NUREG/CP-0055

Proceedings of the

State Workshop on Shallow Land Burial and Alternative Disposal Concepts

Held at
Bethesda, Maryland
May 2-3, 1984

Sponsored by
Division of Waste Management
Division of Fuel Cycle and Material Safety
Office of Nuclear Material Safety and Safeguards
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OCT 23 1984

Dear Participant:

We would like to thank you for participating in the "State Workshop on Shallow Land Burial and Alternative Disposal Concepts," that was held in Bethesda, Maryland, May 2-3, 1984. Your participation contributed to developing a common understanding of existing data and experience on shallow land burial and other disposal alternatives, identifying gaps in knowledge and experience, and exploring the advantages and disadvantages of various disposal options. The workshop provided NRC the opportunity to receive State views on alternative disposal methods. This will help ensure that NRC's current study efforts on regulation of alternative disposal methods will be sufficiently comprehensive, and that State guidance needs are met. We hope that the enclosed published proceedings, NUREG/CP-0055, will provide a useful record for future State and compact deliberations on the subject as the States undertake development-oriented analyses of shallow land burial and any alternative disposal methods.

Sincerely,

G. Wayne Kerr

G. Wayne Kerr, Director
Office of State Programs

Enclosure:
NUREG/CP-0055

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ABSTRACT

Shallow land burial and alternative low-level radioactive waste disposal concepts were the subjects of a State workshop sponsored by the U.S. Nuclear Regulatory Commission (NRC), May 2-3, 1984, in Bethesda, Maryland. NRC emphasized that Part 61 of Title 10 of the Code of Federal Regulations (10 CFR) provides for the licensing of alternative land disposal technologies, and that future NRC technical guidance will be only regulatory in nature. The States should take the lead in pursuing development-oriented analyses, such as detailed concept engineering and economic feasibility studies. It is not within the purview of NRC responsibility to undertake such studies. The work that NRC is undertaking with the U.S. Army Corps of Engineers on alternative disposal methods was reviewed, in addition to the regulatory distinctions between storage and disposal. Research and practices of the U.S. Department of Energy were discussed. Analyses on alternative disposal concepts performed by Texas, Pennsylvania and New York and by Maine, Vermont and New Hampshire, jointly, were presented. State officials and other participants evaluated shallow land burial and alternative disposal technologies. Three of the major conclusions reached by State participants were the following: (1) Significant data gaps and information needs have to be addressed before timely State decisionmaking can be accomplished. State participants felt a generic cost/risk/benefit analysis for all viable alternatives would be useful and might best be performed by the Federal government on behalf of the States. (2) Recognizing the imprecision in summarizing overall attitudes of the workshop participants, alternative disposal concepts that appear to be the most favorably perceived when rank ordered by "critical" factors are augered holes with liners, belowground vaults, earth mounded concrete bunkers, aboveground vaults and mined cavities. (3) The public appears to place greater confidence in disposal methods that incorporate man-made engineered barriers because of some past problems at closed shallow land burial facilities. Concern was expressed by workshop participants that the public may not consider the perceived risks associated with shallow land burial to be acceptable. In addition to the four 10 CFR Part 61 Subpart C performance objectives, public acceptance of risk was considered to be a critical factor by State officials in selecting a disposal technology.

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ACKNOWLEDGMENT

The NRC staff would like to thank all the State and other speakers for reviewing the transcripts of their talks for clarity and accuracy. The State chairmen are acknowledged for taking the time to review their statements during the closing plenary. Also, transcripts of the wall charts were reviewed by the State rapporteurs for accuracy in interpretation so that they could become a part of the proceedings of the workshop; we thank the rapporteurs for their efforts. NRC staff acknowledges the accurate reporting by Tayloe Associates. Finally, NRC staff thanks Catherine Berney for assisting in the final preparation of this document and Mary Mejac for editing.

EXECUTIVE SUMMARY

Approximately 140 persons representing States, compacts, industry, Federal government, and public interest groups met to discuss shallow land burial and alternative disposal concepts for low-level radioactive waste. The meeting was in response to a growing number of inquiries from State officials primarily from the Northeast and Midwest regions regarding alternative low-level radioactive waste disposal technologies and the U.S. Nuclear Regulatory Commission's (NRC) views on these technologies. NRC staff felt that a workshop for all interested States would be more effective in providing timely, consistent information than responses to individual State questions. Consequently, the NRC convened a 2-day workshop in Bethesda, Maryland, on May 2-3, 1984.

The stated purposes of the meeting were to:

(1) Provide a forum for the States to develop a systematic approach for evaluation of shallow land burial and alternative disposal technologies.

(2) Develop a common understanding of existing NRC regulations as they apply to all land disposal technologies, and to interim storage practices before ultimate disposal.

(3) Develop a common understanding of the currently available data base and operational experience with existing low-level waste disposal technologies.

(4) Explore the technical, economic, institutional and sociopolitical advantages and disadvantages of various disposal technologies and identify major issues that would need to be addressed in developing and reviewing disposal facility license applications.

(5) Identify those detailed technical analyses required to resolve major issues related to alternative disposal technologies.

NRC officials, Robert MacDougall and Leo Higginbotham, of the Division of Waste Management, described the NRC's regulations and authority to issue licenses for the near-surface disposal of low-level radioactive waste under 10 CFR Part 61. Although Part 61 focuses on near-surface disposal of low-level radioactive waste, sections of the regulation are reserved for technical requirements applicable to alternative technologies. They emphasized that NRC's work is only regulatory in nature and that if States want to study a particular alternative disposal method, they should take the lead in pursuing development-oriented analyses. NRC indicated it could not provide prelicensing assistance to States without a State commitment to develop a specific alternative disposal technology.

James Shaffner from NRC reviewed the work that NRC is undertaking through an interagency agreement with the U. S. Army Corps of Engineers. The project's objective is to assess the need for and recommend appropriate technical criteria for evaluating five generic alternative low-level radioactive waste disposal methods. Specifically, the performance objectives and minimum technical requirements contained in Part 61 are being evaluated as they apply to five alternative disposal methods. These methods include aboveground and belowground vaults, earth mounded concrete bunkers, augered holes, and mined cavities.

U. S. Department of Energy (DOE) programs were summarized by Elizabeth Jordan, Office of Terminal Waste Disposal and Remedial Action (DOE), and Lance Mezga, Oak Ridge National Laboratory, with the objective of informing workshop attendees about DOE research and technology development activities on alternatives to shallow land burial. Lined and unlined augered holes and hydrofracture disposal were specifically discussed. In a subsequent question period DOE indicated that resources are not available for substantial assistance to States for conducting generic studies of alternatives to shallow land burial.

Analyses that States have made to date in exploring shallow land burial and a number of other land disposal options were summarized by Robert Avant, Texas; William Dornsife, Pennsylvania; Jay Dunkleberger, New York; and Robert Eisengrein, for Maine, Vermont and New Hampshire (with the collaboration of Thomas Carter, Ontario Hydro, Canada).

For the remainder of the first day, State participants and observers were divided into four workshops, which applied a systematic approach to the evaluation of shallow land burial and alternative disposal technologies. The workshop structure was developed jointly by NRC's Steve Romano, Waste Management, and Steve Salomon, Office of State Programs, with the collaboration of the workshop chairmen (Dante Ionata, Rhode Island; Kevin McCarthy, Connecticut; Lee Jager, Michigan; and Don Schott, Wisconsin). Each of the workshop chairmen has represented his State in low-level waste compact negotiations. First, the technical, economic, institutional and sociopolitical factors were discussed with regard to comprehensiveness and importance. Examination of these factors was followed by identification of the advantages and disadvantages of the various disposal concepts including shallow land burial. Data and information needs were identified, followed by a rating of the concepts according to the four factors. The next morning the workshops concluded their evaluations by discussing potential methods for selecting a disposal technology of choice. The rating results were then summarized. While the chairmen prepared their final reports, Richard Cunningham, Director, NRC Fuel Cycle and Material Safety, discussed NRC license requirements for storage of waste and addressed the regulatory distinction between storage and disposal.

At the closing plenary the four chairmen presented workshop findings. Findings reflect the views of workshop participants, who were primarily State officals. Broad conclusions from the workshops are:

(1) Significant data gaps and information needs have to be addressed before timely State decisionmaking can be accomplished in pursuing development of a disposal technology. At a minimum, existing data should be coordinated, especially with regard to economic feasibility and actual operational experience and long-term performance of the

alternative disposal technologies employed in Canada, France and Germany. Ideally, a generic cost/risk/benefit analysis for all the alternatives would be useful and might best be performed by the Federal government on behalf of the States.

(2) All the alternative land disposal concepts appear capable of satisfying the 10 CFR Part 61 Subpart C performance objectives. Four of the alternatives -- augered holes with liners, belowground vaults, earth mounded concrete bunkers, and mined cavities -- appear to satisfy the 10 CFR 61 Subpart C performance objectives more fully than does shallow land burial. The main perceived weakness of shallow land burial appears to be the stability of the disposal site after closure followed by the fact that one performance objective is unresolved, i.e., protection of individuals from inadvertent intrusion. The main perceived weakness of aboveground vaults is that the participants were not sure about the stability of the disposal site after closure. For those concepts where protection of individuals during operations was believed to be an inhibiting factor, participants also believed this problem could be overcome by innovative technology. These are earth mounded concrete bunkers, aboveground vaults and mined cavities.

Augered holes were generally assumed to include liners because of groundwater and annual precipitation considerations in the Northeast and Midwest regions of the country. These were the only regions focused on in the workshop.

(3) Alternatives to shallow land burial appear to be more costly overall, but the importance of cost was not considered to be as important as protecting the public from both radiological and nonradiological hazards of the waste.

(4) The public was perceived to place greater confidence in disposal alternatives that incorporate man-made engineered barriers because of problems at the shallow land burial facilities operated before 10 CFR Part 61 was adopted to correct past deficiencies. No shallow land burial site has been licensed under the new regulations. Public perceptions of risk are considered to be critical in selecting a disposal technology, and shallow land burial does not appear to be favorably perceived by the public at present. The unfavorable perception might be overcome through public education.

(5) All the alternatives will take longer to develop and license than shallow land burial because Federal and Agreement State regulations and guidance on alternatives have not been developed. Some States believe that they cannot develop an alternative before NRC completes its regulatory guidance. NRC believes that States should provide a commitment by undertaking development-oriented studies, and that NRC would provide prelicensing guidance based on demonstrated State interest in pursuing a specific alternative disposal technology. NRC indicated that resources are not available to develop detailed regulatory guidance and technical positions on all conceivable disposal concepts.

(6) In addition to the 32 technical, economic, institutional and sociopolitical factors proposed by NRC for selecting a disposal technology, 35 other factors should be considered. A few of those stressed were retrievability of the waste, the type of waste form, and the nonradiological hazards of the waste.

(7) Finally, public involvement in all aspects of technology selection is deemed important. This approach relates to public education with regard to perceived risk versus real risk, and building confidence in the management of the disposal technology and regulatory oversight.

Recognizing the imprecision in summarizing overall attitudes, alternative disposal concepts that appear to be most favorably perceived when rank ordered by "critical" factors are augered holes with liners, belowground vaults, earth mounded concrete bunkers, aboveground vaults and mined cavities.

The critical factors, as ranked by workshop participants, are:

10 CFR Part 61 Subpart C -- Performance objectives

- o Protection of the general population from releases of radioactivity
- o Stability of the disposal site after closure
- o Protection of individuals during operations
- o Protection of individuals from inadvertent intrusion

Public Acceptance of Risk

- o perceived vs. real risk.

Workshop participants did not reach general agreement on the overall suitability of mined cavities and shallow land burial. The workshop participants noted that a generic cost/risk/benefit analysis that emphasizes the long-term performance of the alternative technologies may help to resolve these uncertainties and put the States on a firmer basis to actively pursue development of a specific disposal technology.

1. INTRODUCTION

Over 140 persons representing States, compacts, industry, the Federal government, and public interest groups met to explore the advantages and disadvantages of shallow land burial and alternative disposal concepts for low-level radioactive waste. The U.S. Nuclear Regulatory Commission (NRC) convened the 2-day workshop at the Linden Hill Hotel in Bethesda, Maryland, on May 2-3, 1984, in response to a growing number of inquiries from State officials regarding alternative low-level radioactive waste disposal technologies and the NRC views on these technologies.

The stated purposes of the meeting were to:

(1) Provide a forum for the States to develop a systematic approach to the evaluation of shallow land burial and alternative disposal technologies.

(2) Develop a common understanding of existing NRC regulations as they apply to all land disposal technologies, and interim storage practices prior to ultimate disposal.

(3) Develop a common understanding of the currently available data base and operational experience with various low-level waste disposal technologies.

(4) Explore the technical, economic, institutional and sociopolitical advantages and disadvantages of various disposal technologies, and to identify major issues that would need to be addressed in developing and reviewing disposal facility license applications.

(5) Identify those detailed technical analyses required to resolve major issues related to alternative disposal technologies.

This proceeding generally follows the chronological outline of the workshop described in the final agenda found in Appendix A. The transcripts were prepared by the court reporters, Tayloe Associates, 1625 I Street, NW, Suite 1004, Washington, DC 20006. They were edited by the speakers for technical accuracy and clarity. Some speakers preferred to substitute prepared preprints for the recorded transcript of their speech. Chapter 2 presents the reports by officials of the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy (DOE). State studies of shallow land burial and alternative disposal concepts are presented in Chapter 3. Questions and answers on disposal of low-level radioactive waste posed during the meeting are in Chapter 4. Storage of low-level radioactive waste described by NRC officials is in Chapter 5. The conduct of the individual workshops is summarized in Chapter 6. Summaries of individual workshops by workshop chairmen are in Chapter 7. Finally, Chapter 8 presents the NRC staff integration of individual workshop results, which includes the rating of factors and ranking of the alternative disposal concepts compared with shallow land burial, general impressions and conclusions. The appendices include related material, such as the workshop preprints, instructions to chairmen and participants, transcriptions of the wall charts and tally sheets from the individual workshops, integration data, and references available from NRC and DOE.

2. REPORTS BY THE U.S. NUCLEAR REGULATORY COMMISSION AND U.S. DEPARTMENT OF ENERGY

2.1 Welcome

The State Workshop on Shallow Land Burial and Alternative Disposal Concepts convened at 8:00 a.m., pursuant to notice (see Appendix B).

MR. SALTZMAN:

Good morning, ladies and gentlemen, I am Jerry Saltzman, State Programs, NRC, and it is a pleasure and honor to welcome you all here to the State Workshop on Shallow Land Burial and Alternative Disposal Concepts.

We'd like to mention that there might be a good crowd here today. If it gets a little hot in the back, we have an overflow room about 20 yards up with a speaker in it and you don't have to watch us.

There's a tight agenda, especially this morning, so I'm going to be keeping a close eye on the time and moving the speakers along. But we are mindful of the fact that a good workshop such as this is only successful if there's a discussion among the participants, and so we've laid out a number of periods during which there can be questions and answers. We've tried to allot after each of the speakers, about five minutes for questions and answers. And then after all the speakers in the morning there will be a period of questions and answers.

Now you will notice in your packets there are question cards. If you would prefer to handle it that way, and it might be easier for us, you can write out your question. Just hold it up during the question and answer period; we'll pick it up and bring the cards together, sort through them and answer them that way as much as we can.

There'll also be a chance to ask questions during the workshops themselves. And tomorrow morning at 8:00 back in this room we'll have another period of about half an hour when all the speakers will be brought back and you can ask questions again.

I might say a word about how we're going to try to handle questions and answers. As you know, this is a State workshop and we have invited State participants. They're in the front area. We do recognize a lot of you have gone through a lot of trouble as observers to come here and have a lot to contribute, both in terms of knowledge and interest. And so the way I would like to do it, at least in these plenary sessions, is to recognize and give priority to the questions and answers of people in the State group first, and then recognize those in the back of the room.

I think you'll find something similar is being done in the workshops, although your workshop chairmen will talk to you there about how they're going to actually handle participation of the observers. I think if we all cooperate, participants and observers alike to keep the questions short and on the subject, we can probably get them all in and get everything answered.

I'd like to repeat an offer that was made, I think in the announcement, that if any of you want to meet with any members of the NRC staff after the workshops are completed tomorrow afternoon, let us know some time this morning and we'll try to make them available to you.

As you can see, there's a court reporter (Editor's note: Tayloe Associates). There will be a transcript, and the transcript will be included, together with all the documents that are being prepared, in a set of proceedings that we hope can be published in about 2 months or so. These proceedings will be sent automatically to everyone who registered for this meeting, and will also be available to members of the public.

