a waste management system for high quality performance over long time periods argues for the creation of new organizational forms with special characteristics, e.g., the creation of a "nuclear priesthood," the provision of special status and incentives, the guarantee of autonomy sufficient to weather ill-considered policy shifts and social unrest, or the creation of an international organization under international authority to manage nuclear waste and reduce threat from proliferation.

1.3. What type or types of organization(s) should be considered to carry out nuclear waste disposal?

Comment: The reader is invited to assess each of the following organizational arrangements in the light of the issues presented in 1.1. above. Past experience with the organizational forms below should be considered but need not determine the choice if new and unusual features are added as discussed in 1.2.2. above.

1.3.1. Federal agency owns and operates facilities.

1.3.2. Government corporation owns and operates facilities.

1.3.3. Government owns facilities which are operated by private contractors.

1.3.4. Private industry owns and operates facilities under contract with the government.

Comment: Contracts in the case of 1.3.3. and 1.3.4. could be exclusive over long time periods or open to periodic rebid.

1.3.5. Privately owned and operated waste management firm(s) contract directly with utilities within regulations set by the federal government.

1.3.6. Various waste management functions could be performed by a mix of preceding organizational arrangements.

1.3.7. Multinational waste facilities, owned and operated by cooperating nations and financially independent of the host country, could perform all functions regulated by an international/multinational agency.

1.4. What organizational problems are posed by the different requirements of the several temporal phases of nuclear waste disposal activity?

<u>Comment</u>: Each of the problems listed below in sections 1.4.1 to 1.4.9 raises questions of how important the problem is; how it should figure in the design and choice of waste management organizations; and what, if anything, can be done in the present to reduce the problem.

1.4.1. Research and development activities are currently performed primarily under contract in government owned and private facilities. Contractors involved during the RD&D stages of nuclear waste disposal will naturally develop the technical capability and personnel resources to participate in later operational phases. Preparation for licensing and the period of pilot operation should give those organizations involved at the beginning an edge in preparing for the operational phase. It may be difficult to alter the status quo even if it appears beneficial to do so.

1.4.2. Depending on the ultimate size and rate of build-up of the nuclear power industry, the scale of waste management operations may tax the capability of organizations to expand appropriately. Plans for increases in the scale of operations will need to be carefully considered.

1.4.3. When the period of waste processing and disposal draws to a close, the scale and nature of waste management functions will change more or less drastically. Organizational arrangements will need to provide for these changes.

1.4.4. After repository closure, the nature of maintenance and monitoring functions will be quite different and may require different organizational arrangements than those appropriate during active disposal operations.

1.4.5. Since monitoring and repository security functions may be carried out for several hundred years, appropriate organizational arrangements will need to be carefully considered with special emphasis on stability of performance and management.

1.4.6. Should the decision be made to maintain "easy" retrievability for long time periods, the scale and nature of long-term performance would be markedly affected.

1.4.7. Should major repository failure occur as a result of improper repository design, it will likely be detected during or shortly after the period of active disposal. Arrangements for protective reaction, including evacuation, repository repair (if feasible) or retrieval and re-disposal elsewhere will be required. Whether "stand-by" capability (such as the standing military) or "skeletal" arrangements like those for civil defense in case of nuclear attack are called for will have important effects on the necessary organizational arrangements.

1.4.8 It seems unlikely that stand-by capability would be maintained over the very long time periods that waste will remain potentially hazardous. Attempting to provide for organizational continuity to monitor and direct protective reactions over a time scale of hundreds or even thousands of years is a highly uncertain undertaking.

Comment: Although organizations and institutions have existed and provided some continuity of function over many hundreds of years in the past, it is difficult to see how actions could be taken in the present to assure such continuity of organizational functioning in the future. Indeed, some have argued that no such provisions should be made. Rather, that we should act only to provide future generations with decision flexibility by preserving information about nuclear waste.

1.4.9. The possibility exists that the hazards of nuclear waste will turn out to be either somewhat greater or somewhat less than presently estimated. Low probability but high consequences natural events leading to repository breaching, new and highly effective technical developments in waste handling, or medical advances that negate the harmful effects of radiation are conceivable. Organizational arrangements, made in the present, seem unlikely to materially affect these speculative outcomes.

2. What regulatory and inspection functions are necessary to oversee the management of nuclear waste?

   2.1. What factors should be considered in specifying arrangements for the regulation and inspection of nuclear waste management operations?

   Comment: There appears to be general agreement that regulatory organizations, like the waste management organizations they regulate, must have high technical capability and standards for their own performance of the regulatory function. They must also be accountable to the established societal authority system and exhibit stability over time as well as adaptability. Additional issues are discussed below.

   2.1.1. How can regulatory organizations be assured of operating independently of the organizations they regulate so as to avoid conflicts of interest over the long time periods of concern?

   2.1.2. Should there be provision for redundancy of the regulatory function? If so, should there be two or more federal regulatory agencies, should the states have regulatory authority, and how can redundant regulations be made compatible yet function independently?

   2.1.3. How can international regulatory agencies effectively regulate organizations without intruding into national security and politics and still maintain effective and realistic international safeguards?

   2.2. What jurisdictional considerations are involved with the regulation and inspection of nuclear waste management systems?

   2.2.1. Standard setting and primary regulatory and inspection responsibilities seem likely to be vested in the federal government.

   2.2.2. Some, if not many, states and a few local governments will wish to set standards and participate in the regulatory function.

   2.2.3. In the case of conflict between federal and other jurisdictions, will the principle of federal preemption apply?

   Comment: Federal preemption is partly a legal question, which will be argued on grounds of constitutional language and precedent; and partly a political question, which will be affected by the relative political power of the federal government and the jurisdiction in question. Issues of geographic equity are germane to preemption and are discussed under issue 1.5 in Chapter 3 and issues 4.1 and 4.3 in Chapter 5. Those discussions will not be repeated here. However, regardless of executive, legislative, and judicial decisions that may reinforce the principle of federal preemption, state and local influence seem likely to exert themselves through the normal political process to affect the choice of waste disposal facility sites as well as the operation of the regulatory and inspection functions within their jurisdictions.

2.2.4. Standard setting, regulatory and inspection responsibilities at the international level will probably be determined by consensus of participating member countries, but are likely to be strongly affected by the country in which the facility is located.

