ULTIMATE DISPOSAL - A PLAN FOR ACHIEVEMENT

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In response to comments on WASH-1539, PNL has been asked by ERDA to prepare a plan for development of ultimate disposal methods. My talk today will not give you a detailed description of plans for attaining disposal of radioactive wastes. The preliminary plan is currently undergoing ERDA review and not yet complete. A final plan is expected within the year. What I will do is outline for you our methodology for developing the plan and our expectations of what the plans for R&D on disposal of high-level and transuranic waste will look like.

FUNCTIONS OF PLANNING

I'd like to begin with some thoughts on the function of planning. In an essay that appeared in Technology Review last fall, Kenneth E. Boulding of the University of Colorado offered some penetrating observations on planning that are highly relevant to our efforts concerning waste disposal.

Professor Boulding listed a dozen "reflections on planning," as he called them. I'd like to share with you those that are most pertinent to planning for waste disposal. They are:

1. The world moves into the future as a result of decisions, not as a result of plans.

   This seems obvious when we stop to think about it, but people--especially planners--tend to lose sight of the fact that it's decisions, not plans that make things happen. For waste disposal, it's the decisions on methods and sites for disposal that will be important.

2. Planning is an activity which produces the product of planners, which is usually some form of communication to decision-makers.

   The key phrases here are "product of planners" and "communication to decision-makers." They tell us, I think, that the function of planning for waste disposal is to communicate a basis for action to the decision-makers.

3. Decisions involve an agenda of alternatives and a valuation scheme which is the basis for choices.

   The message here is that planning must provide for alternatives and, as necessary or possible, assist development and application of the decision-makers' valuation scheme.

4. Decision strategy depends on the degree of uncertainty of the agenda items.

   Professor Boulding goes on from this observation to note that the greater the uncertainty of the agenda, the higher the value which should be placed on decisions that leave future options open. For waste disposal, this can be interpreted to mean that options should be maintained and narrowed as R&D narrows the uncertainty.

5. An important source of bad decisions is illusions of certainty.

   Professor Boulding points out that there's nothing like computer printout and elegant models to create illusions of certainty. Since assessment of waste disposal options will depend heavily on models of physical processes and engineered systems, we must be on guard to avoid illusions of certainty that can lead to bad decisions.

What, then, is the message here for plans for achievement of radioactive waste disposal? I believe it can be summarized as follows:

- Plans for R&D on disposal should maintain options.
- Outputs from plans and activities support the decision process.
- Vigilance to avoid illusions of certainty is essential.

These three statements constitute the guiding principles for plans for R&D on waste disposal. We can now proceed to a description of planning procedures and some statements about how the R&D program is expected to lead to methods for disposal.

PLANS DEVELOPMENT PROCEDURES

I should first emphasize that at present we have a "plan for a plan" rather than an explicit statement of plans. We are gathering information for the plans by obtaining input from various ERDA contractors and by convening workshops. Three workshops have been held so far. They have involved representatives of the ERDA contractors with major responsibilities in waste disposal, representatives of the social sciences, and others who can contribute expertise to the formulation of the R&D plans. We are hoping this Waste Management '75 meeting will provide additional informal input to this planning effort.

To date, the planning process has produced the following concepts for the plan:

- Options for disposal methods and sites will be investigated.
- Levels of effort on options will differ.
- Continental and seabed disposal options will be emphasized.
- Decisions will involve winnowing of options.
- Timeframe for the program is assumed to be about 20 years.

The scope and timeframe for the program were estimated in two ways. First, the people responsible for projecting the scope and schedule of work in the various R&D sectors estimated, on the basis of their experience and professional judgment of state-of-the-art knowledge, that investigation and assessment of options could be completed in 20 years. Second, an independent estimate was made of the number of options that would have to be investigated to assure a very high probability of success in finding acceptable disposal methods and sites within 20 years.

This estimate assumed the selection process would start with investigation of generic disposal system options. Some of these generic system options would be selected for detailed, site-specific studies, and some of these sites and methods would in turn be selected for verification testing. The basic task for this assessment was therefore to estimate how many disposal system options should be considered at each stage in the winnowing process.

The estimate was made using probability theory, and the results obtained are shown in Table 1. As indicated by this table, two things are important to these estimates: the overall confidence level, and the average success probability for each option at each winnowing step.