The next matter is of greater concern to the observers than the members and participants. We had a space restriction in the lunch room, and I'm not sure how many of you who are not participants were able to register for lunch. If you want to hear Mr. Cal Brantley speak it will be possible by staying in the lobby to hear him from the side. The dining room for Linden Hill will be open so you can have lunch. But we have an area behind the lobby for the luncheon speaker, and there was a restriction on the size. Also because of that restriction and the restriction in this room, we're going to ask for no smoking, at least during the plenary sessions, and during lunch.

All of the participants know by their badges and by the papers in their folders which of the workshops they are supposed to go to. There are other State officials who have come on their own, and they have a choice. They can either go to the workshops that have been assigned to them, in which case they can then be full participants. Or if they choose, they can float around to all the workshops, in which case they will be treated more as observers than participants.

Observers are free to go to any of the workshops they want to. I ask you to try to spread it out a little and not bunch up into one workshop. They will be not identical, but they will be following the same methodology for each workshop. They will be handling somewhat different technologies, although all of them will be handling shallow land burial as one of the technologies.

We'll have the workshops this afternoon. The evening is free. I understand that Linden Hill has a lounge over here at the side. There will be a lot of people there, I expect. You're free to have dinner wherever you want. Beside the Linden Hill Hotel, if you hadn't observed it, the Marriott is just down the hill, easily within walking distance. And this is a safe neighborhood as neighborhoods go nowadays.

Tomorrow morning we'll start right off back here again at 8:00 to have a question and answer period, and then you'll break out again for the last hour-and-a-half in the workshops.

While the workshop chairmen and rapporteurs are working together on the remarks that they will make at the last plenary session, we'll come back to this room and Richard Cunningham who's the Director of Fuel Cycle and Materials will speak on storage, which I think is a subject of interest to many of you.

Finally, we will have the final plenary session, and you will all be free to do what you want. I understand the Environmental Policy Institute is holding a session of its own right after this one, and so I expect some of you will be going to that.

I don't know what we've heard yet about checkout time. We're trying to arrange with the hotel to have the checkout time later than the end of our meeting by about an hour to take the pressure off you. I'll let you know as soon as we have that worked out.

Are there any questions about these logistical matters?

(No response.)

Very good. I hope you'll all relax now and enjoy the morning session because I can guarantee this afternoon you're going to be working hard. In dealing with the workshop chairmen yesterday afternoon, I know we have a very extensive program planned for you. It is going to take a lot of participation.

Our first speaker this morning is a substitute speaker. Robert Browning, Director of the Waste Management Division, was called downtown at the last minute by the Chairman. He will be out here a little bit later. But in his place he has Mr. Rob MacDougall who will give us the opening remarks.

2.2 Why the Workshop?

MR. MACDOUGALL:

(Editor's note: The following are the prepared remarks of Robert E. Browning, Division of Waste Management, NRC.)

In recent months we have received a significant number of inquiries from State officials regarding alternative low-level waste disposal technologies and the NRC's views on these technologies. We have recognized the need to provide timely information on this subject, and have worked with State and regional compact officials to arrange this workshop. We hope to accomplish several broad purposes, namely to:

- Develop a common understanding of existing data and experience on shallow land burial and various disposal alternatives;
- Identify gaps in knowledge and experience;
- Provide a forum for State officials to explore the pros and cons of alternative disposal options;
- Consider State decisionmaking needs, and the information and framework required for sound decisions; and

- o Allow NRC to receive State views on alternative disposal techniques, so as to ensure our current study efforts are properly focused.

This morning, I would like to share our perspectives on shallow land burial and its alternatives, and the roles of NRC and the States in establishing additional low-level waste disposal capacity.

- o As you are aware, States are assigned the responsibility to provide for disposal capacity under the Low-Level Radioactive Waste Policy Act. With Congressional consent, interstate compacts may exclude out-of-region waste by 1986. While we recognize not all States and compact regions will be self-sufficient by this date, we strongly believe States should strive to establish needed disposal capacity as soon as reasonably possible.

- o We believe the 10 CFR Part 61 near-surface disposal regulations provide a sound basis for developing and licensing new disposal facilities. The rule reflects substantial knowledge gained through 20 years of experience with shallow land burial, and contains sufficient flexibility to accommodate continuing improvements in this technology.

- o 10 CFR Part 61 focuses on shallow land burial, and reserves sections for other land disposal methods. The decision to develop detailed rules and technical guidance on shallow land burial was based on the Environmental Impact Statement on the rule, and prior studies of alternatives, which identified shallow land burial as a regulatory priority. These analyses were completed with ongoing input from States, industry, environmental groups and other Federal agencies.

- o NRC is currently undertaking a study to evaluate the applicability of the 10 CFR Part 61 technical criteria to other land disposal technologies. Jim Shaffner will provide a more detailed discussion of project schedules and reports later this morning. It is critical to recognize that this study has a regulatory focus. We are not planning to conduct economic feasibility studies, detailed conceptual engineering studies, or other analyses which are development-oriented in nature. We cannot promote the development of a technology which we may later be called upon to regulate. Within the Federal government, developmental and promotional functions for nuclear waste disposal have been assigned to DOE. Our studies are intended to provide guidance, and enable NRC staff to provide responsive and reasonably timely review of any license applications for low-level waste disposal. Development-oriented analyses can proceed concurrently with our work, but should be performed by those who are responsible for such development -- e.g., industry or the States.

- o NRC has authority to license other disposal technologies. Licensing would be based on review of an application demonstrating that 10 CFR Part 61 performance objectives and Part 20 radiation protection standards would be met, as well as appropriate case-specific measures providing for protection of public health and safety, and the environment. Review of an alternative disposal technology application would require more time and analysis than a shallow land burial application. For States to meet disposal capacity needs in a timely fashion, accelerated development activities by industry or the States would be necessary.

- Commercial shallow land burial offers 20 years of applied experience. Any decision to embark on a new learning curve for a technology that does not offer an actual relevant experience base should be made in light of the approaching 1986 out-of-region waste exclusion date, and in recognition of State resource commitments needed to pursue both development and licensing. Within our present resource constraints, we would plan to provide the prelicensing guidance needed to develop a license application for an alternative technology. To date, we have received no expressions of intent to develop or submit an application for an alternative technology.

- We are aware of State concerns regarding the applicability of EPA hazardous waste regulations under the Resource Conservation and Recovery Act to low-level waste disposal facilities. We are involved in continuing discussions with EPA, and are working to resolve conflicts in a way that avoids dual regulation. While we have not fully assessed how our regulatory program will address this issue, we presently believe that the relatively small portion of low-level waste posing a chemical hazard could be controlled within the existing NRC regulatory framework.

- Finally, I would like to address the role of interim storage as it relates to disposal capacity development. Storage pending retrieval and ultimate disposal is not a solution, and may increase problems if progress on ultimate disposal is stalled. A decision to pursue interim storage would be up to individual generators and the States. Dick Cunningham, Director of the NRC Fuel Cycle Division, will discuss tomorrow the technical and institutional considerations specific facilities would have to meet. One of the major considerations of interim storage is provision of plans for final disposal. For this reason, any decision to pursue storage must necessarily be linked to concrete progress on disposal.

I am encouraged by the large showing here today. I believe it demonstrates the commitment of States to fulfill the mission anticipated in the Low-Level Radioactive Waste Policy Act. I hope the workshop proves useful to you, as I'm sure it will provide a useful experience for the NRC staff attending. I hope that by working together, we will be successful in accomplishing the purposes of the workshop, and that both NRC and the States will be able to focus more clearly in the future on the important decisions still before us.

<u>MR. SALTZMAN:</u>

Thank you, Rob. Are there any questions?

There being no questions, we will go on to the next speaker. It is Leo Higginbotham, Chief of the Low-Level Waste and Uranium Recovery Projects Branch in the Division of Waste Management, and he will be speaking on the NRC's low-level waste regulation, Part 61.

2.3 NRC LLW Regulations

Mr. HIGGINBOTHAM:

(Editor's note: The following are the prepared remarks by Mr. Higginbotham.)

I would like to speak for the next few minutes regarding the status of NRC regulations with respect to licensing disposal methods other than shallow land burial.

Mr. Browning has told you that we have the regulations and authority to issue licenses for the land disposal of low-level radioactive waste. The use of the term "land disposal" in the title of the regulation and here is not without purpose -- we want to emphasize that the current regulations and authority for licensing is not restricted to shallow land burial.

In the development of Part 61, there was a focus on the disposal of waste by shallow land burial. The regulation is larger in scope, however, and provides the licensing and regulatory framework for the broader purpose of improved management of low-level radioactive waste.

Since Part 61 was published we have devoted time and resources to preparation of technical guidance to assist NRC staff, licensees, waste generators, site operators, and site developers in applying the rule. The emphasis in this work has again focused on shallow land burial; however, that emphasis has been both necessary and appropriate in light of the need to regulate current operations and practices, and to provide the necessary guidance for anticipated development of new shallow land burial sites.

We saw the development of the rule, and have seen up to now, no great incentive or impetus to concentrate on any other particular single method for waste disposal other than shallow land burial. This doesn't mean we won't do it. It means want to focus our efforts where it will do the most good.

Licensing

Before talking further about licensing of other land disposal methods, I want to emphasize two points about Part 61.

Flexibility

First: The rule reflects a flexible rather than prescriptive approach to regulation. The current technical requirements and performance objectives in the rule address problems identified in past experience. They also, by their design, accommodate potential improvements in facility design and operation, suited to specific characteristics of a site.

The Environmental Impact Statement on the rule, for example, explores improved waste forms, trench grouting, and concrete-walled trenches as variations that may be desirable at a specific site. These or other design features or operating techniques could be proposed by a site developer to complement a site's natural abilities to contain the waste.

Systems Approach

Second: Part 61 is based on a systems approach that encompasses factors affecting site performance, namely, waste form. waste characteristics, natural site characteristics, facility engineering design and operations, site closure and stabilization, and long-term care. Evaluating the adequacy of a proposed disposal site will require consideration of each factor expected to contribute to acceptable facility performance, rather than narrowly considering one aspect such as trench design.

Licensing and Part 61

The performance objectives in Part 61 would apply in licensing an alternative disposal technology; that is, licensing of a method of disposal other than shallow land burial. The procedural requirements of the rule would also apply. By procedural requirements we mean, among other things, the noticing of application submittal, public comment and hearing availability, and the mechanics of review. The regulations in Parts 20, 40, 61, and 70 are sufficient to issue a license, and a new rulemaking is not necessarily required to license an alternative method for waste disposal.

As Mr. Browning pointed out, the review of a license application for an alternative disposal method would require at this juncture more time than the review of an application for a shallow land burial site. This would be due to our current limited experience with other disposal methods and the limited data base for analyses on which to base licensing decisions.

Our current study of alternatives through the Corps of Engineers will increase our knowledge base regarding potential disposal methods. We also anticipate that the comparative analysis of alternative disposal methods you will begin today will provide some insight for further study and help us focus the direction of our work.

To date we have not proposed detailed guidance on standard format and content of an application for alternative disposal technologies. Neither have we developed detailed technical positions on the various technologies. Rather, we will commit the resources necessary for prelicensing guidance and related technical assistance if there is a serious intent to develop a license application for a specific disposal technology other than shallow land burial.

There are several reasons for this approach. First: We have received no indications that a particular alternative shallow land burial is under serious consideration. Prudent use of our resources and budget realities preclude a major effort to develop technical guidance, and additional regulations for the numerous potential alternative technologies that could come under discussion. A concentration on earth mounded concrete bunkers, or vaults, for example, would produce limited benefits if a proposal for mined cavity disposal was submitted.

Also, and most important, our role is regulatory in nature, and we cannot appropriately develop disposal technology. Finally, our providing prelicensing guidance on the basis of a demonstrated commitment to pursue licensing of a specific technology will translate, in our view, to more effective and timely processing of an application.

At this time, I will turn to Jim Shaffner of my staff to describe the nuts and bolts of the Corps of Engineers alternative study.

MR. SALTZMAN:

Are there any questions for Leo?

VOICE:

I wonder if I could make a comment? I have been dealing with your agency now for 6 years, and I understood 6 years ago what Leo just said. But I am most grateful that he said it so clearly this morning in front of all of us so we now hear one story. I think that was great.

MR. SALTZMAN:

Thank you.

We have been responding to lots of questions. I tried to get the responses around to everyone who we think has interest in the subject. But sometimes, between one answer and another, even though they are drafted essentially by the same people, it just doesn't work. There might be a little inflection in one or nuance in another. And we thought this way we'd get a whole bunch of you together at once; you could hear the same story and go home and say, "This is what the NRC and DOE are saying."

VOICE:

I got the impression from your talk that an application for an alternate technology would clearly take longer than an application for shallow land facility.

Can you give any idea about how much more delay would be built into a decision?

I know that's a tough question to answer in the abstract. But if you can just give us some guidance as to how much time you think one ought to build in if they choose an alternate technology rather than shallow land burial.

MR. HIGGINBOTHAM:

Sure, I'll try.

Right now I think we have budgeted and planned for about 2 years to license a shallow land burial site. Add roughly another year for alternative disposal technologies.

VOICE:

Speak up, please.

MR. HIGGINBOTHAM:

The question was: How much longer would it take to license an alternative disposal method, something other than shallow land burial?

We've budgeted or planned for about 2 years for the review process for a shallow land burial site. And I just told the gentleman to add perhaps another year.

But as I said, it primarily comes from not knowing what kind of an application we might get. If someone could tell us tomorrow, "Okay, here is what we're going to send you," in 2 years, when we got the application, we'd probably be able to deal with it more efficiently. That's because it would give us 2 years to develop internal procedures and technical analyses to review a "new" disposal method.

Shallow land burial we could deal with fairly easily right now. We will be able to deal with it more efficiently a year from now. It's the same way with an alternative to shallow land burial.

MR. SALTZMAN:

There's a gentleman in the corner there.

VOICE:

When would your regulations be in effect?

In May of '85, will you have regulations?

MR. HIGGINBOTHAM:

Regulations for alternative technology?

VOICE:

Yes.

MR. HIGGINBOTHAM:

You mean maybe some additional technical requirements in Part 61?

VOICE:

Yes.

MR. HIGGINBOTHAM:

Probably '85. But I think the statement that's been made in the past was -- and what might come out of this study that Mr. Shaffner will talk about, the

Corps of Engineers Study of alternatives -- we'll take a look and see whether or not or how much and what kind of requirements will need to be added -- if any.

We haven't decided yet what those are, what they might be, or even if there are any that need be added.

VOICE:

Leo, I guess I have difficulty understanding why there would be a year's delay if you had a site that met all the site suitability requirements and all you were doing was additional barriers like cement walls or a better waste form. Why would it take another year? It seems you're improving upon shallow land burial.

MR. HIGGINBOTHAM:

I don't disagree with that at all, Bill. It would probably depend on the specific proposal, of course.

What I built in was the hearing process, public participation, and so on.

VOICE:

You indicated the difficulty that the NRC perceives in developing alternative technologies because it has to also regulate.

Aren't the States in the same situation? Or do you perceive the States with the greater ability to develop because of a lesser need to regulate?

MR. HIGGINBOTHAM:

The remark was really directed toward the non-Agreement States.

I realize the Agreement States have the same problem. There's no question of that. But they could probably deal with it easier than we could.

VOICE:

So, the non-Agreement States, you would think they wouldn't have the same problem?

MR. HIGGINBOTHAM:

I'd like to suggest that one of the States might wish to address the point.

MR. SALTZMAN:

I think we'll take two more questions.

By the way, could you identify yourself, because the speaker in the other room can't pick it up.

MR. AVANT:

Avant, Texas.

The answer to his question is very simple. We have an arm's-length separation between the State regulatory agency and the State authority that would dispose of the waste. So, we would be the disposer -- the disposer of the regulations or the alternative technology.

So, as far as Texas -- and I expect for some of the compact States -- there's going to be an arm's-length separation there, too.

MR. SALTZMAN:

One more. This lady here.

SENATOR KANY:

Judy Kany, of Maine.

Does the NRC have any applications pending? Or does anyone have any applications pending today for shallow land burial?

Are there applications pending for long-term storage, with an accompanying proposal for ultimate disposal? And if so, how detailed must the accompanying proposal for ultimate disposal be?

MR. SALTZMAN:

The question, Senator Kany, is whether any Agreement State has a pending application for shallow land burial or a pending application for long-term storage, accompanied by a description of the ultimate plans for disposal. And if so, how detailed is that description of -- does the ultimate plan for disposal have to be?

MR. HIGGINBOTHAM:

The answer to those questions are: No. No. And just about as detailed as we would require for an application for disposal.