2.3. What factors need to be considered in carrying out regulatory and inspection functions?

Comment: Regulatory and inspection functions may be viewed in general as actions to insure that waste disposal operations meet the specifications set as satisfying agreed-upon standards. In the present climate of multiple options and technical alternatives for waste management there are no clear standards on which specifications have been set. Future decisions growing out of current RD&D activities, national and international social policy considerations, and perhaps economic factors will set these system specifications. For the present we can do no more than discuss general regulatory functions.

2.3.1. Standard setting. How can standards be clearly stated and designed such that deviation can be detected with relative ease? How can it be determined that standards are complete and sufficient, i.e., that, taken as a whole, they will insure that the system functions as intended? How can standards set by several jurisdictions (e.g., international, federal, and state) be made compatible to form a clear basis for licensing, review, and inspection?

2.3.2. Licensing. What special considerations might apply to nuclear waste management licensing? For instance, how much relative attention should be given to generic versus site-specific environmental impact statements? How long a period of pilot operation is appropriate as a basis for licensing decisions?

2.3.3. Technical review. How can there be assurance that this function will be an independent check of the adequacy of the standard setting procedure and the adequacy with which a facility cleared for licensing meets the standards?

2.3.4. Inspection. Will redundancy of inspection by independent agencies insure that standards are met and that long periods of adequate performance do not lead to complacent performance of the inspection function or to a community of interest between the inspected and the inspectors that can result in tolerance of small infractions? Should inspectors or inspecting agencies be periodically replaced?

2.3.5. Enforcement. What enforcement issues can be identified?

2.3.5.1. Regulatory enforcement relies primarily on negative sanctions. Penalties available include license revocation, fines and personal sanctions. How can license revocation and fines be imposed on public organizations? Are other sanctions available? Is the function of an international regulatory agency really adequate when its apparent power is restricted by governmental cooperation and its only negative sanction is public censure?

2.3.5.2. A major problem with waste management regulation will probably be the detection of actions that do not quite meet the standards. How can the point at which penalties are justified be defined? How can the severity of penalties be determined? Are there positive sanctions that encourage performance that fully meets the standards?

2.3.5.3. An additional problem with license revocation is the availability of alternative means of performing the needed functions. Halting the operations of an organization or a facility performing vital functions can be considered only if there is an adequate alternative means for performing these functions. Some have suggested that in the case of waste management this would require the construction and certification of stand-by facilities and perhaps stand-by organizations to be used if problems develop with operational ones. To what extent is this justified?

3. What financial arrangements are necessary to assure the management of nuclear waste in the near and far term?

Comment: Current policy on financing nuclear waste disposal is outlined in 10 CFR 50, Appendix F. It lays down the principle that the costs of nuclear waste disposal are to be paid by users of nuclear power. At the time utilities turn waste over to the government for disposal, they are to pay the federal government a fee which is to defray all costs of disposal and perpetual surveillance. Presumably costs would be built into the current rate structure. Money not expended by the government in construction and active operation of the waste management system would presumably go to establish a perpetual trust fund. Proceeds from this fund would be used for long-term monitoring and security. Recent estimates of cost for waste disposal do not appear burdensome. About one percent of the value of generated power has been estimated to be sufficient (Rowe and Holcomb, 1974; Kubo and Rose, 1973). However, the fees paid by utilities have yet to be worked out and cannot be settled until the waste management system is more fully defined. Utility commissions will then have to approve rate adjustments to defray these costs.

3.1. What uncertainties affect the estimation of costs of nuclear waste management?

3.1.1. What is the impact on waste management costs of a decision to reprocess spent fuel to recover unused uranium and/or plutonium?

3.1.2. What are the differential costs of various technical alternatives for waste management currently under active consideration?

3.1.3. What are the costs of maintaining retrievability for various periods after waste emplacement in a repository?

3.1.4. What are the costs of interim storage of waste after it is in federal government care pending reprocessing or final disposal decisions?

3.1.5. What are the costs of intensive monitoring activity during and for a period of time after waste emplacement?

3.1.6. What are the costs of establishing and maintaining in a state of readiness the capability to monitor and provide for protective reaction should repository failure occur during or shortly after waste emplacement?

3.1.7. What are the costs of monitoring and security functions over several hundred or thousand years after repository closure?

3.1.8. What are the costs of establishing and maintaining an information system to inform future societies about nuclear wastes and their location?

3.1.9. What are the costs of correcting or coping with repository failure should corrective action be necessary at some time in the future?

3.1.10 What are the costs of providing protection against diversion of nuclear materials by terrorists or hostile nations?

3.2. What are the broad policy options for nuclear waste cost estimating?

3.2.1. The "expected value" cost estimating approach. Under this approach, careful estimates of the most likely cost of each aspect of the system over time are made. The intent is to predict how the system is actually expected to operate and what this will cost. High probability events are given much more weight than low probability events. The full cost of routine operation is included with provision made for a reasonable number of accidental events. In brief, the expected value approach estimates the cost of the most likely scenario.

3.2.2. The "contingency plan" cost estimating approach. Cost estimating under this approach includes all the costs of the expected value approach but makes provision for the financing of less likely (but possible) events. For instance, we could assume that the state of technology a hundred years from now will have deteriorated and will be unable to direct protective reaction to a waste leak. To counter this possibility we could take extra (and more costly) measures to secure waste in engineered barriers within geologic storage and we could set in motion elaborate mechanisms to preserve nuclear technology in a state of full readiness.

Supporters of the contingency plan approach argue that the extra measures will help prevent passing on costs to future generations who will not enjoy compensating benefits of nuclear power usage. Detractors argue that there will be a substantial margin of safety designed into the system as presently conceived and that the costs are open-ended because there is no rational way to decide how much extra protection to provide. They argue that if our intent is to make the world safer for future generations, our decisions should be consistent with the principle of committing financial resources where they will do the most good, rather than providing expensive and probably unneeded extra safety in nuclear waste disposal.

Comment: Whatever cost estimating approach is used, it will result in a range of possible costs for various waste management functions. Decisions will need to be made about what point on these ranges of cost will become the financing targets for each waste management function. Given the expected technical uncertainties, these decisions may rest heavily on social values.

3.3. What long term considerations affect financial planning?

3.3.1. Uncertainties in estimating future costs. These uncertainties were discussed above under issue 3.1. Most of these uncertainties fall into two classes: uncertainties stemming from the cost impact of decisions yet to be made about design elements of the waste disposal system, and uncertainties relating to the probability of occurrence of waste releasing events.