TABLE 1. Number of Disposal Options to be Investigated

Study Level	Number of Options
Generic	15-20
Site-Specific	5-6
Pilot Plant	2-3

We believe, on the basis of present knowledge, that the average probability of success for the generic system options should not be estimated to be any higher than 40%. Consequently, at least 15 such options should be investigated. However, R&D results can be expected to sharpen our characterization of acceptable disposal systems. In terms of probabilities, this would mean that the probabilities of success for the site-specific and testing studies would be higher than these current estimates. In terms of program requirements, fewer such studies would be required than are estimated here. The estimates for the site-specific and the testing studies can be revised as the program proceeds.

PROGRAM PROCEDURE

The R&D program on disposal is expected to proceed from generic disposal concepts to implementation at specific sites as illustrated by Fig 1. This is, of course, a standard sequence of events for a design development effort. For waste disposal, however, this sequence will be accompanied by a winnowing process in which many generic concepts are reduced to relatively few that will receive detailed investigation.

The winnowing process requires decisions and the decisions, as Professor Boulding noted, require an agenda of alternatives and a valuation scheme. The disposal options provide the agenda of alternatives; analysis and evaluations assist use of a valuation scheme.

The analysis and evaluation functions are expected to be an extremely important part of the disposal R&D program. They must be highly comprehensive, they must meet the decision-makers' needs, and they must, insofar as is possible, avoid illusions of certainty.

Preliminary concepts have been developed for the scope required for the analysis and evaluation functions and the ways these functions will be applied to the winnowing process.

We anticipate that analysis and evaluation will have to embrace four basic areas of interest: feasibility, safety, system performance, and implementation impacts. Each of these four basic areas in turn involves a number of sectors of interest, as listed below:

Feasibility

- Technical Feasibility
- Timing of Availability
- Disposal Site Stability
- Alternative Uses of Site
- Accessibility to Man
- Other?

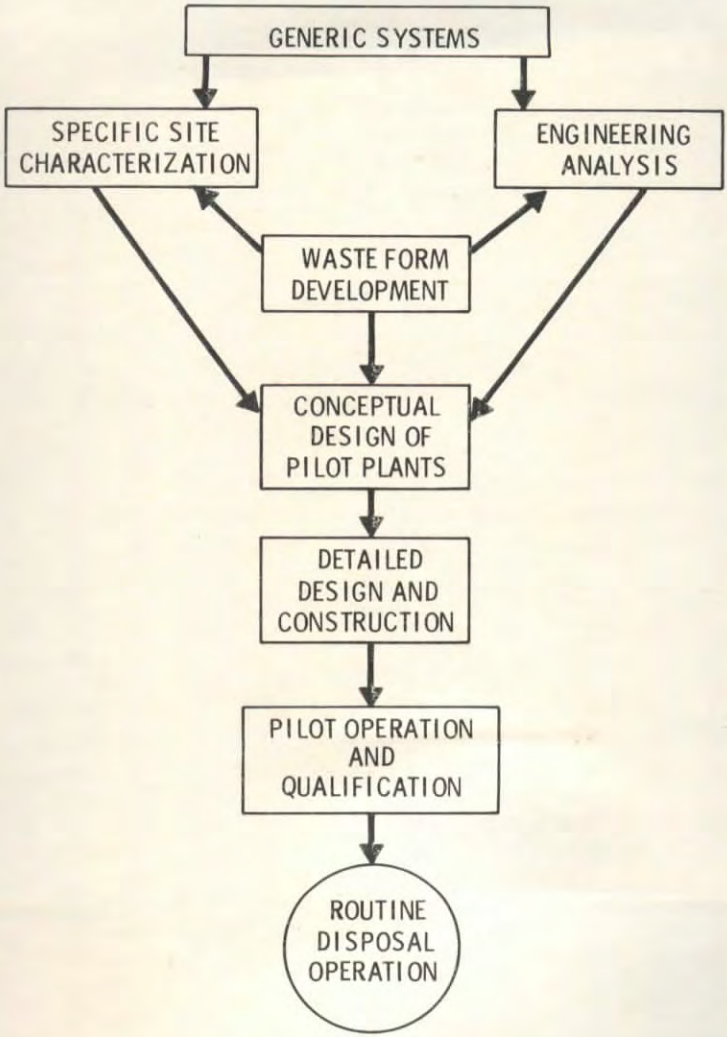

FIGURE 1. Procedure for Implementation of Disposal Concepts

Safety

- Post-Emplacement Phenomena:
  - Waste Degradation
  - Geosphere Transport
  - Biosphere Transport
  - Potential Radiation Dose to Man
- Operational System:
  - Processes and Facilities
  - Transportation
  - Other?

System Performance

- Costs
- Logistics
- Manpower
- Other?