You're submitting a plan for an alternate disposal method. Most of the considerations that we would want to be taken into account for a shallow land burial site or any other disposal technology we would want to see in such an application.

I'm talking about financial considerations, institutional controls, the works.

SENATOR KANY:

May I follow through on that?

Would the description of the ultimate disposal have to include its actual site or location?

MR. SALTZMAN:

The question was whether the description for ultimate disposal would have to include a site.

MR. HIGGINBOTHAM:

I don't believe so. Although don't take that for final answer. I just don't feel comfortable giving you a definite answer. Maybe.

(Laughter.)

MR. SALTZMAN:

Thank you very much, Leo. And thank you for the questions.

Our next speaker will be Jim Shaffner, who will describe the Corps of Engineers report to you. (Editor's note: "Alternative Methods for Disposal of Low-Level Radioactives Wastes," NUREG/CR-3774, Vol. 1, April 1984.)

2.4 Disposal Concepts Being Studied by NRC

MR. SHAFFNER:

As you're well aware, there are no magic solutions for tough decisions to be made regarding low-level waste disposal -- or will there ever be.

My purpose this morning is to discuss conceptually some technical information regarding engineering techniques for disposal of low-level waste. And I emphasize the term "engineering techniques." I'm going to include in that shallow land burial. My reasons will be made clear later.

Hopefully, the information I'm going to present will be of some help to you in your work this afternoon.

First, I'd like to answer a few questions before they're asked.

Why is NRC looking at alternatives to shallow land burial? Is shallow land burial no good? Have we lost confidence in it?

And the answer to the latter is a resounding "no." We have not lost confidence in it.

But the NRC is a regulatory body. We are not a promoter of or detractor from any technology. What we're trying to do with the Corps study is respond to perceived interests by States, compacts, and others with regard to alternative methods of disposal.

So, with the Corps study, we're trying to do the things that we need to do as a regulatory body to facilitate licensing. We are not in the business of doing research and development with regard to alternative disposal techniques, but we are trying to recognize the reality that the States are interested in alternative technologies, both for sociopolitical and for sound technical reasons. So, that's what we're trying to address (with the Corps study).

In that regard, we entered into an interagency agreement with the Corps of Engineers a little less than a year ago. And that study is primarily the subject of my discussion this morning.

You heard the date May 1985 in one of the earlier questions. I believe that might be a reference to a time when the Corps of Engineers study will be complete.

I would like to take an opportunity to mention that Mr. Jim Warriner from the Corps of Engineers is in the audience this morning. I'm not going to embarrass him and ask him to stand up. But he'll be available as a resource person in your discussions this afternoon.

(Slide 1)

If anybody in the back of the room can read this slide, please let me know, because you've got the greatest eyesight in the world.

The only reason I put it up is to mention that the Corps study is broken into three tasks:

Task 1, which has been completed recently is the conceptual evaluation of alternatives and assessment of the criteria as they exist now in Part 61.

Task 2, which is ongoing right now, calls for the development of modified and supplemental criteria that would apply to these various alternatives.

And finally, Task 3 calls for the development of license applications review procedures that will facilitate the licensing process.

(Slide 2)

To expand a little bit, I think it's also significant to talk about things that are beyond the scope of the Corps report.

First of all, quantitative assessment of cost -- you all are interested in cost data. Well, that is conspicuously absent from the Corps of Engineers report -- and rightly so in our estimation.

Quantitative assessment of environmental impacts and sociopolitical impacts is also beyond the scope of the study. Also, technical requirements for waste form and waste classification as presented in Part 61 are assumed constant in the Corps report. Certainly various alternatives could have some impact on waste form and waste classification. But those changes are beyond the scope of this particular report.

The basic assumption that I think was alluded to in some of the earlier presentations for all disposal methods, Part 61 requirements related to licensing performance objectives, financial assurances, State and tribal participation, and records and reports remain constant. So, the Corps is

NRC Project Schedule

"Criteria for Evaluating Engineered Facilities"

USAE Waterways Experiment Station

TASK 1	TASK 2	TASK 3
1 June 1983—7 January 1984	20 Jan 1984——19 Jan 1985	21 Jan 1985 —15 April 1985
Evaluation of Alternatives & Assessment of Criteria	Development of Modified / Supplemental Criteria	Development of License Application Review Procedures Final Project Report Tasks 1,2&3

Slide 1

CORPS OF ENGINEERS STUDY OF ALTERNATIVE METHODS OF DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE

SCOPE:

TASK 1: CONCEPTUAL DESCRIPTION OF ALTERNATIVES AND ASSESSMENT OF TECHNICAL CRITERIA

TASK 2: DEVELOPMENT OF MODIFIED OR SUPPLEMENTAL CRITERIA FOR EACH ALTERNATIVE

TASK 3: DEVELOPMENT OF LICENSE APPLICATION REVIEW PROCEDURES

BEYOND SCOPE:

QUANTITATIVE ASSESSMENT OF COST

QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS

QUANTITATIVE ASSESSMENT OF SOCIO-POLITICAL IMPACTS

CHANGES IN TECHNICAL REQUIREMENTS FOR WASTE FORM OR WASTE CLASSIFICATION

BASIC ASSUMPTION:

FOR ALL DISPOSAL METHODS PART 61 REQUIREMENT RELATED TO LICENSING; PERFORMANCE OBJECTIVES; FINANCIAL ASSURANCES; STATE AND TRIBAL PARTICIPATION; AND RECORDS AND REPORTS SHALL REMAIN CONSTANT.

Slide 2

simply looking at technical criteria in Subpart D that I'll get into in more detail as I go on.

Most importantly, we are looking at disposal of low-level radioactive waste, not storage of low-level radioactive waste.

So, as I go into these various alternatives, please keep that in mind. We're not talking about interim storage; we're talking about disposal.

Is there anything magic about the alternatives that the Corps is looking at? Certainly not. Nor are we looking at all-inclusive suite of alternatives. We're not looking at exotic things like extraterrestrial or solar disposal. We're not looking at sea disposal. We're not looking at deep geologic disposal. That was a little bit of a digression, but I needed to point that out.

Now, as far as these basic assumptions are concerned, there is one thing I do want to make clear --

(Slide 3)

-- I know you're probably more painfully aware of these performance objectives in Part 61 than I am, but I just want to point out we're not talking about one set of performance objectives for shallow land burial and another set for alternatives. The performance objectives, as they're listed in Part 61, will apply, written for all the alternatives being studied by the Corps of Engineers.

(Slide 4)

One of the Subpart b technical criterium that the Corps is looking at with respect to alternatives is site suitability: how easy is it to model the site, population considerations, natural resources, ground and surface water considerations, geomechanical hazards, and the impacts of surrounding facilities. Another criterium is site design: looking at things like the ability of the site to be closed properly, enhancement of the site, control of the surface water infiltration and control of surface water runoff. Operations and closure criteria considerations include depth and stability, subsidence considerations, surface radiation considerations, relocatability -- and I don't mean, by that, picking up the waste and carrying it somewhere else; I mean, by that, by means of an engineering survey, to relocate (i.e., find again) either a specific disposal unit or relocate, within that disposal unit, a particular waste package for whatever reason you might have.

A buffer zone is another consideration, closure consideration as is closure by increments. Some of these alternatives, by their very nature, would require incremental closure.

And finally monitoring: preoperational monitoring, operational monitoring and postoperational monitoring and along with that a mitigation plan that would go hand in hand with the monitoring. The plan would be implementable should the monitoring tell you that its implementation was required.

PART 61 PERFORMANCE OBJECTIVES

61.41 PROTECTION OF POPULATION FROM RADIOACTIVE RELEASES
ENVIRONMENTAL RELEASES MUST RESULT IN ANNUAL DOSES LESS THAN:

25 MR WHOLE BODY
75 MR THYROID
25 MR ANY OTHER ORGAN

AND

REASONABLE ATTEMPT TO MAINTAIN ALARA

61.42 ENSURE PROTECTION OF INADVERTANT INTRUDERS AFTER REMOVAL OF INSTITUTIONAL CONTROLS.

61.43 OPERATIONS TO BE CONDUCTED IN COMPLIANCE WITH PART 20 STANDARDS

61.44 OVERALL SITE STABILITY MUST BE SUCH THAT ONLY SURVEILLANCE MONITORING AND MINOR CUSTODIAL CARE ARE REQUIRED.

Slide 3

TECHNICAL CRITERIA WHICH ARE THE BASIS OF THE CORPS ALTERNATIVES STUDY

SITE SUITABILITY

SITE DESIGN

SITE OPERATIONS AND CLOSURE

SITE MONITORING

Slide 4

(Slide 5)

As I have said, the Corps of Engineers study addresses about five alternatives. I am going to talk about a sixth. I am going to talk first about shallow land land burial as an engineered disposal method.

As you are well aware -- or maybe you are not so well aware, soil is an engineering material just as concrete and steel and plastic as well. We use it as such all the time and we build roads and bridge foundations and dams. So to think of concrete -- a concrete facility as an engineered facility and shallow land burial using soil as a barrier as something other than an engineered facility in my opinion is incorrect.

So I am going to talk about six alternatives and I am going to couch the first four in one group: shallow land burial, below ground vaults, earth mounded concrete bunkers and augered holes, and then I'll go on to above ground vaults and mined cavities.

(Slide 6)

Shallow land burial -- a rather idealized view of a shallow land burial disposal unit. I show basically a trench excavated in geologically suitable soil that has been properly characterized according to Part 61 with a sloping floor that would slope toward a leachate or drainage collection system. Typically the walls are not vertical because of soil stability considerations. I showed them here because I can't draw them any other way. Walls and floors are comprised of in situ soil -- that is "engineer" for dirt that God put there. A monitoring stack riser is provided for either gaseous effluents or leachate collection monitoring, as you will. A sandbed that is optional. Some facilities are using them. Some are not. An impervious mounded cover of soil. What is holding all this up? Stable waste as called for in Part 61.

Now what are some of the performance considerations? Certainly stability, which is addressed in Part 61. Intruder protection: there are no inherent barriers to intrusion in a shallow land burial facility. Release considerations: using soil as a containment material, you would have a controlled release.

We have a large data base of experience for both operations and worker protection associated with shallow land burial -- approximately 20 to 25 years' worth of such experience.

Certainly shallow land burial facilities are susceptible to long term geologic processes. These are things that would come out in the site characterization process -- susceptibility to earthquakes and things like that.

They are susceptible to long-term changes, regional rises in the water table. Again, this would have to be properly considered in a site characterization study.

ENGINEERED DISPOSAL METHODS

SHALLOW LAND BURIAL

BELOW GROUND VAULTS

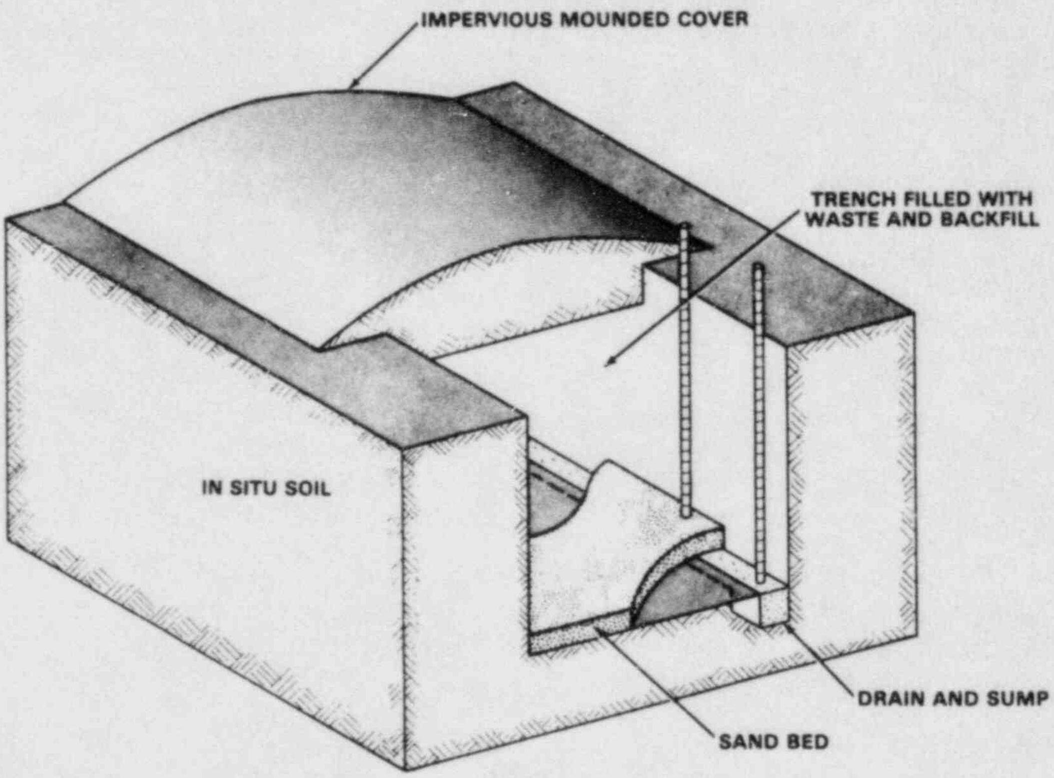
EARTH MOUND CONCRETE BUNKERS

AUGERED HOLES

ABOVE GROUND VAULTS

MINED CAVITIES

Slide 5



CONCEPTUAL CUTAWAY VIEW
ENGINEERED SHALLOW LAND BURIAL

Slide 6

We do have, as I said, a lot of experience with shallow land burial. However, keep in mind that all the sites, the commercial sites that now exist, were licensed prior to Part 61, so as far as experience with sites that were licensed under Part 61, we just don't have any.

And the experience -- I don't want to get too much into it --we feel in some ways the experience with shallow land burial has been very good, particularly in arid sites, and there have been some problems with shallow land burial in the humid East, but problems that are probably a little bit blown out of proportion.

There have been some instances of migration of small amounts of radio-nuclides,within acceptable safety limits.

As far as the criteria that are in Subpart D with respect to shallow land burial, of course all would apply.

The below ground vault is the next alternative I would like to look at. It won't be too much different from the conceptual drawing of the shallow land burial trench.

(Slide 7)

But I have added a few goodies to it. Here we are talking about a facility that is constructed below the surface of the earth -- the ceiling and walls of material other than soil material -- concrete, steel, fabricated metal forms, plastic foam are materials suggested by the Corps of Engineers.

They also suggest that the floor need not be of this material, that that would be an option, to have the floor constructed of the same material. In other words, you would still be relying on the in situ soil to provide some of your containment and inhibition of waste migration.

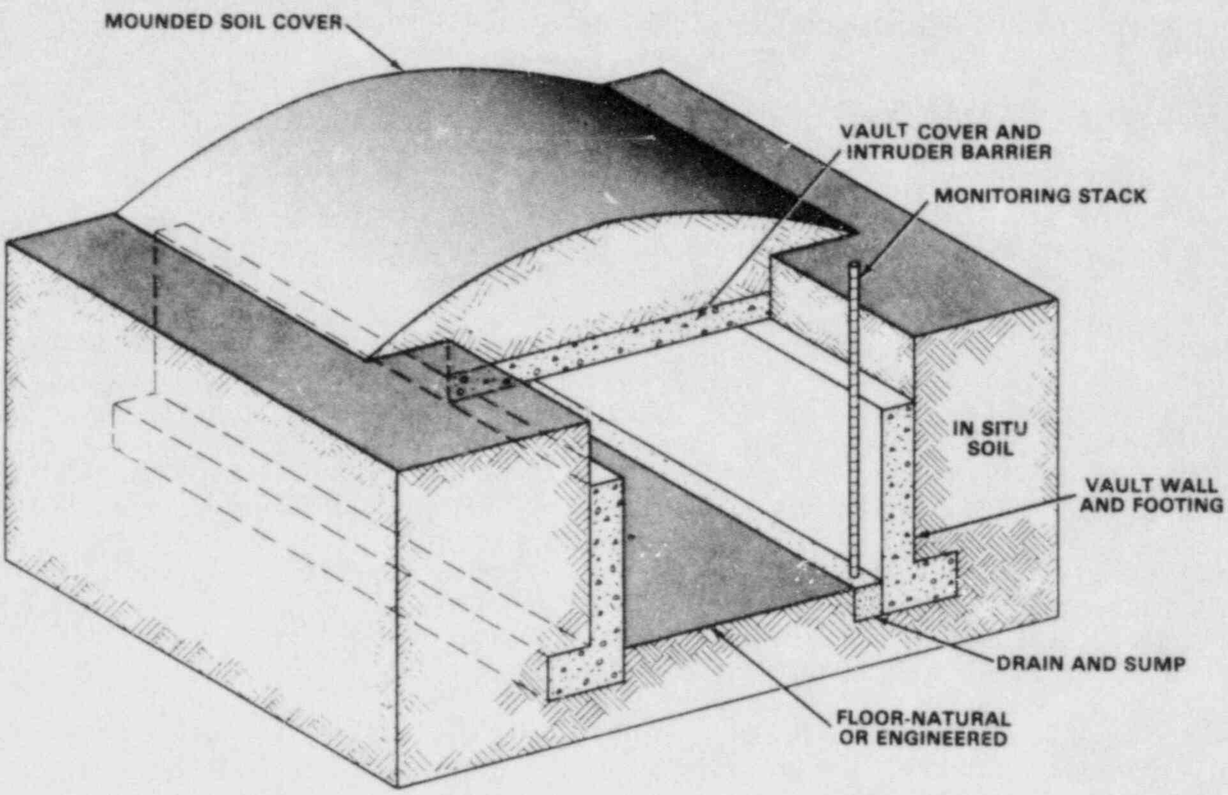
This is an interesting concept. You might want to grapple with that a little bit this afternoon, the pros and cons of a contiguous unit as opposed to a floor made of soil material.