3.3.2. Decisions made by future generations. It is possible that in the future the hazards of nuclear waste may actually be less (see issue 1.4.10 above) or may be judged unimportant. Future societies could decide to discontinue waste monitoring activities and dismantle organizations set in motion now to perpetuate waste disposal technology. Conversely, future generations may decide to retrieve and use fissionable or rare materials or to redispose of them in some fashion not currently feasible. In any case, decisions made in the future and beyond our control could impact the ultimate cost of waste disposal. Should we try to take account of these possibilities? How can we do so?

3.3.3. Societal stability. Long-term financing will presumably be accomplished by some sort of perpetual trust fund. Perhaps investment in land or renewable resources unlikely to lose their value over long time periods would be effective. In the event of a massive breakdown in societal control over institutions and laws, such trusts could fail.

3.3.4. Change in technological capability. The state of technology in the future will affect the costs of monitoring and taking protective reaction. These activities may be either more or less expensive than estimates based on our current technology. How can estimates of future technical capability be made?

3.3.5. Timing of natural events. Nuclear wastes now appear likely to be placed in deep geologic media. Only very low probability natural events are likely to cause <u>massive</u> breaches in containment. Should a massive breach occur early in the disposal period when radioactivity levels have had little chance to decay, the cost of protective reaction might be very high. A breach a thousand years later would probably have much smaller consequences. In financial planning, what assumptions should be made about the timing of natural events that may breach a repository?

4. What arrangements are necessary for the monitoring of nuclear waste and for taking protective reaction measures in the event of system failure after the period of active disposal has ended?

4.1. What functions may be necessary in different time periods?

4.1.1. Phase 1, now to 100 years after repository closure.

Comment: During this period the bulk of radioactive decay and thermal release occurs. The waste management functions up to the point of repository backfilling and closure were listed as items 1 through 8 in the second paragraph of the introduction to this chapter. Phase 1 activities after repository closure are listed below.

4.1.1.1. What provisions should be made for control and management? In Phase 1 it is likely that monitoring of repository security, plant maintenance, and maintenance of an onsite technical staff will be required.

4.1.1.2. What provisions should be made for monitoring of repository integrity? This function involves continuous observation of seismic, thermal and radiological conditions to assure that the repository is behaving as expected.

4.1.1.3. What provisions should be made for taking protective reaction? For instance, should there be back-up facilities? (See related issue 2.3.5.3.) Should there be evacuation plans?

4.1.1.4. What provisions should be made for information transfer? Should a special system of records about the repository and its contents be maintained to assist in repair and provide a basis for long-term information transfer?

4.1.2. Phase 2, 100 to 700 years after repository closure.

Comment: During this period fission products will continue to decay to inert levels, leaving only the long-lived radio-isotopes as the basis of continuing hazard.

4.1.2.1. Control and management. As Phase 2 progresses there may or may not be a perceived need to maintain active security and plant maintenance. Decision makers several hundred years hence may decide that a repository that has not been threatened for hundreds of years need not be actively staffed and guarded. Of course, if the repository has been a source of problems during this period, active management is likely to continue. What actions, if any, should be taken now to affect these decisions?

4.1.2.2. Monitoring of repository integrity. Assuming the repository has performed as expected, it is likely that radiological monitoring and seismic surveys may become periodic or be abandoned entirely at the discretion of the decision makers at that time. It has been suggested by some that site monitoring could provide a part-time job for one or two technicians. Of course, other prognosticators feel a sizable staff will be kept busy for thousands of generations into the future. What provisions should and can be made now?

4.1.2.3. Protective reaction. What provisions can or should be made now?

4.1.2.4. Information transfer. It seems likely that special efforts will continue to be made to maintain an information base about waste characteristics and repository design. At the least, warning signs or physical barriers may exist at the site and information may be maintained at several locations on or off site. How can such provisions be made?

4.1.3. Phase 3, more than 700 years after repository closure.

4.1.3.1. Control and management. Onsite management is unlikely if experience has been good to that period. Should we try to insure it anyway?

4.1.3.2. Monitoring of repository integrity. It is unlikely that monitoring would continue unless previous monitoring has detected ominous changes. Should we try to provide for it anyway?

4.1.3.3. Protective reaction. What provisions can we make that would improve protective reaction capability in this period?

4.1.3.4. Information transfer. Institutionalized efforts to preserve specific information about the waste disposal system may cease but there is little reason to believe that the information would be lost to mankind unless there is cataclysmic social upheaval. In this event nuclear waste problems might seem comparatively insignificant anyway.

4.2. What provisions should be made for the long-term transfer of information about nuclear waste? (Three positions are characterized.)

4.2.1. None. Information about all aspects of technology has survived, at least since the advent of written language, without special provisions beyond those that have been institutionalized in the form of libraries and data banks maintained by laboratories and universities. There is every reason to expect that knowledge about nuclear fission will remain functionally useful for many future generations and will be maintained without any special efforts set in motion in the present.

4.2.2. Effort should be made to destroy information about the repository and even hide its location. The argument is that curiosity in the future may lead to ill-considered human intrusion and that hiding the repository may make this less likely. Most reject this approach on grounds that it is unworkable and that efforts to hide a repository (even were it judged a wise thing to do) would fail.

4.2.3. Special effort should be made to preserve waste disposal information. This issue has been discussed in a general way under issues 4.1.2.4. and 4.1.3.4. above and won't be further developed here. Most observers endorse some special measures to preserve information about the nuclear waste disposal system for at least a hundred years or so.

4.3. What factors are likely to affect nuclear waste monitoring functions over time?

Comment: The general issue associated with all of the following factors is what actions should be taken in the present and near term future to influence them, and how the chances that these actions will be effective can be improved.

4.3.1. Experience with the functioning of the repository in any time period is likely to affect the nature of monitoring activities in the subsequent time period. If all has been quiet, monitoring is likely to decrease. If problems have been detected, monitoring will continue on a more active basis.

4.3.2. Societal stability will help make monitoring activities possible. Presumably whatever institution has responsibility for repository monitoring will be more insulated from short term political decisions than some current agencies that must fight for budget allocations each year. Even so, a degree of social and political stability may be required to sustain the monitoring organization(s).

4.3.3. Organizational stability and the maintenance of capability and viability will be necessary to the continuous functioning of a monitoring system. Organizational adaptability will also be necessary to provide for continuous functions in the face of shifting societal conditions. Mechanisms for the smooth succession of responsibility over long time periods may be an important feature of the monitoring system.