Implementation Impacts

- Environmental
- Social
- Institutional
  - Local
  - National
  - International
  - Land Use
  - Resources
  - Energy
  - Economic
  - Demographic
  - Other?

The ways that analyses and assessments in these sectors will be used to assist the decision process are illustrated by Fig. 2. You will note in this diagram that feedback loops are indicated. This is because we expect that these assessments will impact and perhaps change design concepts and site priorities. We may find, for example, that priorities and concepts established early in the winnowing process are altered as the assessments are expanded and refined. In general, we anticipate the possibility that the winnowing will proceed iteratively as a result of interactions between the design development activities and assessment functions.

Figure 2 shows that assessment of environmental, social, and other implementation impacts is done after the disposal concepts become site-specific. This is because our investigation of requirements for such assessments has to date indicated that they require a specific basis if they are to be useful and meaningful. The iterative feedback process involving these assessments can be facilitated, however, by making design and other technical information on the disposal concept available for assessment as soon as possible.

Two basic types of tools will be used to make the assessments. One type is the analytical models commonly used in scientific and engineering studies and the other is interpretive analysis of data that characterize the disposal system.

Assessment tools of the type expected to be necessary for this program exist today. They have labels such as risk analysis, cost-benefit analysis, nuclide transport models, decision theory, and utility theory. Even though these methodologies exist, it is by no means certain that today's state-of-the-art capability will be adequate for this program. We know, for example, that additional models to describe transport of radionuclides in geologic media will be needed. We have already started a critical review of models used to predict nuclide transport in man's environment and radiation

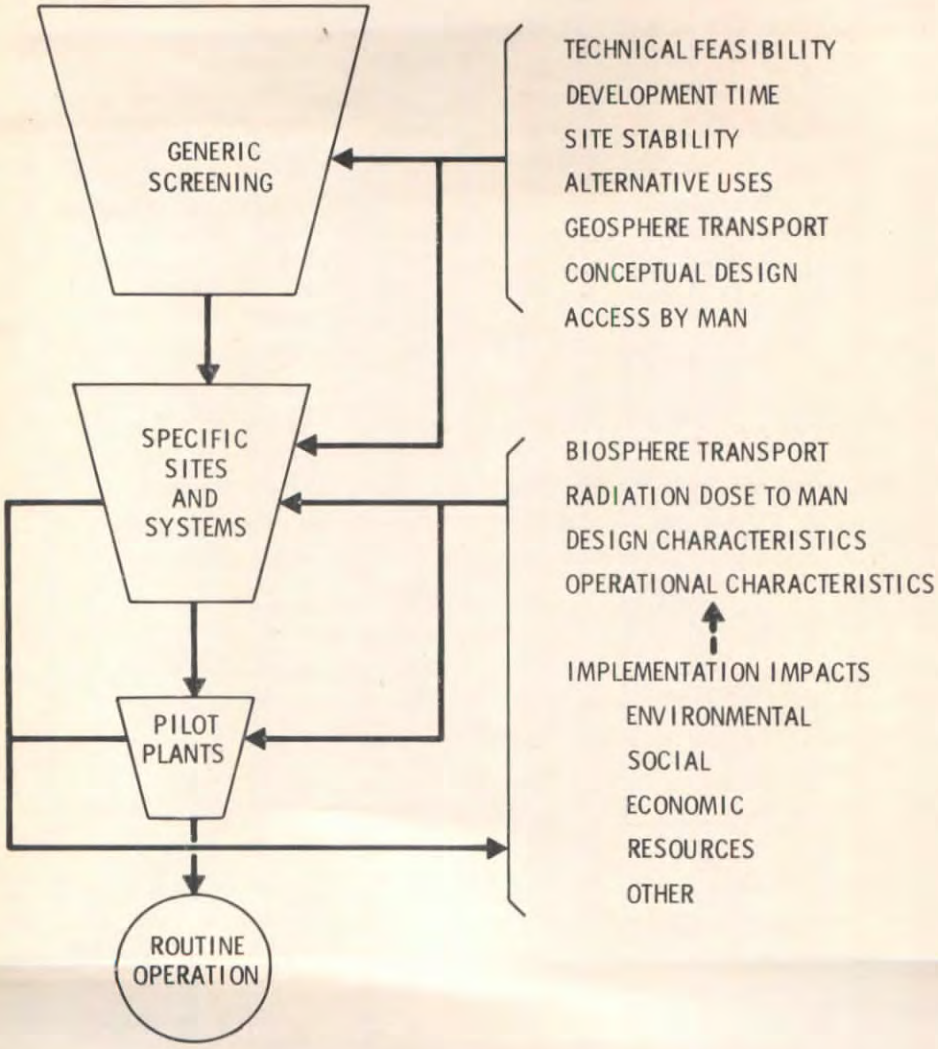

FIGURE 2. Assessment of Disposal Concepts

dose to man. We have also begun investigation of methods to assess and compare disposal concepts at the generic level. The methodologies should provide a good basis for decisions involving many options without the investment of time, cost, and detail that will be necessary when the options have been narrowed to a few.