Other than that, you still have your monitoring stack, and a mounded soil cover over the concrete cover.

Performance considerations: visual, not too different from shallow land burial. It is below the surface, visually unobtrusive. It's intrusion resistant. Its very nature of the construction material would limit intrusion. Certainly it impedes migration, although -- there would not be zero release. The migration through concrete or steel is likely to be a lot less than in some soil materials.

It is an inherently stable structure. It would not be necessary to rely on the packages to provide stability.

Some operations considerations: there would be limited access during operations and the possibility of higher worker exposure would be something that would have to be considered in the design and operations of the below ground vault.



CONCEPTUAL CUTAWAY VIEW
BELOW GROUND VAULT DISPOSAL

Slide 7

Experience in this country: Oak Ridge is using below ground vaults for retrievable TRU storage. In Canada they have extensive experience in storage of low-level radioactive waste in below ground vaults.

As far as the performance criteria, Corps of Engineers has determined that most apply as written. There would have to be some additional consideration of the effect of the soils on the structural integrity - both the chemical interaction of soils and whatever material was used and also the structural considerations.

There would probably have to be some additional criteria with regard to shielding and possibly a re-look at alternative specific monitoring.

Next, I would like to talk of something that we call an earth mounded concrete bunker.

(Slide 8)

I am going to strain your vision again, I am afraid.

I don't expect you to be able to read the words at the bottom of the thing, but this is -- this is kind of an evolutionary rather than revolutionary technique. It evolved from a number of different technologies. The French are using this facility right now for the disposal of low-level radioactive waste.

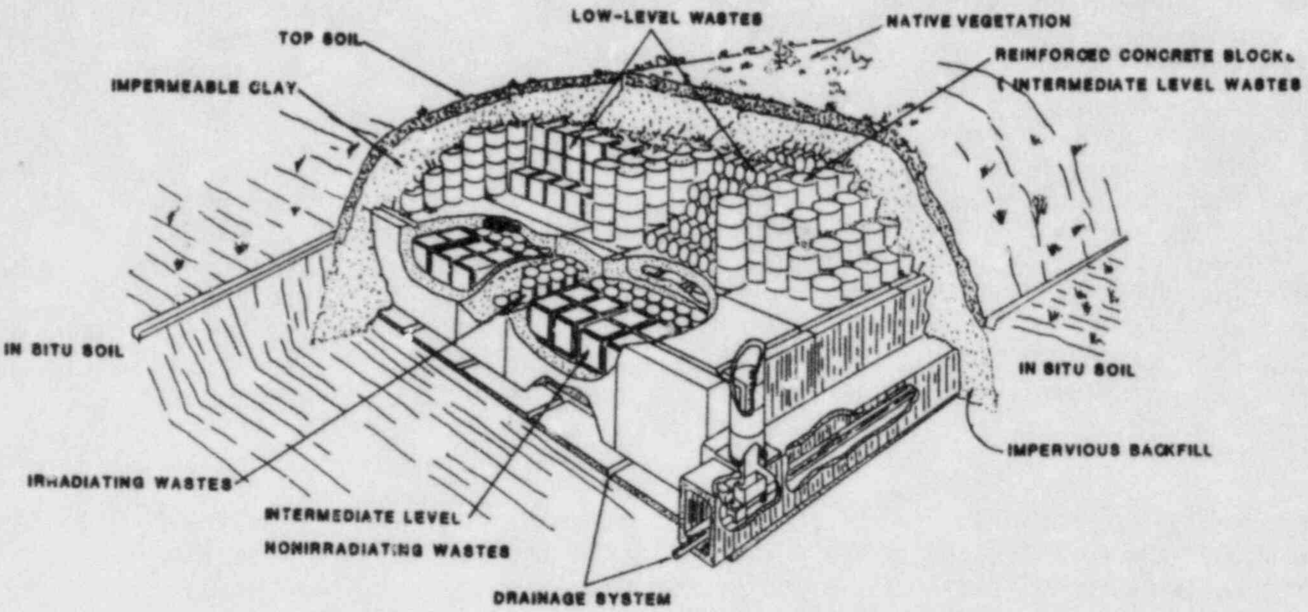
Essentially, it employs the excavation of a super trench, as it were, a very large trench. A concrete slab is constructed at the bottom of the trench with integrated drainage that all goes to a central point.

Above the slab are cells constructed out of concrete, which are filled with compacted waste or treated waste. The cells are then backfilled with liquid concrete, which then sets up and you end up with a big concrete mass.

Between the cells there are interstices in which the French use to place hotter waste, waste with a higher surface activity. That again is filled with concrete so you end up with a big concrete monolith at the bottom of this facility.

Again, a platform is constructed. Additional drainage is added and above that you have what is called a tumulus, which is made up of individual waste packages, containers, as you will, to form a structurally stable tumulus, which is then covered over with impervious soil and topsoil. Drainage is added to the top to control surface runoff. I will leave that up there for a while so you can look at it.

Some performance considerations with regard to earth mounded concrete bunkers: interactions between the multiple barriers have to be considered. There are various engineering materials that are involved here: concrete, asphalt, for some of the drainage controls or infiltration control, the drums, the soil. There are many possible chemical and physical interactions.



The perspective view of an Earth Mounded Concrete Bunker depicts the approximate locations of wastes which are separated according to level of activity. Intermediate-level wastes are embedded in concrete monoliths belowground: low-level wastes, or intermediate-level wastes with appropriate packaging, are stored aboveground in earthen mounds over the concrete monoliths. A drainage network is provided within and around the structure to prevent contact of water with the wastes and to provide collection and monitoring capabilities.

Figure 7. Perspective View of an Earth Mounded Concrete Bunker. Source: modified from F. Van Kote, "Twelve Years Experience in Low- and Intermediate-Level Waste Disposal."

Slide 8

Certainly this is a very, very complex system. There are rigorous engineering requirements associated with all phases of its design, construction and implementation. There would have to be rigorous controls with regard to scheduling, receipt, storage, processing and disposal of waste. Certainly there would be many ancillary facilities, such as concrete batch plants, waste compaction facilities, waste treatment facilities.

This is clearly not a system that is amenable to a low-volume operation.

As I mentioned, the experience with earth mounded concrete bunkers - the practical or the actual use experience is primarily in France, at the Centre de la Manche. One of my coworkers is over there looking at that facility right now while I am talking to you. No, I don't resent it.

(Laughter.)

They do also have some experience in this country. ERDA now DOE has limited experience with variations, and I will put a couple up here for your consideration.

(Slide 9)

This is another EMCB concept that might have associated with it a kind of a temporary weather shield, this thing that looks like a circus tent.

(Slide 10)

And a kind of a rudimentary form of the same thing, a low concrete V with a sump built into it, mounded over with earth.

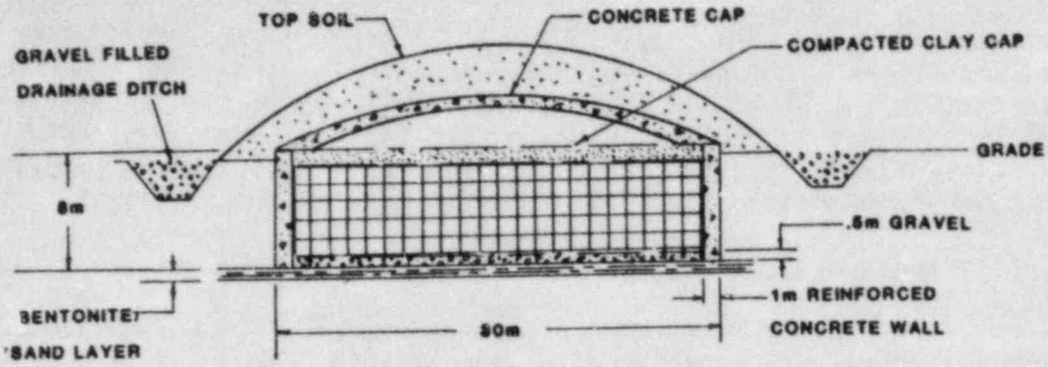
(Slide 11)

Okay, on to the next alternative I would like to talk about, for those of you who got the little packet that was sent out before the meeting, it was the thing that looked like a mushroom because among my many talents is not artwork. But I have a little better depiction today. It is augered hole disposal -- a round trench, if you will.

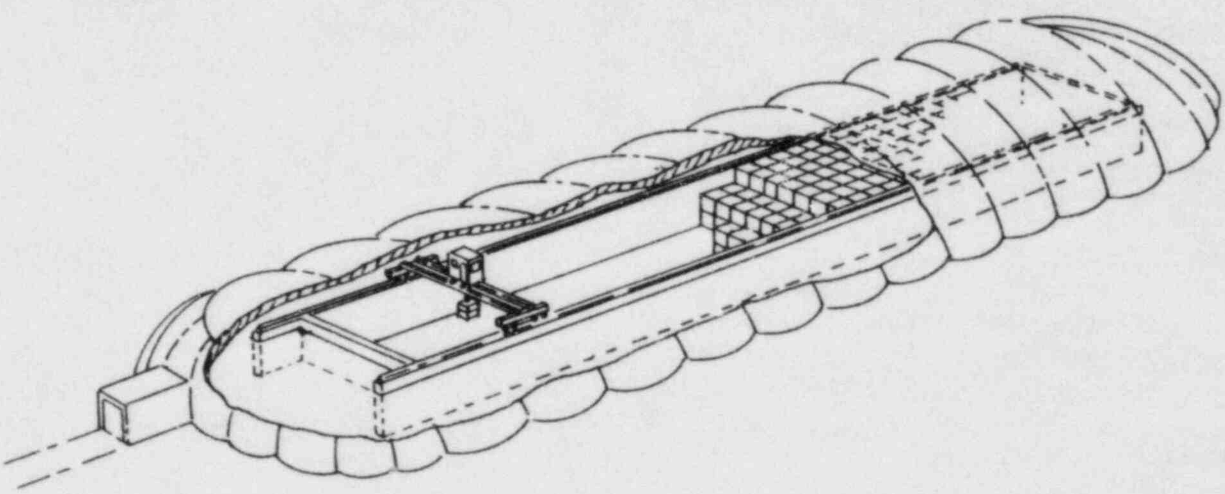
Basically, a hole is sunk vertically or nearly vertically in the earth's surface using conventional available technology, augers, roller bit, rotary attachments to commonly available construction equipment in order to construct a cylindrical hole into the earth for the disposal of waste.

The limitations for the size of these things are probably 3 meters in diameter and 30 to 40 meters in depth, stretching the limit of near-surface disposal in some of those cases.

We would have the same hydrogeologic considerations you would for shallow land burial. Again, you would want to find soil material that is structurally suitable. Maybe the requirements should be a little more rigorous in that you would need material that was amenable to standing vertically, primarily cohesive soil; although DOE has had some good success out in Nevada constructing these things in material that I wouldn't think would support vertical sidewalls.



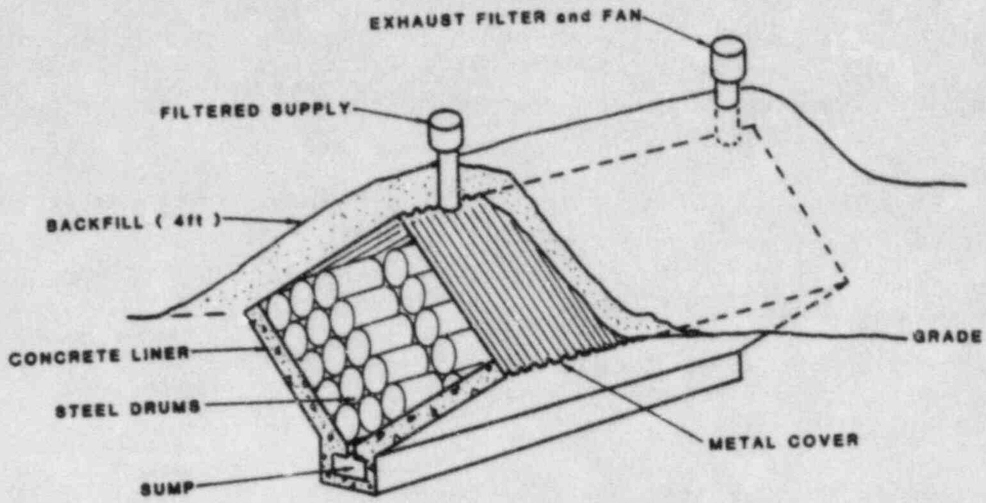
TYPICAL CROSS-SECTION
thru
FACILITY AFTER CLOSURE



The conceptual drawing of a concrete walled disposal vault depicts an air supported weather shield which is used during the operational stage. The facility represents only one of many possible variations to the Earth Mounded Concrete Bunker concept. The use of an air supported weather shield has potential application to most of the alternative disposal methods considered in this report.

Figure 12. Earth Mounded Concrete Bunker with an Air Supported Weather Shield. Source: modified from M. A. Feraday, "Canadian Experience with the Storage and Disposal of Low- and Intermediate-Level Waste," pp 411-429 in Proceedings of the Symposium on Low-Level Waste Disposal, Washington, DC, 1982.

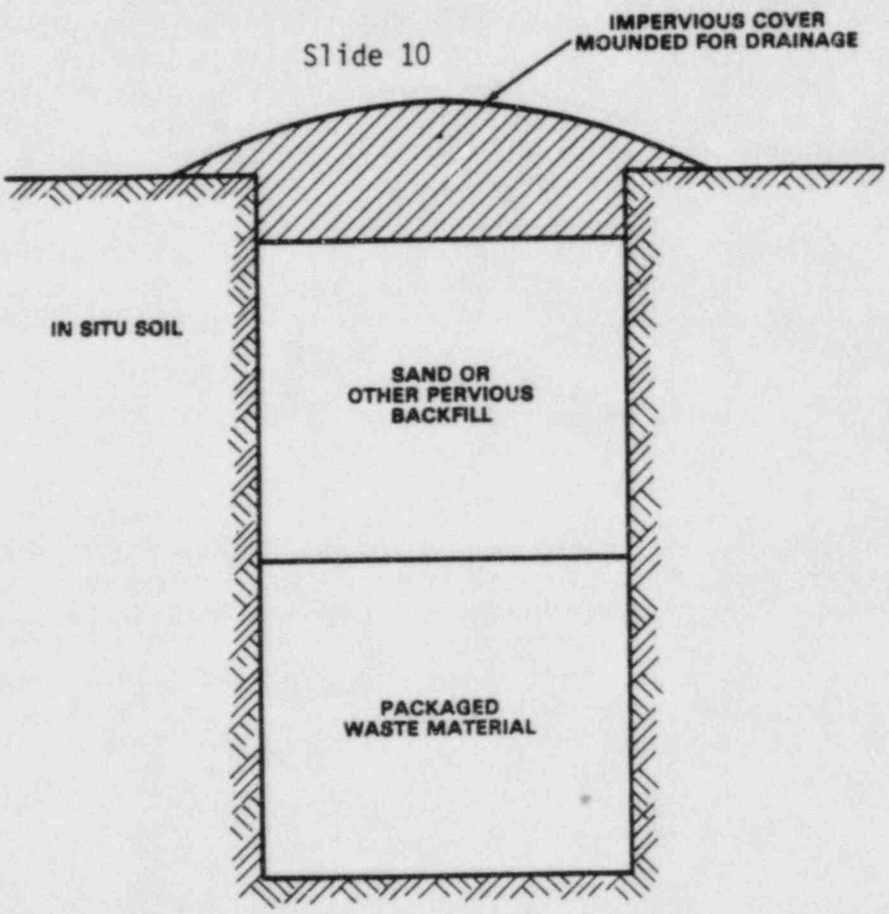
Slide 9



This variation of the Earth Mounded Concrete Bunker concept has been tested by the Energy Research and Development Administration. Steel drums containing transuranic wastes are placed in concrete lined trenches which are subsequently covered and then backfilled with earth.