4.3.4. The state of technology will affect the nature and effectiveness of the monitoring function. If advances are experienced, the new and more effective procedures will facilitate the function. If technology backslides, the information transfer function and organizational stability will be critical ingredients to continued effective monitoring.

4.3.5. The information transfer mechanisms will, over long time periods, make effective monitoring possible.

4.3.6. Future societal decisions may act to intensify monitoring activities or reduce and even eliminate them. For instance, technological advances in weather monitoring have caused the discontinuation of certain weather observation practices. Volcanoes inactive for long time periods are only perfunctorily studied. Observation of sunspot activity, once a curious pastime, intensified as observational techniques improved and theories linking sunspots to world weather patterns were developed.

4.4. What factors are likely to affect protective reaction capability in the event of system failure in various time periods?

Comment: In general the same factors that affect monitoring also affect the ability to carry out effective protective reaction. The maintenance of a functional organization with at least the capability of organizing the response to a repository failure would appear to be important. Again, societal stability, information transfer, and the state of technology are conditions that improve the chances for effective protective reaction. Additional factors are discussed below. Again the issue is, how can we influence them?

4.4.1. The nature of the failure event will partly determine what and whether anything can be done to repair or remedy the situation, or whether evacuation or shielding actions are the only immediate alternatives.

4.4.2. Since the time period affects the magnitude of the hazard (due to decay of the waste materials) the assessment of consequences at the time of a given breach will interact with the nature and magnitude of the breach to affect the decisions about what if anything to do about it.

4.4.3. The suddenness of a breaching event and whether there is advance warning will affect the protective reactions. For instance, a slow change in a river's course that threatens a repository may cause corrective action to move the river while an earthquake that suddenly changes a river's course might prompt evacuation.

4.4.4. Future societal decisions to maintain or not to maintain various degrees of readiness to respond to repository failure will affect the capability to respond should a failure occur.

CHAPTER 5: PUBLIC INVOLVEMENT ISSUES

INTRODUCTION

There are at present several avenues by which public involvement in nuclear waste management decision making can occur. The National Environmental Policy Act of 1970 stipulates that generic environmental impact statements must be prepared in conjunction with waste management research, development and demonstration activities. Further, before waste management facilities can be constructed on a prospective site, an impact statement assessing environmental and social impacts and discussing why other sites and other approaches are less appropriate must be prepared. These statements must be presented to the public for review and comment and are the focus of a series of public hearings.

While some have argued that public input enters the decision process only after the technical die is cast, the impact statement process does afford opportunity for extended public involvement. Representatives of organizations that have taken generally pro-nuclear stances and anti-nuclear stances (e.g., the Atomic Industrial Forum and the Natural Resources Defense Council, respectively) have access to government agency decision makers and Congress. These lobbying efforts enrich the information base on which decisions rest and help assure that differing points of view are heard.

In recent years agencies, commissions and hearing boards in various states have become increasingly active in examining developing waste management plans, particularly when they involve prospective facilities in those states. Public access to these bodies is increasing.

State initiative votes on nuclear policy afford another, and very direct, means for the public to express its views. Congressional appropriations hearings are increasingly well publicized in the case of controversial energy issues. Interested persons and groups can use traditional political mechanisms to make themselves heard in these instances. In addition, government agencies involved with various aspects of waste management planning and regulation hold public meetings around the country to provide information to and feedback from the public.

The above mechanisms have been criticized on grounds that despite the multiple opportunities only a tiny fraction of the public is actually involved, that critics of waste management planning seldom have sufficient financial resources to enable them to play an active role, that hearings are often polarized with the result that productive problem solving is prevented, that the weight of government technical input overwhelms more humanistic considerations, that despite the appearance of openness the important decisions are disproportionately influenced by a few insiders, that vested interests in the nuclear research and industrial organizations have too much influence, that the power of committed opponents to utilize legal mechanisms to delay decisions prevents constructive and public decision making and increases costs which the public must ultimately pay, that the scientific and technical basis on which nuclear opponents base their objections are of questionable validity, that fear tactics are used to sway a public largely ignorant of relevant technical information, and that committed opponents act to enhance their personal visibility rather than in the broad public interest.

In this chapter we do not use the term "the public" in a broad way. In the broadest sense, the public includes everyone. Obviously, not everyone is actively involved in any public decision. However, in cases like electing public officials every citizen (excluding the underage, the mentally incompetent, and convicted criminals) has the right to vote, although only a minority commonly exercises this right. Other terms such as the "involved public" or the "affected public" are used to identify those segments who have some stake in the outcome of a given policy decision.

There are a variety of public issues associated with the involvement of the public in nuclear waste management decisions. These issues are not unique to nuclear waste management; they are more or less common to a number of other policy domains in which social values are imbedded in technical decisions, e.g., fluoridation of water, public rapid transit, and mandatory energy conservation measures.

SUMMARY OF PRIMARY AND DEPENDENT ISSUES

Primary Issues:

1. Should the public be involved in nuclear waste management decision making?
2. What factors affect the appropriateness of individual and group involvement in nuclear waste management decisions?
3. What should be the process by which public involvement occurs?
4. What are the most important enabling conditions necessary to productive public involvement?

Dependent Issues:

- 1.1. What are the anticipated benefits of public involvement in nuclear waste decisions?
- 1.2. What are the potential risks and costs of public involvement in nuclear waste decisions?
- 2.1. Must participants have technical knowledge?
- 2.2. Must participants be committed to problem solving?
- 2.3. Must participants be directly affected by waste management decisions as a precondition of participation?
- 3.1. What functional role should the public play in the decision process?
- 3.2. What is the appropriate timing of public involvement in the decision process?
- 3.3. How extensive or broad should public involvement be?
- 4.1. Must the federal government be proactive in encouraging and providing incentives for public participation in nuclear waste management decisions?
- 4.2. How can the public become more informed about technical options and their possible impacts on the public?
- 4.3. What changes, if any, in current practice might enhance productive public involvement in nuclear waste decision making?

ISSUE OUTLINE

1. Should the public be involved in nuclear waste management decision making?

   1.1. What are the anticipated benefits of public involvement in nuclear waste decisions?

1.1.1. Higher quality decisions may result because public values and perceptions will be incorporated directly into decisions. There will be less chance that vested interests and the generally pro-nuclear technical community will overlook the views of the public. In short, decisions made with public participation may be more balanced.

1.1.2. More timely decisions may result because public participation may have a moderating influence on the speed of the decision process. This may slow decisions or hasten them relative to the pace of decisions without public participation.