In short, we foresee need for an R&D effort aimed at analysis and evaluation methodology. Such R&D is expected to be part of the disposal R&D program.

We expect to deal with the "illusions of certainty" problem in two ways. One will be to have the results of analyses and evaluations subject to broad-based critical review. These reviews will be expected to probe the assumptions and methods used to produce the assessments. The other method for trying to minimize the illusions of certainty will be to replicate the key studies with two or more independent efforts. This technique is commonly used in technological assessments. It is considered essential for the scope of considerations involved in selecting disposal methods.

CONTENTS OF THE R&D PLAN

I previously indicated that a comprehensive R&D plan for disposal of the various types of wastes is not yet fully developed. We have, however, developed an initial statement of plans for R&D on disposal of high-level and transuranic wastes. I would like to outline the areas expected to be included in this R&D effort and the basis for the plan.

The plan is expected to be based on two basic inputs:

1. The BNWL-1900 compilation of information on disposal options and concepts, and
2. conclusions and assessments based on BNWL-1900

The conclusions and assessments derived from BNWL-1900 in some cases take the form of program plans for specific sectors of work such as continental and seabed disposal to geologic media.

During the time since BNWL-1900 was issued, considerable effort has been devoted to determining the structure and content of an R&D program based on that document and other sources. Our present opinion is that the program should maintain investigation of numerous disposal concepts. Levels of effort should, however, range from high to low, represented by monitoring of progress in programs sponsored by other agencies or groups.

Definitions of level of effort are arbitrary and imperfectly measured by funding levels since activities that require relatively modest funding may have pivotal roles in charting the course of the program. Since the program is not yet fully developed and funding requirements have not been estimated in detail, I will not attempt to characterize levels of effort. I will, however, list the R&D topics being considered. These are:

- Terrestrial Geologic Disposal
  - Continental
  - Seabed
- Disposal to Iced Regions
- Partitioning
- Transmutation
- Extraterrestrial Disposal
- Analysis and Evaluation Methodology
- Waste Forms

So far we have reached three tentative conclusions concerning the R&D plan content. These can be summarized as follows:

- Terrestrial geologic disposal should be a major thrust.
- No work on iced regions except to monitor other programs.
- Near-term partitioning work should focus only on an evaluation of incentives.

In general, we foresee that only terrestrial disposal will be able to accommodate the bulk of the wastes. We also believe that several disposal media that promise to satisfy basic requirements for long-term stability and isolation have been identified. For these reasons, we anticipate that terrestrial geologic disposal will be an important part of the R&D program.

Partitioning has previously been investigated as a waste processing operation because it offers the possibility that long-lived actinides might be isolated for special disposal techniques such as transmutation. The need for partitioning--evaluated in terms of the alternative, which is capability of disposal media to maintain long-term isolation--has not been established, however. Such evaluations are already underway.

Work on disposal to iced regions will be restricted to monitoring of progress in other programs because many of the basic physical data needed for development and assessment of disposal in these regions do not exist today. The data would be difficult and expensive to obtain, and the continental and seabed options look much more attractive at this time.

I have already commented on the importance of developing adequate analysis and evaluation methodology, and the importance of optimizing waste forms should be obvious.

In perspective, the projected R&D program for disposal of high-level and transuranic wastes is seen as an extension of prior on-going work. We expect to revise and update the plan periodically, and we

expect to maintain effective interaction among those concerned with progress and results. We also expect it to serve as the prototype for R&D plans for other types of waste.

SUMMARY

I have discussed four major topics relevant to R&D plans for disposal:

- Functions of Planning
- Plans Development Procedures
- R&D Program Procedures
- R&D Plans Content

My comments on these topics have tried to emphasize four major points:

- Plans and their results support decisions on disposal methods.
- Decisions will winnow options on the basis of comprehensive assessments.
- The R&D plan for disposal will be comprehensive and maintain options.
- Timeframe for the R&D program may be about 20 years.

Prior and on-going work has provided a good foundation for this planning effort and the content of the plans. The R&D plans are expected to be developed this year and updated periodically.