Figure 13. Variation of the Earth Mounded Concrete Bunker Concept. Source: modified from W. R. Gilmore, Radioactive Waste Disposal, Low and High Level, p. 273, Noyes Data Corp., Park Ridge, NJ, 1977.

Slide 10



CONCEPTUAL ELEVATION VIEW
AUGERED HOLE DISPOSAL

Slide 11

Essentially you place the waste at the bottom of the hole in as stable configuration as possible, backfill with sand or pervious material and then cap it with an impervious cover, mounded so that it was not susceptible to surface water infiltration.

These things, as constructed, are inherently stable. It's fairly easy to engineer the stability of them, because they are fairly small. We're not talking about a span of 30, 40 feet or 100 feet. It would probably only be a few feet over which you would have to effect stability.

The waste would have to be loaded remotely into these things. There's no way you're going to send a person down there to stack the waste and make sure it's stable.

It's very unlikely that they would be susceptible to inadvertent intrusion.

Another consideration is that of low space economy. There would be a lot of interstitial space that was essentially dead space. It would be necessary as part of the site, but it would not be available for waste disposal. They would, however, be easy to construct once you got geared up. You could use the same piece of equipment to construct many of these in a short period of time.

DOE has extensive experience with research with regard to augered holes. They are currently running a study in Nevada in which they are looking at the applicability of these facilities for waste that would be considered greater than Class C. In Canada, they are using a variation of augured holes called tile holes for waste storage; that's essentially an augered hole with a concrete liner -- or liner of material other than soil.

With regard to the Subpart B criteria, most of the criteria would apply directly -- this is a very, very similar concept to shallow land burial. There may be additional criteria with regard to requirements of the host soil to ensure stability as it was being constructed.

Okay. Now, let's come above the surface for a minute.

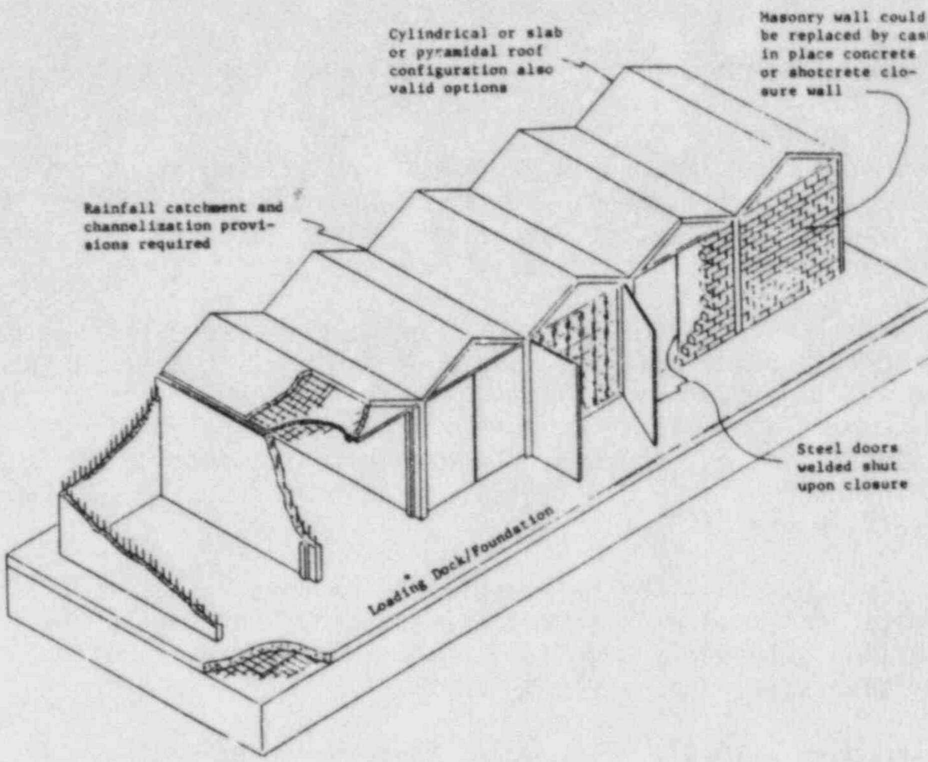
(Slide 12)

And here, again, I would like to remind you, as I talk about these things, that I'm talking about disposal, not storage, aboveground vaults, mausoleums, permanent monuments to nuclear waste, whatever you want to call them.

We're talking here -- I say "we"; I mean the Corps of Engineers -- are talking about a facility that is constructed all or mostly above the surface of the earth of an engineered material other than soil and of varying shapes, sizes, configurations, as you will.

I've shown a nuclear garage here, but the shape can certainly vary.

Performance considerations -- certainly climatological and geomechanical stresses have to be an important consideration in aboveground vaults. These structures are susceptible to things that are going on above the surface of the earth -- rainfall, you know, whatever degradation that can be associated



The separate cells of the overall disposal vault structure could be constructed and used progressively as needed. The construction depicted here is primarily of reinforced concrete, cast in-place to minimize leakage-prone joints. As a cell is filled to capacity it is sealed permanently, while neighboring cells are in operation. Cellular disposal reduces quantities of leakage in the case of a single cell failure. Truck unloading docks are included as part of the foundation. Cellular vaults are inherently feasible for waste requiring strict segregation.

Figure 5. Conceptual Sketch of Cellular Aboveground Vaults for LLW Disposal.

Slide 12

with the chemicals in rainfall over a period of 300 years or so -- geomechanical stresses, earthquakes, mass wasting, things like that.

Certainly they are visually apparent. They are right out there in the open for people to see and touch if they want to -- or not necessarily touch, they'd probably be inside a buffer zone.

There would have to be consideration in these things for venting and leachate collection.

Here, as opposed to the belowground vault, we are talking about a totally integrated structure in all cases. So, there would have to be some mechanism whereby small amounts of gas that were either disposed of or were generated as a result of disposal could be handled in a systematic manner.

Also, a very important consideration would be more vigorous first-line monitoring, because you do not have the luxury of geologic or soil containment. Once you have a problem with a facility like this -- obviously, you're not designing it to have a problem, but Murphy's Law does apply. If you do have a problem, once it gets out there's no geologic containment of the release. So,it's very important that your first-line monitoring system within the structure itself is very reliable.

Here, again, you would have, by the nature of the construction of these things, a limited access and therefore the potential for high worker exposure. You would probably have to use some rather exotic waste-handling equipment for disposal in aboveground vaults.

Let me just throw up a couple of examples that the Corps of Engineers came up with for your consideration.

(Slide 13)

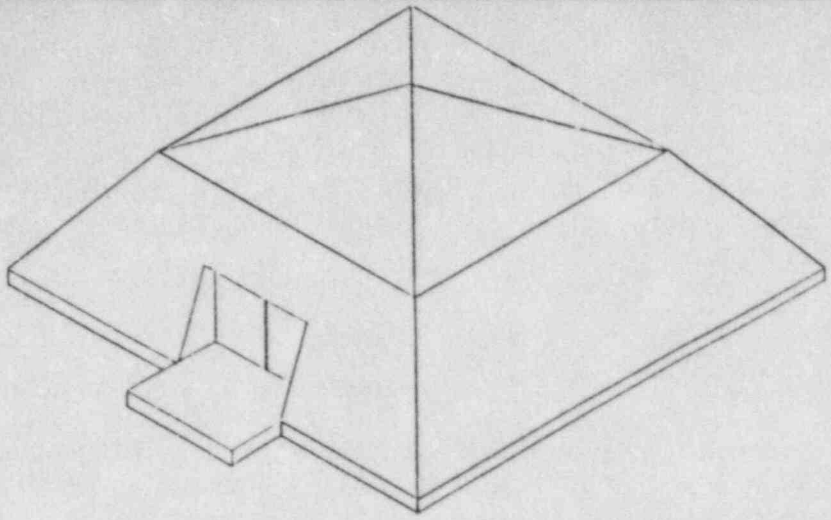
Your nuclear pyramid, your nuclear igloo, and your nuclear barn -- take your pick.

Again, the criteria -- there would be similar structural considerations, as with belowground vaults. There, obviously, would be no potential for groundwater intrusion associated with aboveground vaults.

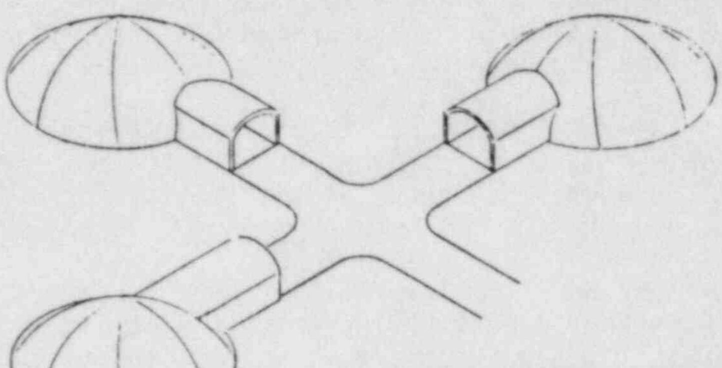
Again, you would have above-surface considerations, acid rain, landslides, tornados, also the possibility of accidents -- like the possibility of a small plane crashing into a vault.

The final alternative I would like to talk about this morning is mined cavities. Here we're talking about preexisting cavities totally enclosed in homogeneous geologic media below the surface of the earth, probably at a depth of much greater than 30 meters.

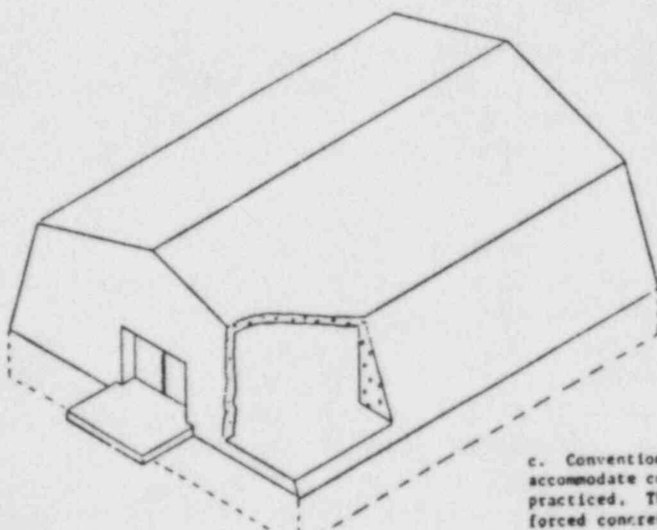
The Corps looked at coal, they looked at metal mines, limestone and bedded salt. And their preliminary conclusion in their Task 1 report is limestone and bedded salt seem like the best candidates for disposal of low-level waste



a. The most durable structural alternative of an aboveground vault would be a pyramidal form made of thick monolithically poured reinforced concrete. The expense of such construction would be higher per unit of capacity than other alternatives but it would be most durable in the face of catastrophic hazard.



b. Alternative configurations for aboveground vaults include dome shapes made by shotcrete shells sprayed on inflatable, removable forms. Clustering of units enhances segregation, isolation, and progressive construction sequences. The portal assemblies shown could be moveable and reusable after unit closure.



c. Conventional rectilinear aboveground vaults would accommodate common warehouse operations as presently practiced. The structures could be formed from reinforced concrete incorporating buttressed walls for protection of the disposed waste as well as enhancing structural durability. Metallic or masonry construction would be inherently less stable and offer less leakage prevention than concrete.

Figure 6. Three alternative forms of aboveground LLW disposal vault: Pyramidal, Dome or Igloo, and Rectilinear.

Slide 13

and that a mine in these areas, using these media, would probably be dry, chemically stable and structurally stable. And these are several important performance considerations.

(Slide 14)

I'll throw up one concept of a mine cavity disposal for your consideration.

We're constrained somewhat here by the fact that we are talking about pre-existing mines. So, what we get is what we use -- hopefully, we'd come up with something where we would have cells, where we'd have the luxury of segregating waste if that was what is required, and also to provide shielding for workers that were working in a different area of the mine.

We would certainly want to make sure, as I said, these things are both structurally and chemically stable and geologically separate from any regional aquifers. We'd want to make sure there was absolutely no possibility of surface water access. That would imply permanent sealing of shafts after the mine ceased to be useful for disposal.

We would have to consider the fact that there would be limited access to these things, probably more so than any other alternative. The interior working space would be very close, and the possibility for worker exposure could be very high.

On the other hand, there would be very low intruder potential. These things would be well below the surface of the earth. It's unlikely that man's activities in the future would interfere with these things.

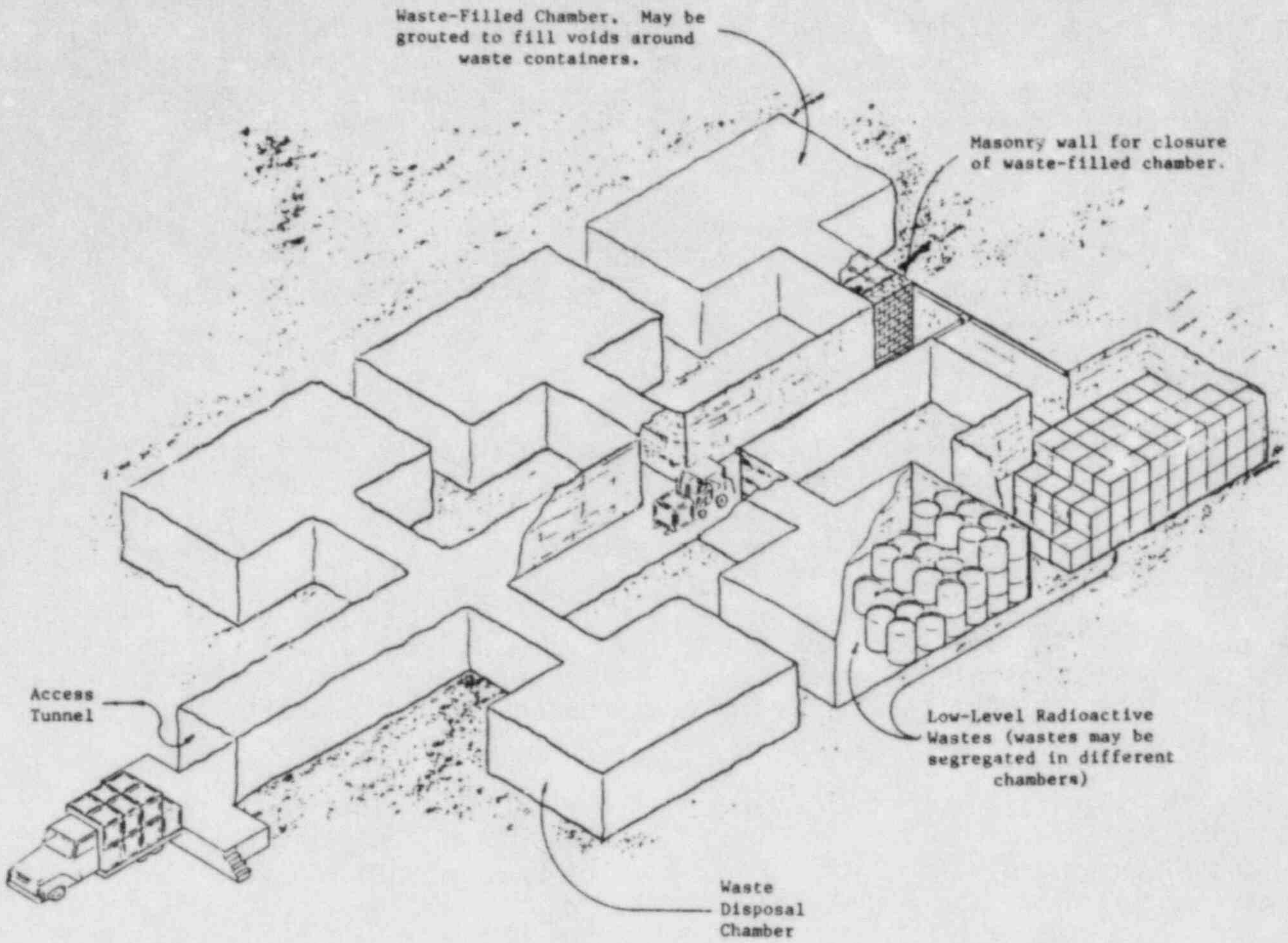
Also, I'm told they can be very resistant to earthquakes if they're not lying directly on a fault. And certainly in site characterization that would be something we'd want to be sure of.