1.1.3. Decisions made with public participation may be more readily accepted by the public.

1.1.4. Decisions once made with public participation may be easier to implement because the legislative, judicial, and institutional mechanisms necessary to waste management implementation can proceed knowing that the decisions have broad public support.

1.2. What are the potential risks and costs of public involvement in nuclear waste decisions?

1.2.1. Public participation may degrade the quality of waste management decisions. Technical considerations, poorly understood by the public, may not be given sufficient weight with the result that more popular but less technically appropriate courses of action may be chosen.

1.2.2. Less timely decisions may result. The delays often inherent in bringing wider participation to bear may unnecessarily extend the decision process with the result that risks and economic costs associated with temporary measures are extended in time.

1.2.3. Public participation may lead to polarization and confusion and heighten unwarranted public fears that will prevent any decision from gaining broad public acceptance.

1.2.4. The decisions reached with public participation may prove technically difficult to implement or the institutional mechanisms necessary to effect implementation may be hampered by lingering polarization and public confusion.

<u>Comment</u>: Some may consider the question of public involvement a moot point since waste management planning is already in the public domain. However, some observers argue for more participation and some for less. Others argue that in waste management planning the technical constraints are overwhelming and that more or less public participation will not materially affect the final decisions that are made.

2. What factors affect the appropriateness of individual and group involvement in nuclear waste management decisions?

   2.1. Must participants have technical knowledge?

      2.1.1. A measure of technical information may be beneficial so that benefits and risks/costs in the present and future associated with alternative waste management decisions may be realistically assessed by the public.

      2.1.2. Given that the technical community has the responsibility for forecasting benefits and risks/costs, some feel that the public can, with only minimal technical orientation, evaluate the outcomes of alternative courses of action.

   2.2. Must participants be committed to problem solving?

      2.2.1. Groups and individuals who wish to participate in nuclear waste decisions should be committed to finding a solution.

      2.2.2. Others may feel that participation in the decision process does not require a commitment to find a solution to waste management problems. Active protest is legitimized by some as a useful role in public policy deliberations even if its sole outcome is delay.

   2.3. Must participants be directly affected by waste management decisions as a precondition of participation?

      2.3.1. In general, those directly affected by waste management decisions, e.g., residents of an area where waste management facilities may be built, are seen to be appropriate participants in decisions affecting them.

      2.3.2. In the case of nuclear waste management decisions where the benefits of nuclear power are very widely distributed, and where costs and risks may also be widely distributed, perhaps no group or individual should be excluded from participation on grounds that they are not directly involved.

3. What should be the process by which public involvement occurs?

3.1. What functional role should the public play in the decision process?

3.1.1. Consultative. The public should be kept informed, asked for opinions and presented reasons for decisions.

3.1.2. Participative. The public should help suggest solutions, help evaluate those solutions and help choose among those solutions.

3.1.3. Deterministic. Within the technical constraints, the public should determine the solution.

3.1.4. The public should continue playing a part in the normal political process. As with most domestic issues, the public will participate in various ways at various levels and branches of government through various means.

3.2. What is the appropriate timing of public involvement in the decision process?

Comment: Decisions commonly proceed in several roughly sequential stages. Following identification and definition of the problem that requires action, there is a search for alternative solutions, evaluation of the pro and con aspects of the alternative solutions (including technical feasibility and the expected positive and negative outcomes), choice of a course of action, and implementation of the course of action chosen. In a complex decision area like nuclear waste management there are many decisions that occur in different time periods. These decisions are somewhat interrelated or iterative; that is, earlier decisions often reduce the field of available alternatives for later decisions.

3.2.1. Some argue that public values should be taken into account in the search for alternatives and the evaluation of those alternatives, but the final decision should not be chosen by the public.

3.2.2. Some argue that technical constraints and feasibility should be the prime considerations early in the decision stages and that the final choice should be up to the public.

3.2.3. Some argue that the public must be involved at every stage of the decision process.

3.3. How extensive or broad should public involvement be?

3.3.1. Some argue that any individual or group who wishes to participate should do so.

3.3.2. Some hold that participation should be limited to those with sufficient technical background to evaluate technical considerations, who have knowledge of a fairly broad set of issues, who are directly affected by waste management decisions and who show good faith in being committed to solving problems.

4. What are the most important enabling conditions necessary to productive public involvement?

4.1. Must the federal government be proactive in encouraging and providing incentives for public participation in nuclear waste management decisions?

4.1.1. No, it already is occurring and will increase or decrease naturally.

4.1.2. Yes, some feel the federal government must actively encourage public involvement in waste management decisions and should provide funding for individuals and groups who wish to play a more active role.

4.1.3. Some feel that public participation in this issue area should be discouraged and that prospective participants should be examined closely to establish their credentials for participation. (See issue 3.3.2. above.)

4.2. How can the public become more informed about technical options and their possible impacts on the public?

4.2.1. Appropriate federal agencies could intensify efforts to provide technical and nontechnical information about waste management, and actively seek exposure in the electronic and print media.

4.2.2. The technical community could devote more effort to translating technical material into more readily understood forms.

4.2.3. Committed supporters and opponents of nuclear power could be encouraged to air their views on waste management in public forums and to document their claims and counterclaims.

4.3. What changes, if any, in current practice might enhance productive public involvement in nuclear waste decision making?

4.3.1. For those who feel there is already too much public involvement in a content area that is inappropriate for any but very limited public involvement, the federal government should take a strong stand, select an approach from among those available and move ahead to implement it without further delay.

4.3.2. Others argue that the current system can be made to work with greater effort and resolution on the part of the federal government and that procedural changes at this point are unwise.

4.3.3. Various procedural changes have been suggested, e.g., that the environmental impact hearings be held <u>prior</u> to tentative endorsement by the Nuclear Regulatory Commission, that nuclear waste management is an exclusively federal concern and that states should be prohibited by federal pre-emption from active involvement in waste management matters, that some restraints be placed on the ability of intervenors to block and delay progress through the courts, that a moratorium be declared on further nuclear development until the waste management systems can be thoroughly pilot tested, or that waste management plans be subjected to much more extensive public discussion, including a possible national vote.

CHAPTER 6: CONCLUSION

Since the objective of this analysis was to raise issues rather than resolve them, substantive conclusions are not appropriate and we offer none. However, we hope that stating an extensive set of issues and some of the contrasting positions on them may have several beneficial effects.