However, monitoring and remedial action associated with mine cavities would be very difficult. Again, they're going to be very remote, and it would be hard to go back in and do any remedial action if it was warranted. And the monitoring to assure that it wasn't warranted would also be fairly difficult to effect.

So, early on, in the use of the mine cavity, you'd want to develop a high degree of confidence in your design and operations, that long-term monitoring was not going to be something that was extremely essential.

We do have experience with mine cavities in this country with regard to storage of material. I believe limestone is used extensively in the Midwest for the storage of records and things of that nature.

In Europe, the Germans are using mine cavity disposal for hazardous waste at Herfa Nerode. And they have previously used the Asse Salt Mine for disposal. And right now they are currently using that facility as a research facility.



Modified Room and Pillar Mine in Bedded Limestone or Salt. Wastes may be segregated by chamber if required. If retreat method of filling chambers is used, the connecting passage ways may be filled with wastes and grouted to fill voids. Individual chambers may be sealed off when full by masonry or cast in place concrete walls. Instrumentation such as extenseometers could be installed from the main access tunnel.

Figure 17. Mined Cavity Concept for LLW Disposal

Slide 14

Certainly there would have to be expanded criteria for mine cavity disposal because of the possibility of regional influence of the effects of releases from mine cavities. The considerations must be of temporary shielding so that worker exposure could be kept down. There would have to be expanded site characterization and site selection criteria, again because of the regional influence.

Now, I've gone on pretty long here. But I would like to just touch briefly on the meat of the Corps' report the alternative versus criteria matrix. I'm not going to go into any kind of detail -- first of all, because you can't see this slide.

(Slide 15)

The bottom line of the Task 1 report, we asked the Corps to array the various alternatives, against the criteria subsets in Subpart D, site suitability, et cetera, and tell us, does the alternative apply directly as it stands now? Does it not apply at all? Or is there a modified -- or is there need for a modified or supplemental criteria?

The white -- areas totally white mean the criteria applies directly as written. The cross-hatched area means they have identified additional or modified criteria. And the little asterisks means that the criteria apply, but there's a qualifying statement in the text of the Task 1 report.

I think the significant fact we're seeing here is that in most cases the criteria, as they are written in Part 61, Subpart D, do apply to these various alternatives. And I think this kind of squares with the fact that we do have a good data base for shallow land burial.

And what we're seeing is probably more rather than less criteria than would be required for some of these various alternatives.

With that, I will open it up to questions.

MR. SALTZMAN:

Thank you.

Let me make a couple of announcements first.

One is it is getting a little warm in here. The overflow room -- it's probably 10 degrees cooler in there. It has good sound and a lot of people are sitting in there looking out the window and thinking about other things, other than shallow land burial.

Second, one person who has paid for a meal has not picked up his or her ticket.

In addition, there are a number of tickets now available for lunch. For those observers who would like to do it, it's $7.30. Tickets will be available right outside the door during the break, which will come in about half an hour. And I recommend you do it. We have a very good speaker.

10 CFR 61.D.50: Site Suitability

ALTERNATIVE DISPOSAL METHOD	(1) Acceptability	(2) Capable of Being Characterized	(3) Population Development	(4) Resource Exploitation	(5) Flooding	(6) Surface Runoff	(7) Ground-Water Intrusion	(8) Ground-Water Discharge	(9) Tectonic Hazards	(10) Surface Wasting Hazards	(11) Other Facility Impacts
Belowground Vaults									*	▨	
Aboveground Vaults					*	*	NA	▨ NA	*	▨	
Earth Mounded Concrete Bunkers						*	*		*	▨	
Mined Cavities		*	*	*	▨ NA	*	▨ NA		*	▨	
Augered Holes									*	▨	
Report Sec. Ref. Criteria	3.1 & 4.3										

51: Site Design

ALTERNATIVE DISPOSAL METHOD	(1) Satisfy Performance Objectives	(2) Closure Capability	(3) Enhance Natural Characteristics	(4) Infiltration and Degradation	(5) Surface Runoff Control	(6) Minimize Contact with Water
Belowground Vaults		*		▨		
Aboveground Vaults	*	*		▨		
Earth Mounded Concrete Bunkers		*		▨ *		
Mined Cavities		*		▨	▨	*
Augered Holes		*				
Report Sec. Ref. Criteria	3.2 & 4.3					

52: Site Operation and Closure

ALTERNATIVE DISPOSAL METHOD	(1) Waste Segregation	(2) Depth and Stability Standards	(3) Satisfy 52(a)(4)-(a)(11)	(4) Waste Packing Methods	(5) Subsidence Prevention	(6) Surface Radiation Limits	(7) Locate Units by Surveys	(8) Maintain Buffer Zones	(9) Close Units and Stabilize	(10) Maintain Closure During Disposal	(11) Limit Contents to LLW
Belowground Vaults	*			*	NA	▨					*
Aboveground Vaults	*			*	NA	▨			*		*
Earth Mounded Concrete Bunkers				*	▨	▨			▨		*
Mined Cavities	*			*	▨	▨			*		*
Augered Holes						▨					*
Report Sec. Ref. Criteria	3.3 & 4.3										

53: Site Monitoring

ALTERNATIVE DISPOSAL METHOD	(a) Preoperation Monitoring	(b) Mitigation Plan	(c) Operational Monitoring	(d) Surveillance Monitoring
Belowground Vaults			▨	
Aboveground Vaults			▨	▨
Earth Mounded Concrete Bunkers			▨	
Mined Cavities			▨	*
Augered Holes			▨	
Report Sec. Ref. Criteria	3.4 & 4.3			

KEY: NA "Not applicable as Written"
▨ "Additional or Modified Criterion Identified"
blank space "Criterion Applicable as Written"
* "Qualifying Statement in Text"

Figure 22. Matrix of Criteria Applicability to Alternative Disposal Methods

Slide 15

And one other thing, Rob MacDougall forgot something that he'd like to add in right now. Then we'll take some questions.

MR. MACDOUGALL:

I know that the mind can observe no more than the fanny can endure, but I thought that, ironically, one of the more important points in the talk that Bob was supposed to give this morning has a provision in it that I wanted to get across to you.

As you listen to all the presentations on all the alternatives and consider what you need to do to develop for yourselves the detailed engineering studies and the viability studies and that sort of thing, I hope you will keep in mind that when you come to us there are limits on NRC's ability to reprogram resources to develop the necessary guidance for any particular technology in the absence of some reasonably authoritative commitment by a State or a private developer to actually develop one of these things.

Obviously, we don't want to be in a position of having to explain to Congress why we've spent so many hundreds of thousands or millions of dollars developing a set of regulatory guides on a disposal technology that there's no demand for.

So, I ask you to keep in mind that constraint on our ability to develop guidance as you go through this exercise of deciding for yourselves how the various alternatives to shallow land burial stack up against shallow land burial itself.

Thank you.

MR. SALTZMAN:

Thank you, Rob.

Questions?

VOICE:

Yes, I have one.

I notice the study didn't consider other institutional controls that might be in place for any of these alternatives. And it causes me to wonder if there isn't, in fact, some control that would be in place from soil conservation when you use mine cavities, especially existing mines as was suggested?

Has NRC considered that? And have you approached that agency, similar to the way you're approaching EPA, with a memorandum of understanding?

MR. SHAFFNER:

No, we haven't.

This is just a conceptual study at this stage. I imagine there's probably a lot of agencies we'd have to touch base with.

VOICE:

Would you repeat the question, please?

MR. SHAFFNER:

Why don't you repeat the question?

MR. KOLPA:

My name is Ron Kolpa, with the Iowa Department of Waste Management.

In the case of an alternative for mine cavities, I would imagine there are other levels of institutional controls in place in Soil Conservation (Service).

Does NRC have any intention of pursuing similar memoranda of understanding as they have done with EPA as far as how those controls would apply?

MR. SHAFFNER:

I assume you're referring to Soil Conservation Service. It's not a regulatory agency. So, I don't know how we would relate to them directly. Certainly we would want some input. And in general, the answer to the question is yes, we would have to touch base with probably a lot of other, both Federal and State, authorities.

Again, at this stage, the Task 1 study is a conceptual study, and we haven't gotten into that detail yet.

MS. MCGRATH:

My name is Colleen McGrath and I am an observer. You pointed out the difference between storage and disposal and I am just wondering how you differentiate?

MR. SHAFFNER:

The question had to do with the difference between storage and disposal. Storage implies that the waste is put someplace temporarily and then will be moved someplace else or some other activity will go on to ensure the permanent disposition of the waste. Disposal, on the other hand, refers to that process up front, not handling the waste two or three times but putting it in its final resting place right away.

MS. MCGRATH:

To follow up, I wonder how monitoring would fit in? Does that have anything to do with differentiation?

In other words, is the permanency of the spot -- does that have anything to do with how long it would be monitored?

MR. SHAFFNER:

There would have to be some form of monitoring both associated with storage and disposal -- the question had to do with the level of monitoring of facilities, both storage and disposal facilities. Did I paraphrase it okay? I didn't say it exactly the way you said it.

The answer is monitoring would be appropriate for both storage and disposal because in the case of disposal, we are talking about long-term consequences and monitoring facilities would be of a more permanent nature and probably a more rigorous and formalized process would be associated with disposal than with storage in all cases.

MR. KUHRTZ:

Steve Kuhrtz from New Jersey. You pointed out that in the Army Corps study, an evaluation of cost of these alternatives was beyond the scope of their study, which I suppose I can appreciate.

But in your talk you mention that there is a fair amount of experience with other countries, particularly Canada, France, Germany, and that DOE has been working with some of these alternatives and I wondered if the NRC could save the trouble of 35 or 40 or 50 of us States trying to go the French Embassy or Canadian Embassy to try and get some cost information. Based on your experience with these alternatives and whether the NRC can try and solicit that information on our behalf?

MR. SHAFFNER:

The question had to do with solicitation of cost information and would the NRC do it and I am going to punt because I can't make that decision right here that we could do it.

VOICE:

Ask the DOE people to do it.

MR. AVANT:

One thing I have got, and I have got the French paper here, on the back page of it -- and you can get copies of it if you would like to see me afterwards -- it says $300 per cubic meter for waste disposed, $500 per cubic meter for contact waste disposed in normal concrete arrangement, a thousand dollars per cubic meter for waste disposed of in special trenches -- that is the French report. So, $300, $500 and $1000. (Editor's note: "12 Years of Experience of Shallow Land Disposal of Low and Intermediate Level Radioactive Waste in France," Francis Van Kote, NUREG/CP-0028, Vol. 3, March 1983, pp. 177-200.)

MR. SALTZMAN:

Mr. Avant from Texas told us he has the French report and the cost varied from $300 to $1000 per cubic meter. Is that a published report? I guess it is a published report.

MR. AVANT:

It is a report by France's Van Kote, is how he says his name. I am not sure what the date is on it.

MR. SALTZMAN:

I think we'll see if we can get a hold of that and try to reproduce it for you at some point, if not today or tomorrow.

MR. ORIEN:

I am Larry Orien. Sargent and Lundy. Could a long-term, say a 5-year storage facility, be converted to a disposal facility that would have to go through licensing during that storage period?

MR. SALTZMAN:

Could a 5-year storage facility be converted to a disposal facility with additional licensing?

MR. SHAFFNER:

I won't give you an unqualified yes, but I would say in certain cases that would be possible. It would undergo rigorous scrutiny and if it passed and things could be done to assure confidence that it could be a disposal facility, that I would have to say yes.

MR. SALTZMAN:

I think we'll take one more question.

MR. FISHER:

Jack Fisher, USGS. Those numbers that Bob Avant gave on the French experience are difficult to use because the French are involved in government support of the low-level waste program and I would want to look at the individual components before using them.

MR. SALTZMAN:

The comment was from --

MR. SHAFFNER:

That comment pointed out something I should have pointed out in my talk, that the French facility and the dollars associated with it are a little bit misleading because the French facility is a government-run facility and therefore could be subsidized somewhat by the government.

MR. SALTZMAN:

Thank you, Jim. Jim and all the speakers will again be available tomorrow morning to answer any more questions that come up or if they come up during the course of the workshop.

Our last speakers before the break are a representative from the Department of Energy, Elizabeth Jordan, and Lance Mezga, the manager of the low-level waste program at Oak Ridge National Laboratory.

2.5 Research and Practices of the U.S. Department of Energy

MS. JORDAN:

Low-level waste has been generated by the nuclear weapons materials programs since the 1940's. The controlled disposal of low-level waste from production and research and development activities of the Atomic Energy Commission, Energy Research and Development Administration (ERDA) and now the Department of Energy has continued.

The primary means of LLW disposal has been the accepted practice of shallow land disposal. Shallow land burial and its varied modifications allow DOE operations to dispose of low-level waste in an environmentally safe manner. DOE's experience with shallow land burial or near surface disposal has demonstrated that low-level waste can be adequately contained by disposal in this manner provided that technically sound procedures are applied.

Unlike the commercial sector, DOE is not subject to NRC, or Agreement State regulatory control. We exercise a self-regulatory responsibility through DOE orders, one on waste management, 58202, and another on environmental protection, safety and health protection, DOE Order 5480.1A.

Waste management activities are conducted in a manner that doses are as low as reasonably achievable. A systems approach which considers the waste form, the site, as well as engineered features, is used to meet these performance objectives. Such a performance-oriented approach provides for utilization of the total system to accomplish these objectives.

In addition, we conduct research activities and these research activities are being carried out to develop more cost-effective technologies to provide protection equivalent to that afforded by the performance objectives in 10 CFR 61. Historically our research has focused on near-surface disposal, including waste form, site performance and engineered features, to better understand the entire system. For certain waste, we believe that "greater confinement" may be necessary. This should be approached using shallow land burial as the basis and then adding modifications, such as waste form or engineered features.

I want to emphasize that the overall system must be properly designed to demonstrate that this would result in cost-effective, improved isolation of the waste.

(Slide 1)

MR. MEZGA:

My name is Lance Mezga from Oak Ridge National Laboratory.

Today I am going to talk about the Low Level Waste Management Program and Interim Waste Operations greater confinement disposal technologies.

(Slide 2)

The integrated technology development program consists of two components. The first component is the Low-Level Waste Management Program, which has as its charter the development of generic technology for commercial and defense activities.

The second component deals with DOE defense waste operations and has as its charter the development of site-specific technology required in order for DOE to operate its facilities in a safe and cost-effective manner.

(Slide 3)

The overall objective of the technology development is to provide the documentation necessary to ensure that low-level systems are operated in a safe and environmentally acceptable manner.

(Slide 4)

We are currently developing technology in five areas. First is corrective measures technology aimed at improving performance of previously closed sites.

Second is improved shallow land burial technology.

The third, greater confinement technology, includes alternatives to shallow land burial and is the focus of this presentation.

Two other areas of technology development are model development and validation to improve our ability to predict performance and also the development of treatment methods for problem waste.

(Slide 5)

In the area of disposal methodology, DOE believes shallow land burial is the most cost-effective disposal option. However, we recognize that successful shallow land burial relies on good site selection, facility design, and operating practices. We also recognize that a small volume of waste may require greater confinement than provided by conventional shallow land burial because of its long-lived hazard.

LOW-LEVEL WASTE MANAGEMENT PROGRAM AND INTERIM WASTE OPERATIONS GREATER CONFINEMENT DISPOSAL TECHNOLOGIES

BY
LANCE J. MEZGA
MANAGER, LOW-LEVEL WASTE MANAGEMENT PROGRAM
ENERGY DIVISION
OAK RIDGE NATIONAL LABORATORY
MAY 2-3, 1984

ornl

Slide 1

ORNL WSC-32995

THE INTEGRATED DOE LOW-LEVEL WASTE TECHNOLOGY DEVELOPMENT PROGRAM CONSISTS OF TWO COMPONENTS

- LLWMP: COMMERCIAL AND DEFENSE GENERIC TECHNOLOGY DEVELOPMENT
- DEFENSE WASTE OPERATIONS: DEFENSE PROGRAMS SITE-SPECIFIC TECHNOLOGY DEVELOPMENT

Slide 2

PROGRAM OBJECTIVE

PROVIDE THE TECHNOLOGY AND DOCUMENTATION REQUIRED TO ENSURE THAT COMMERCIAL AND DEFENSE LLW MANAGEMENT SYSTEMS ARE OPERATED IN A SAFE AND ENVIRONMENTALLY ACCEPTABLE MANNER

Slide 3

AREAS OF TECHNOLOGY DEVELOPMENT

- CORRECTIVE MEASURES TECHNOLOGY
- IMPROVED SHALLOW LAND BURIAL TECHNOLOGY
- GREATER CONFINEMENT DISPOSAL TECHNOLOGY
- MODEL DEVELOPMENT AND VALIDATION
- TREATMENT METHODS FOR PROBLEM WASTES

Slide 4

DEPARTMENT OF ENERGY PHILOSOPHY

- FOR MOST LOW-LEVEL WASTE, SHALLOW LAND BURIAL PROVIDES THE SAFEST AND MOST COST-EFFECTIVE DISPOSAL OPTION
- THE NEED FOR GREATER CONFINEMENT THAN THAT PROVIDED BY SHALLOW LAND BURIAL IS ASSESSED ON A SITE-SPECIFIC BASIS WHICH CONSIDERS THE TOTAL WASTE DISPOSAL SYSTEM, i.e., THE WASTE, THE WASTE FORM, AND THE ENVIRONMENT

Slide 5

(Slide 6)

For DOE, that volume is estimated to be approximately 1000-1500 cubic meters or less than 10 percent of the total volume of waste generated by DOE.

(Slide 7)

The object of the greater confinement disposal technology component is to provide the technology for the disposal of those wastes which are not acceptable for conventional shallow land burial.

(Slide 8)

As I said, we believe shallow land burial provides a safe and cost-effective disposal option for most low-level waste.

We believe the need for greater confinement should be assessed on a site-by-site basis evaluating the total waste disposal system, i.e., considering the waste, the waste form, and the site characteristics (most importantly the geology and the hydrology). This approach allows us to consider the variations in the local geology and hydrology and the variations in the Department of Energy waste streams in selecting the most cost-effective disposal option for any particular facility.

(Slide 9)

Greater confinement can be achieved either by improving the waste form, burying the waste at greater depth, using engineered barriers or improvements or through some combination of those approaches.

Waste form improvements are aimed at physically and chemically stabilizing the waste so it does not move from the trench.

Greater depth burial achieves greater confinement by increasing the distance between the biosphere and the waste itself, thereby increasing the distance and time of travel between the two.

The use of engineered barriers is very similar in that the barriers slow down or completely eliminate movement from the trench. That is, they significantly increase the travel time between the waste and the environment.

(Slide 10)

The Department currently uses three technologies for the greater confinement disposal of low-level waste. I should point out at this point that the DOE activities related to belowground and aboveground vaults referred to by Jim Shaffner are not used for the disposal of low-level waste. Those disposal options are used for transuranic (TRU) waste storage. The Department of Energy is not disposing of low-level waste in aboveground facilities or in vaults at this time.

We feel shallow land burial for the most part provides sufficient safety.

DISPOSAL METHODOLOGY

- FOR MOST LOW-LEVEL WASTE, SHALLOW LAND BURIAL IS THE MOST COST-EFFECTIVE DISPOSAL OPTION. SUCCESSFUL SHALLOW LAND BURIAL RELIES ON ACCEPTABLE SITE SELECTION AND PROPER OPERATING PROCEDURES
- A SMALL VOLUME OF WASTE MAY REQUIRE GREATER CONFINEMENT THAN PROVIDED BY CONVENTIONAL SHALLOW LAND BURIAL BECAUSE OF LONG-LIVED HAZARD

Slide 6

PRELIMINARY ESTIMATES OF WASTE VOLUMES CANDIDATE FOR GREATER CONFINEMENT DISPOSAL

	GCD WASTE[1]	TOTAL VOLUME OF LLW[2,3]
DOE FACILITIES	1,300 - 1,600 m^3/yr	1,971,400 m^3
COMMERCIAL GENERATORS	16,000 m^3/yr	941,900 m^3

[1]T. L. GILBERT AND C. LUNER, 1984
[2]DOE, 1983
[3]VOLUME OF WASTE GENERATED THROUGH 1982

Slide 7

GREATER CONFINEMENT DISPOSAL TECHNOLOGY

THE OBJECTIVE OF THIS PROGRAM COMPONENT IS TO DEVELOP AND DOCUMENT THE TECHNOLOGY FOR THE DISPOSAL OF WASTE WHICH IS NOT GENERALLY ACCEPTABLE FOR SHALLOW LAND BURIAL

Slide 8

GREATER CONFINEMENT DISPOSAL OPTIONS

GREATER CONFINEMENT CAN BE ACHIEVED BY

- IMPROVING THE WASTE FORM
- BURYING THE WASTE AT GREATER DEPTH
- USING ENGINEERED BARRIERS OR IMPROVEMENTS
- COMBINATIONS OF THE ABOVE

Slide 9

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ORNL WSC-33003

GREATER CONFINEMENT DISPOSAL TECHNOLOGY ACTIVITIES

OBJECTIVE	TECHNOLOGY OPTION	SITE TESTED/ DEMONSTRATED
ISOLATION THROUGH GREATER DEPTH BURIAL (NON-NEAR SURFACE DISPOSAL)	LARGE DIAMETER BOREHOLE	NV/REECO
ISOLATION THROUGH GREATER DEPTH DISPOSAL AND IMPROVED WASTE FORM	HYDROFRACTURE	ORNL
	INTERMEDIATE DEPTH BURIAL WITH SALTSTONE WASTE FORM	SRL/SRP

Slide 10

In the area of greater confinement, we have three projects, as I said, which are ongoing. The first approach is the Greater Confinement Disposal Test at the Nevada Test Site in which we are using a large-diameter bore hole to achieve isolation through greater depth burial, non-near-surface disposal.

We are looking at two other projects whereby greater confinement is achieved by both greater depth at burial combined with an improvement in the waste form. At Oak Ridge hydrofracture is being used for the disposal of liquid waste and at Savannah River, intermediate depth burial combined with an improved waste form is being investigated.

(Slide 11)

Basically at the Nevada Test Site, we are looking at a large-diameter bore hole. It is 10 feet in diameter, roughly 3 meters, with a depth of about 120 feet. The hole is unlined and drilled in alluvial material.

(Slide 12)

Conventional auger drilling is employed for this technology, the kind of drill rig that you see on the side of the road where road crews are putting up signs or telephone poles.

(Slide 13)

We recognize that our auger is a little bit bigger than most because the hole is 10 feet in diameter.

(Slide 14)

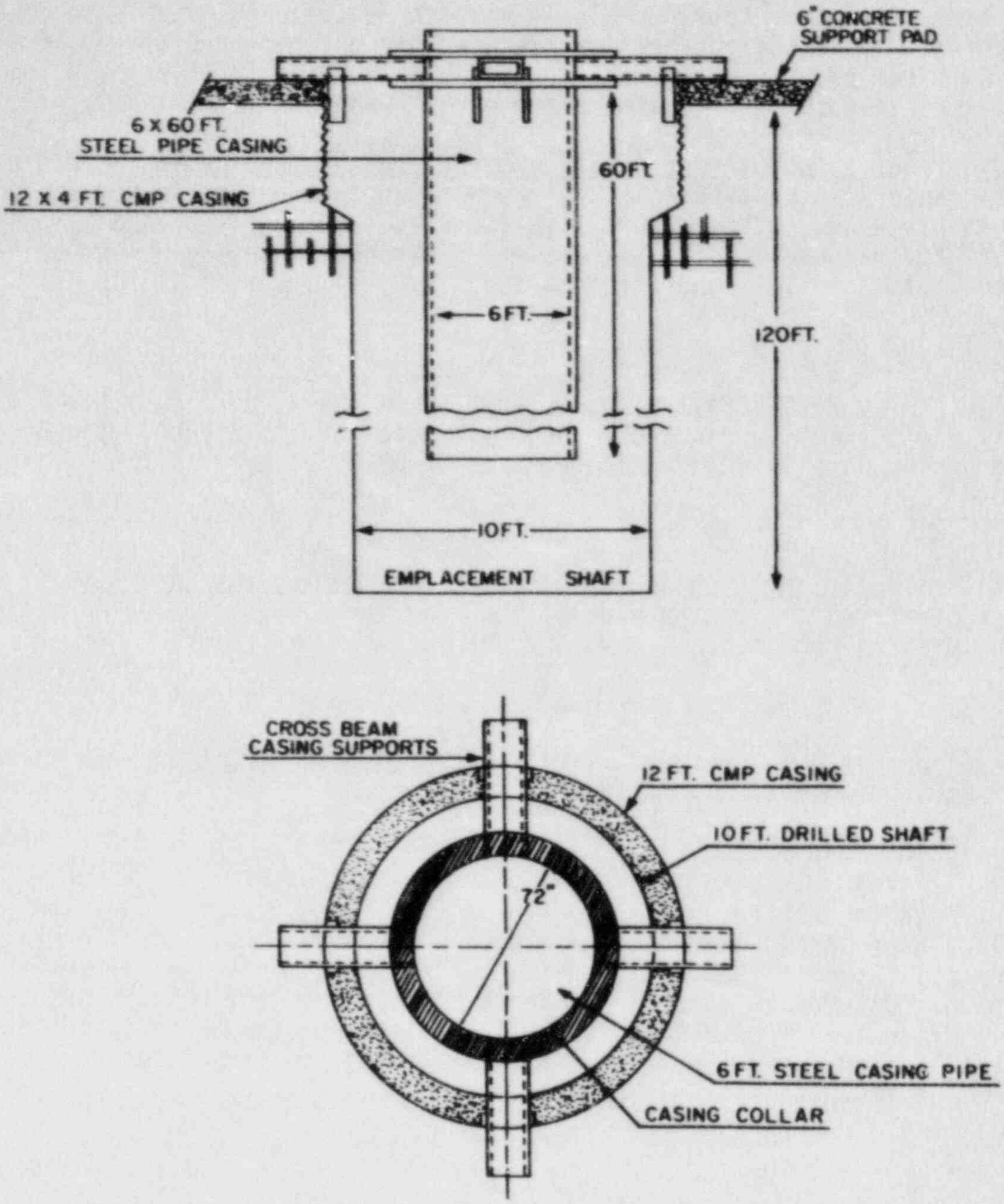
Once the hole is drilled, part of our objective is to document that the technology does indeed operate in a manner which does provide greater confinement. Part of that challenge is to develop a monitoring system for both the near field and also at farther distances from the hole. What you see here are monitoring cables which will be lowered into the hole to monitor near waste moisture and temperature changes to see how they affect the hydrology of the disposal unit.

(Slide 15)

Looking down the hole, you really don't get the perspective that it is 120 feet deep, but it is. The hole is unlined and you can see that the alluvial materials are standing rather well. The cables shown are monitoring cables. The larger areas on the yellow cable are the soil moisture and temperature probes wrapped to protect them from the damage as soil is dropped into the hole during backfilling operations.

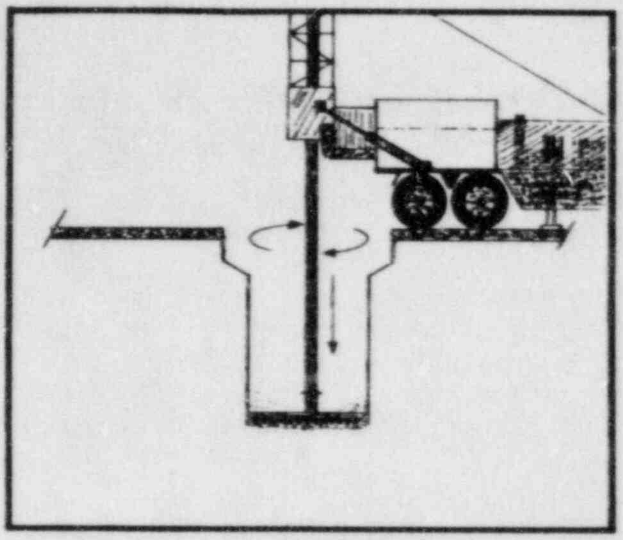
(Slide 16)

From the surface, you can see the disposal hole in the left center and smaller monitoring holes arrayed around it. At the present time, cesium capsules and tritium waste have been placed in the greater confinement disposal facility and the hole has been backfilled.