(1) It could provide a starting point for a technology assessment and may suggest issues to consider in undertaking a professional cost/benefit analysis of nuclear waste management options.

(2) It may remind nuclear waste decision makers of the complexity and interrelatedness of nuclear waste disposal decisions and act as a checklist that may prevent relevant issues from being ignored in the decision process.

(3) For lay persons not well acquainted with nuclear technology and nuclear waste issues, it may help inform them of the social implications of nuclear waste decisions so they may more responsibly participate in a policy evaluation role.

(4) For those who are presently active supporters or opponents of continued nuclear power development, it may bring additional perspective and better understanding of their own and opposing views.

(5) It may help clarify and sharpen issues which presently may be somewhat indistinct.

While this issues analysis may contribute to issue resolution through clarification and ventilation, actual resolution of these issues is a process that will continue indefinitely. When issue disagreements are over factual matters, additional research, development and demonstration activities will help resolve them. When disagreements are rooted in values, the political process is supposed to deal with them. Careful assessment of public values can also help when value laden issues are in contention. Public opinion polls can help provide value assessment if the right questions are asked (Melber et al., 1977). However, many of the issues we have stated are so new (or unknown) to the public that one cannot expect clear positions to have been formulated. In these cases, the use of complex judgment tasks to measure public values and attitudes (see Maynard, Nealey, Hébert and Lindell, 1976) can be of use. Resolution of issues will also be assisted by actually making nuclear waste policy decisions. As decisions are made, some issues will become irrelevant and others will be sharpened and thus become clearer targets for resolution.

In the introduction and throughout the issues analysis we have referred to the difficulty posed by the question of whether or not nuclear power will continue to develop and thus produce additional waste. This question seems likely to impede issue resolution in nuclear waste disposal for some time. As we have pointed out, some issues appear to be independent of this decision but a great many are bound up with it. Even in those issues where a decision to continue with nuclear power appears logically irrelevant to issue resolution, this question hangs in the background, impeding progress toward agreement.

The effect on issue resolution also flows in the reverse direction. That is, a decision on whether to continue with nuclear power development is partially dependent on resolving waste management issues. Perhaps both committed opponents and supporters of nuclear power perceive that resolution of nuclear waste disposal issues would give a green light to further nuclear development. This perception leads to the prediction that one side will push for quick resolution while the other will seek to block resolution of nuclear waste issues. In the meantime, nuclear wastes exist and present current and future hazards. The resolution of waste management issues must somehow proceed. Hopefully, our analysis will contribute to this end.

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ANNOTATED BIBLIOGRAPHY

The purpose of this brief annotated bibliography is to identify several primary sources that discuss nuclear waste management issues at some length, and to provide for the reader a sampling of the diversity of viewpoints discussed.

The notations following each annotation indicate the sections and issues from our analysis that are the focus of discussion by that source.

Bishop, W., Frazier, P., Hoos, I., McGrath, P., Metlay, E., Stoneman, W. and Watson, R. Proposed Goals for Radioactive Waste Management. NUREG-0300. Office of Nuclear Material Safety and Safeguards, United States Nuclear Regulatory Commission, Washington, D.C., May 1978.

The proposed goals, which articulate and expand the factors essential to a publicly acceptable solution, are organized around three time periods: active use, active social involvement, and continuing isolation. Issues of uncertainty, decision-making, implementation of technology and organizations, constraints and responsibilities within the system, future flexibility and system independence from future generations and societal stability are addressed by the goal sets. The implicit assumptions guiding the Task Force as well as the intended objectives are identified and discussed. (Chapters 2, 3, 4 and 5; all dependent issues.) (Available from National Technical Information Service, Springfield, Virginia 22161.)

Brewer, T. Strengthening the International Safeguards System: Institutional and Financial Issues. Paper prepared for the Annual Meeting of the International Studies Association, Washington, D.C., February 22-26, 1978.

The paper clarifies the role and resources of the International Atomic Energy Agency in expanding and strengthening the international nuclear safeguards system. Anticipated demands on the system due to forecasted increases in civil nuclear capabilities, economic and political constraints which impinge on IAEA programs and an analysis of data on trends in program priorities and the relationship between demands on the IAEA safeguards program and resources are considered. The need for continued strengthening of the system is seen as beneficial in spite of apparent intrinsic problems.

(Chapter 3, issues 1.2, 1.3, 1.4, 1.5, 2.1; Chapter 4, issues 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3.) (The paper is available from the author, Department of Political Science, Eastern Michigan University.)

Conclusions of the Symposium and Future Trends. Panel discussion from "Management of Radioactive Wastes from Fuel Repository," Nuclear Waste Disposal Conference, sponsored by the Organization for Economic Cooperation and Development (OECD), Nuclear Energy Agency, and the International Atomic Energy Agency, Paris, 1972.

Future risks of waste disposal, and our implied moral responsibility to the future, are proposed as neither the only, nor the biggest problem bequeathed to the future. Representatives of participating countries cite evidence from national programs demonstrating safe methods of waste management. Panel recommendations include a proposal that large-scale transportation be avoided. Also recommended is the need to solve technical problems before embarking on international disposal operations. (Chapter 2, issue 1.1; Chapter 3, issues 1.1, 1.2, 1.3; Chapter 4, issue 1.2.)

Friends Committee on National Legislation. "Controversy Over Nuclear Power" (excerpt from a 1976 policy statement issued by the Friends Committee). Congressional Digest, February 1977, 53, 55, 57 and 59.

Waste disposal is discussed in a broader context of energy policy and nuclear power production. Nuclear waste, a threat to world peace due to potential for terrorism and diversion, is also a threat to health and the environment from emissions associated with storage and fuel reprocessing. Formidable policing and security problems associated with repositories, technological problems in achieving containment and the absence of a demonstrated safe repository mandate the need for a moratorium on the construction of nuclear facilities until the issues are studied further. Alternate energy sources are preferred over the unacceptable risks now presented by the nuclear industry. (Chapter 2, issues 1.1, 1.2, 1.3, 2.2, 2.3; Chapter 3, issues 1.1, 1.2, 1.3.)

Glinsky, V. Toward a stricter international discipline over the uses of nuclear energy. Remarks before California Arms Control Seminar, Los Angeles, July 25, 1977.

Present international and national regulations inadequately address reprocessing controls and the retransfer of export materials. Methods for obtaining controls are discussed, and their implications for geographic equity. Controls imposed by supplier nations also present problems, particularly with respect to varying and overlapping regulations. (Chapter 3, issues 1.2, 1.3; Chapter 4, issues 1.3, 2.1, 2.2, 2.3.)

Hardin, C. "A state's viewpoint on radioactive waste criteria." Proceedings: A Workshop on Policy and Technical Issues Pertinent to the Development of Environmental Protection Criteria for Radioactive Wastes. Sponsored by the Office of Radiation Programs, United States Environmental Protection Agency, held in Albuquerque, New Mexico, April 12-14, 1977.

A single standard for unacceptable level of risk associated with radioactivity is proposed and briefly discussed. The primary topic for consideration is the development of waste criteria and potential problems with respect to relative roles, rights and responsibilities of the state versus the federal government. The siting of disposal facilities requires criteria which con-consider the balance of risks, benefits and costs from the perspective of the state, nation and region. The impact of repository siting criteria based on regional characteristics is discussed and recommendations made for achieving balance between federal and state perspectives. (Chapter 2, issues 1.2, 1.3, 1.5; Chapter 4, issue 2.2.)

Hébert, J., Rankin, W., Brown, P., Schuller, C., Smith, R., Goodnight, J., & Lippek, H. Nontechnical Issues in Waste Management: Ethical, Institutional and Political Concerns. PNL-2400. Richland, WA: Battelle Pacific Northwest Laboratories Report, September 1977.

Major nontechnical issues in the management of commercially produced nuclear waste are identified and analyzed in the context of ethical, institutional and political implications. Political problems of interfacing local, state and federal concerns and responsibilities are considered as well as the application of ethics and morality to waste management issues. A number of key issue-value relationships are presented. The institutional analysis considers possible problems of long-term human institutions and various institutional arrangements for the short term, i.e., transportation, regulatory and emergency issues. (Chapters 2, 3, 4 and 5; all dependent issues.)

Kennedy, R. T. Understanding nuclear power: A role for government? Remarks before the Atomic Industrial Forum International Conference on Nuclear Power and the Public: A European-American Dialogue. Geneva, Switzerland, September 29, 1977.

Providing the public with information on the nuclear option is discussed as a legitimate and appropriate role of the government. The effects of recent public disclosure laws as well as media coverage of the nuclear option are discussed. Research is seen as an area in which the government can act to enhance the acceptability of nuclear power. Industry and government are responsible for providing information that is clear and straightforward, neither misleading nor downplaying issues. (Chapter 5, issues 1.1, 1.2, 2.1, 4.1, 4.2, 4.3.)

Kneese, A. The Faustian bargain. Resources. Resources for the Future, Inc. Reprint #44, September 1973.

The use of cost/benefit analyses is considered inappropriate to answer the most important policy issues relevant to the nuclear fuel cycle. It is argued that since the major advantages of the nuclear option are readily quantifiable but not necessarily the hazards, the cost/benefit approach renders the benefits more real, and the costs more obscure. Uncertainty, safeguards, transportation problems, moral issues of long-term risk, public involvement in decision-making, proliferation and waste volume are factors discussed as the costs of the nuclear option. The exploration and use of alternatives is suggested and warnings given regarding the need to slow down the nuclear machinery while there is still that option. (Chapter 2, issues 1.1, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3; Chapter 3, issues 1.1, 1.2, 1.3, 1.4; Chapter 4, issues 1.4, 2.1, 2.2, 2.3, 3.1; Chapter 5, issues 1.1, 3.1, 3.2, 3.3, 4.2, 4.3.)

Kuehn, T. J. Social and Institutional Constraints of Nuclear Waste Management: An Exploratory Analysis of the Issues. Pasadena, CA: Jet Propulsion Laboratory, November 1977. (JPL Publication 77-45. Prepared for Energy Resources Conservation and Development Commission, State of California.)

The thesis is advanced that nuclear energy technology has outpaced the ability of social and political institutions to manage, regulate, and monitor its development and impact. The social dissonance surrounding decision-making about nuclear energy is indicative of the disparity between social and technological capabilities. The present milieu of uncertainty regarding nuclear energy is linked to public concern about its economic uncertainties, scientific unknowns and the risk of proliferation. While public concern is focused on the social and institutional issues of safety, security and proliferation, the nuclear community responds by dealing with technical and engineering aspects of the issues.

The report discusses social challenges of waste management in the areas of selection and validation of alternative fuel cycles, cost-benefit analysis of reprocessing and risks and uncertainties of waste disposal. Policy, management and regulation concerns are considered and problems of institutional development are examined, comparing the social, economic and organizational requirements of the recycle and one-through alternatives for nuclear waste management. (Chapter 2, issues 1.2, 1.3, 1.4, 1.5, 2.2, 2.3; Chapter 3, issues 1.2, 1.3, 1.4, 1.5; Chapter 4, issues 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 4.3; Chapter 5, issues 1.1, 1.2, 2.1, 2.2, 2.3, 3.1, 4.1, 4.2, 4.3.)

Latiner, S. Citizens' Guide to Nuclear Power. Washington, D.C.: Center for the Study of Responsible Law, 1975.

Problems in federal waste disposal plans are identified and their implications considered in view of inadequate performances by the responsible agencies and the seriousness of radioactivity and its risk over many generations. Among the problems cited are inadequate protection against sabotage and proliferation, individual compensation for risks incurred, questionable economic planning (i.e., capital investment costs, provision for decommissioning cost) and the political ramifications of the rule of federal preemption for citizen involvement and decision-making power. Methods of political intervention are discussed as the only defense against the present waste program. (Chapter 2, issues 1.2, 1.3, 1.4, 2.2, 2.3; Chapter 3, issues 1.2, 1.3, 1.5, 2.1, 2.2; Chapter 4, issues 2.1, 2.2, 3.1, 3.3; Chapter 4, issues 1.1, 2.2, 3.1, 3.2, 3.3, 4.2, 4.3.)

Levenson, M. & Zifferero, M. "The public issues of fuel reprocessing and radioactive waste disposal." Nuclear News, 1977, 29(2), 45-48.

Difficulty in defining who the "public" is, and the unique future implications of the nuclear option are described as major factors complicating the nuclear debate. Reasons cited as accounting for the difficulty in appraising public opinion include: multiple definitions of the public, instability of the nuclear issues, and diverse reactions from regions, or nations, with different values, or where political forces are influenced by various interest groups. The implications of the issue of future risk for public decision-making are discussed. (Chapter 2, issues 1.1, 1.3, 1.4, 2.2; Chapter 3, issue 1.3; Chapter 5, issues 1.1, 1.2, 2.1, 3.1, 4.2.)

Lusch, R. F. Public opinion and costs: A synopsis of viewpoints. Proceedings of the Symposium on Waste Management, Tucson, Arizona, October 3-7, 1976.

Reported are workshop issues on which consensus emerged. First the need for public education about nuclear energy was identified. The need for the nuclear industry to earn credibility and the need for information regarding acceptable technologies to be made available to public information officers were the other major issues identified. Noted in the discussion of these issues were the need for realism and non-defensiveness by industry representatives, possible approaches to increasing industry credibility and an emphasis on timeliness in issuing agency statements. (Chapter 5, issues 1.1, 1.2, 2.1, 3.1, 4.1, 4.2, 4.3.) (Available from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161.)

Management of Commercial Radioactive Nuclear Wastes: A Status Report. Washington, D.C.: Federal Energy Resources Council, May 1976.

Increasing use of nuclear power is proposed as essential to reduce national dependence on insecure energy sources. The proposition is supported by evidence from past experience and current technological capabilities to deal with wastes. Also cited as justification for expanding the nuclear industry is the evidence of the government's commitment to assure safe waste management and terminal storage facilities. Further, the position is taken that radioactive waste volume is small compared to other wastes produced by society; consequently, the costs for disposal of these wastes will not have

substantial impact on energy costs. Activities required for selecting and implementing programs and technologies are discussed and an estimated timetable of activities and goals relevant to waste management through 1985 is presented. (Chapter 2, issues 1.1, 1.3; Chapter 3, issues 1.1, 1.2, 1.3, 1.4, 2.1; Chapter 4, issues 3.1, 4.2, 4.3.)

The Sierra Club and Nuclear Power. Pamphlet assembled by Sierra Club Members: E. Coan, S. Moglewer, P. Schneider, R. Sextro & A. Tucker. San Francisco, CA, April 1975.

Safety, public health, terrorism and uncertainty regarding long-term storage are primary concerns. Consideration of nuclear waste disposal requires the public to determine acceptable levels of risk from accidental releases, increased rates of cancer and birth defects, potential for terrorism and the well-being of future generations. Security problems and infringement on civil liberties render the recycle fuel option even more unacceptable. The position taken is that the waste problem must be solved prior to committing to creating any waste. (Chapter 2, issues 1.2, 1.3, 1.4, 2.2, 2.3; Chapter 3, issues 1.1, 1.2, 1.3, 1.5; Chapter 4, issues 1.4, 2.1, 3.1, 3.3, 4.4.)

Starr, C. Public issues in the fuel cycle. Paper presented to the American Nuclear Society, November 1976.

The impact on public perception of the government's failure to demonstrate that safe disposal is achievable has created the need for credible, comprehensive public information comparing alternatives for decision making. Primary public concern is over long-term radioactivity and materials diversion. The position is taken that the technology for waste isolation is achievable, the alternatives inadequate and the potential impact on the future of an energy shortage, overwhelming. The inevitability of proliferation, the improbability of terrorism and the ability to deal with sabotage address public concerns about diversion. Reprocessing, an option which would keep costs down and preserve resources, is considered in terms of its foreign policy implications. (Chapter 2, issues 1.1, 1.2, 1.3, 2.3; Chapter 3, issues 1.2, 1.3; Chapter 4, issues 2.1, 2.2, 2.3, 3.1; Chapter 5, issues 2.1, 4.1, 4.2, 4.3.) (Available from the author, Electric Power Research Institute, Palo Alto, CA.)

United States Environmental Protection Agency Office of Radiation Programs. Office of Radiation Programs, Program Statement, EPA 520/7-76-7007. Washington, D.C., May 1976.

The Program Statement describes the radiation control problem and specifies the significance of radiation risks in quantitative terms. The responsibilities and philosophy of the agency, its sources of authority, and the diverse activities focusing on types of radiation sources are discussed, as well as the impact of uncertainties on policies and responsibilities. An overview of specific program areas indicates relative priorities among radiation problems. Uranium fuel standards are cited as one of the highest priorities. Plans for public involvement and information are described also, and various criteria for producing consumer materials are discussed. (Chapter 2, issues 1.2, 1.3; Chapter 3, issues 1.2, 1.3, 1.5; Chapter 4, issues 1.4, 2.1, 2.2, 2.3; Chapter 5, issues 1.1, 4.1, 4.2, 4.3.)

United States Nuclear Regulatory Commission, Office of Public Affairs. News release #S-1-77, v. 3, no. 4, February 1977. Testimony of Commissioner Victor Glinsky, U.S. Nuclear Regulatory Commission, before the California Energy Resources Conservation and Development Commission Informational Hearings on Nuclear Fuel Reprocessing and Waste Disposal, Sacramento, CA, January 3, 1977.

The Nuclear Regulatory Commission's role in decisions facing the nation regarding nuclear power is outlined. Current activities of the NRC include plans for a licensing review of a waste repository and reassessment of the environmental impact of the back end of the fuel cycle. Consideration of reprocessing and recycling options continues and the increasing need for expanded spent fuel storage sites is being considered as well as the complexities of licensing of long-term facilities. Possible constraints of social and political acceptance on the future direction and time lines of these activities are mentioned. (Chapter 2, issues 1.1, 1.2, 1.3, 1.5, 2.3; Chapter 4, issues 2.1, 2.2, 2.3, 4.1, 4.3, 4.4; Chapter 5, issue 3.1.)

Willrich, M. Institutional arrangements for radioactive waste management. Proceedings of Conference on Public Policy Issues in Nuclear Waste Management. Conference sponsored by the Energy Research and Development Administration,

the Nuclear Regulatory Commission, the National Science Foundation, the Council on Environmental Quality, and the Environmental Protection Agency, Chicago, October 27-29, 1976.

The developing of governmental institutions necessary for the safe management of waste, now and in the long term, are discussed. Modifications in existing organizational structures are recommended to ensure effective management. Divided responsibilities between governmental and private industry complicate achievement of trade-offs between long and short term considerations and efficient management. Faults in the current regulatory framework are identified and a comprehensive national and international regulatory plan is proposed. The merits of a federally chartered public corporation are considered as an institutional form suited to handle all waste including military. (Chapter 3, issue 1.5; Chapter 4, issues 1.1, 1.3, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3. 4.4.)

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