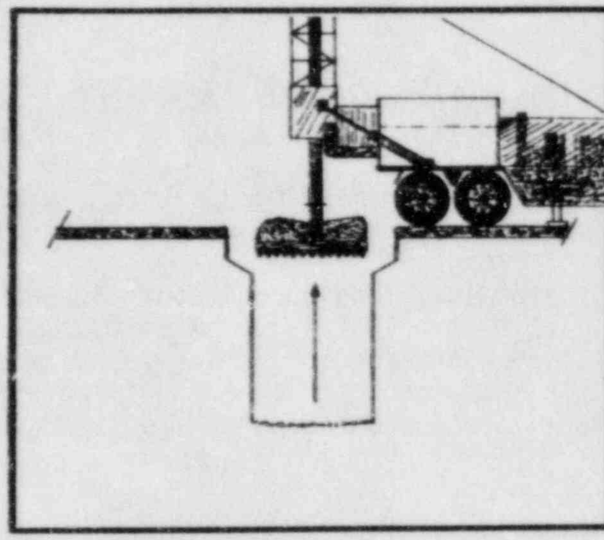


DESIGN OF EMPLACEMENT SHAFT CASING

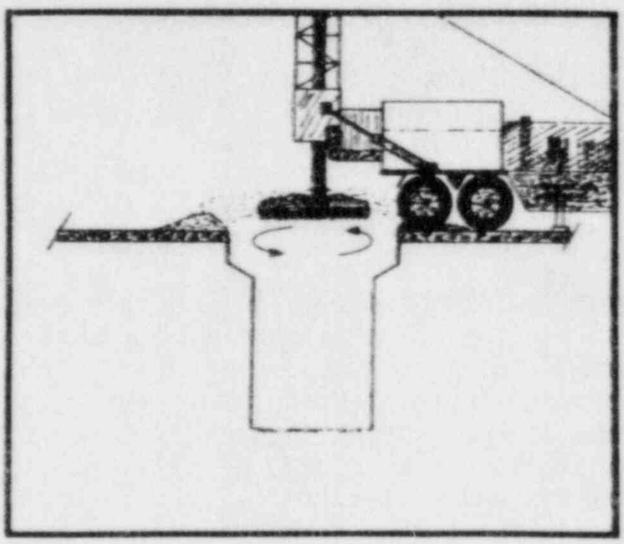
Slide 11



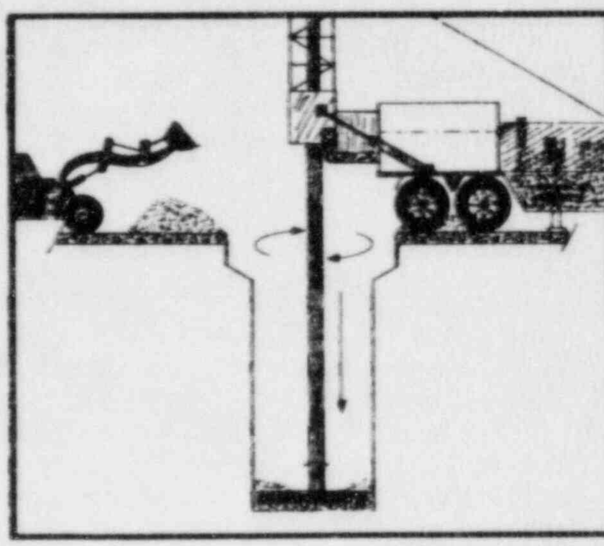
Auger drills into soil



Bit carries soil to surface



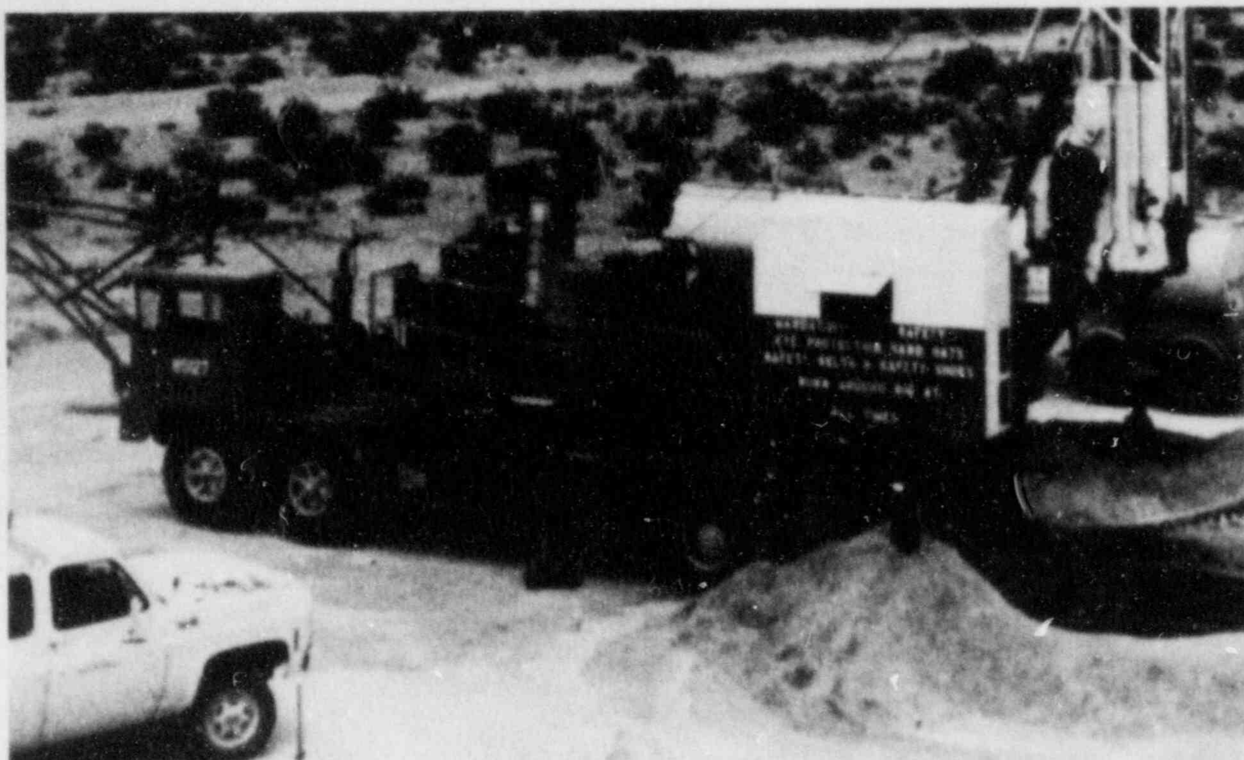
Backspinning throws soil off bit



Front-end loader removes soil

EXCAVATION OF DRILLED HOLES

Slide 12



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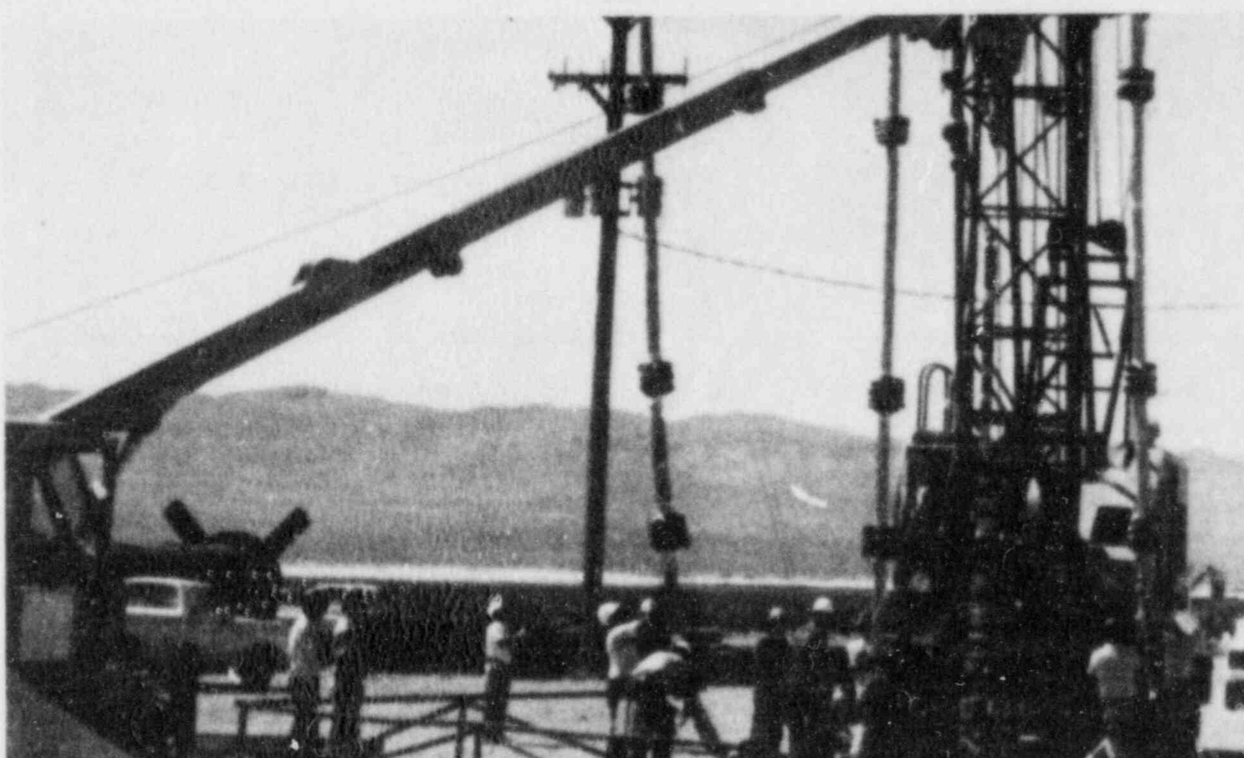

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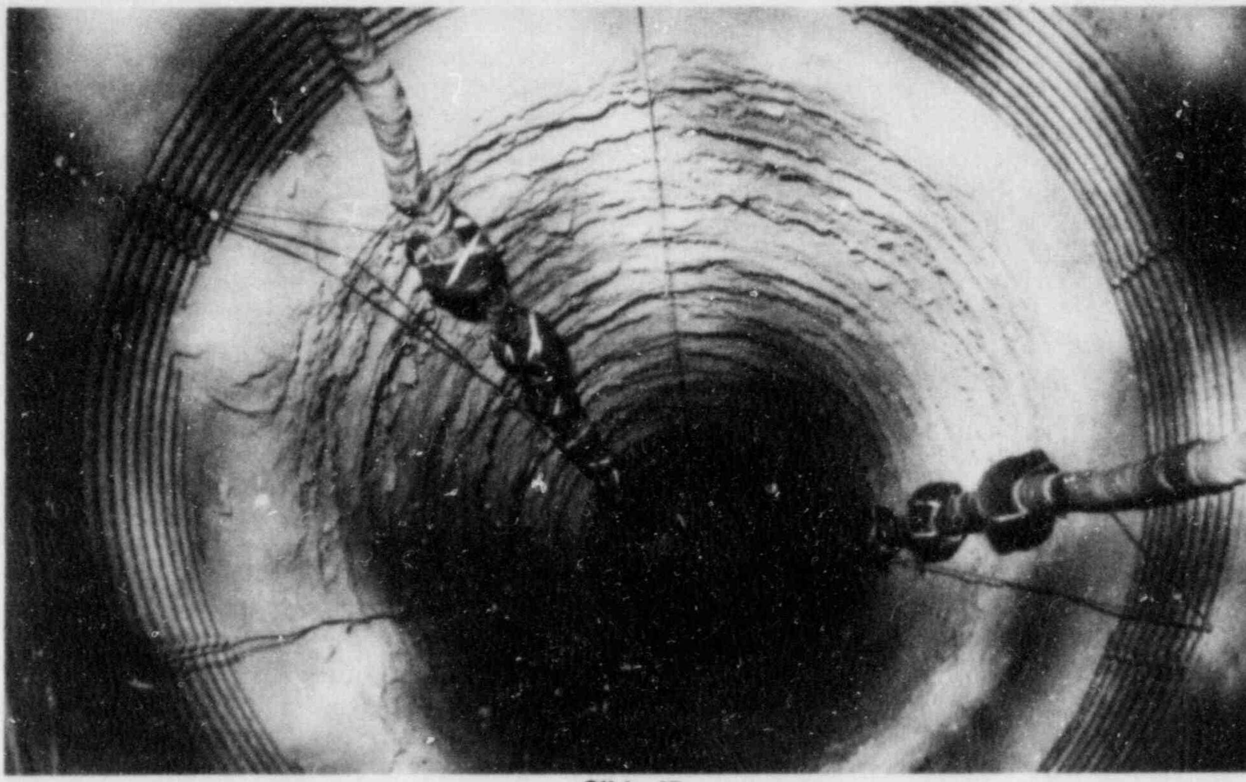
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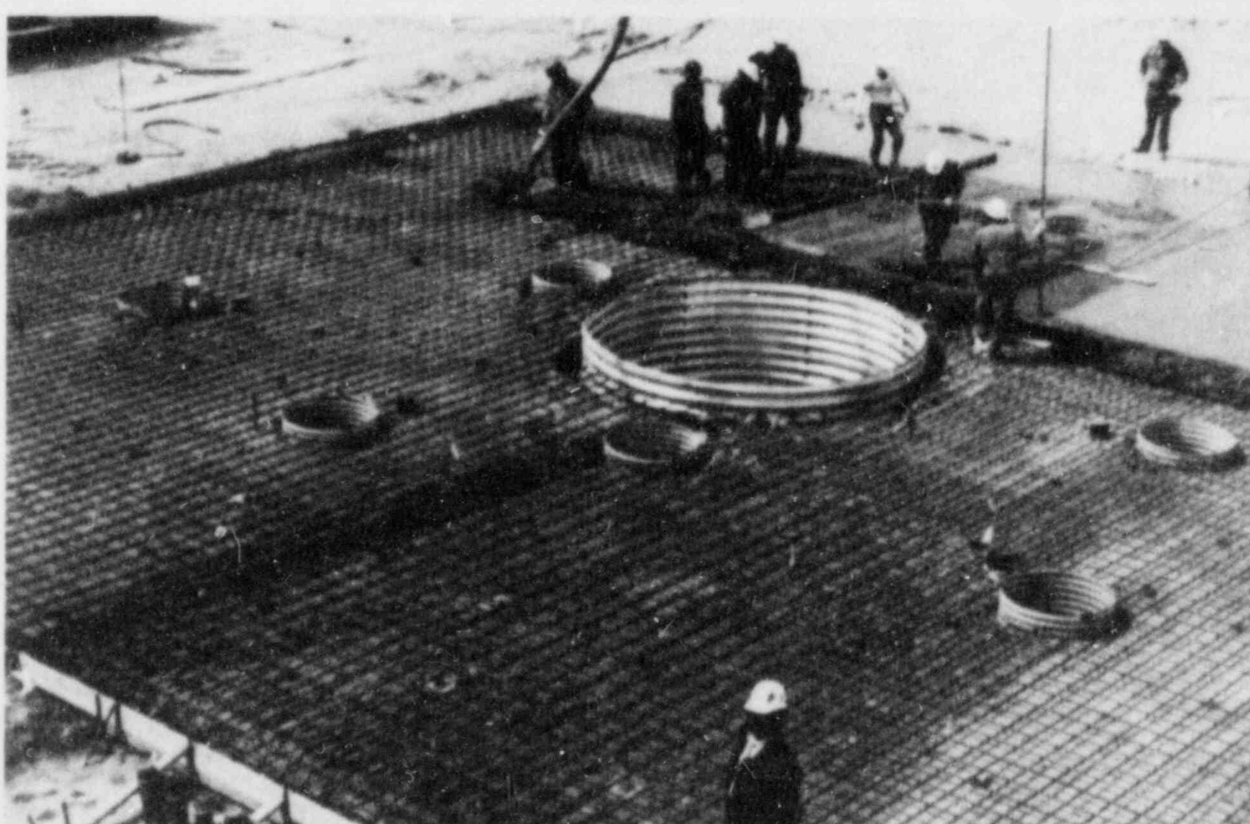

Slide 16

Ongoing activities focus on modeling and monitoring facility performance.

The Nevada Operations Office plans at this time to employ this option for the routine disposal of tritium waste. This decision is based on their site specific performance assessment, which indicates there is potential for upward migration of tritium. Greater depth burial with an attendant larger buffer of soil between the waste and the surface will eliminate that problem.

(Slide 17)

The second option is hydrofracture being employed at Oak Ridge for liquid waste. Hydrofracture consists of drilling a small-diameter well, in this case to a depth of about 1100 feet, into the underlying shale. The shale has very low permeability. It also has a very useful feature, horizontal shale partings and horizontal bedding planes.

The waste comes to the facility in liquid form. It is then mixed with grout and other additives to "fix" the radionuclides. It is then injected under pressure down the well and into the shale. Pressure causes the shale to split or fracture along these horizontal partings and a grout sheet develops.

The sheet then solidifies, resulting in an improved waste form located at depth in a geologic material of very low permeability. Isolation is achieved through a combination of greater depth and improved waste form.

This technology, currently employed for Oak Ridge's liquid waste, also has the potential for being employed with those wastes which can be shredded or size reduced in some other way to allow the waste to pass through the injection hole.

The other site that is investigating greater confinement at the present time is Savannah River. They are presently looking at two concepts.

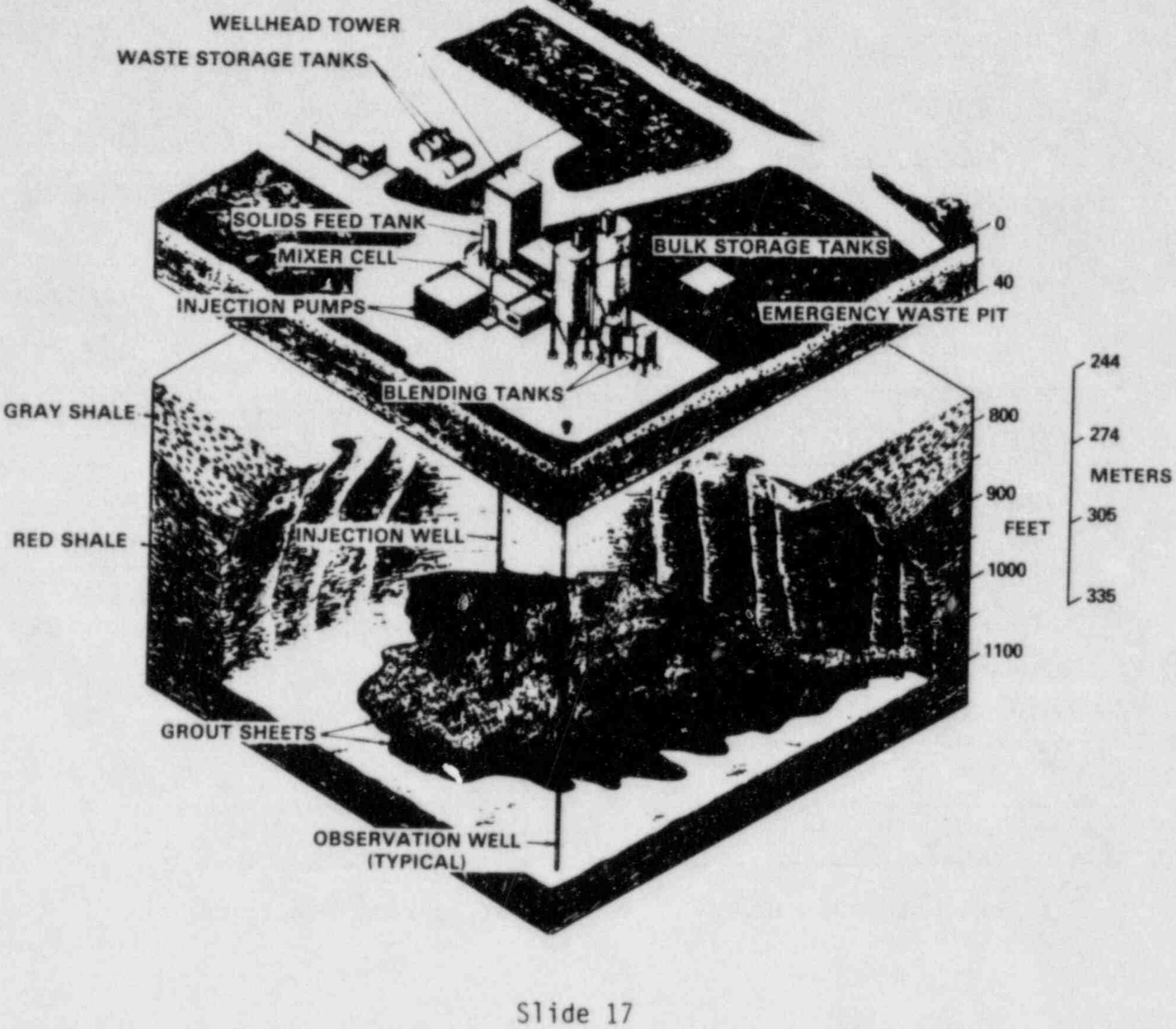
(Slide 18)

The first concept they're investigating is an improved shallow land burial concept involving a deeper trench. In this option, the trench is excavated to the level of conventional shallow land burial. Concrete sheet pile walls are then placed along the trench border to provide structural stability and for prevention of lateral migration of ground water into the site.

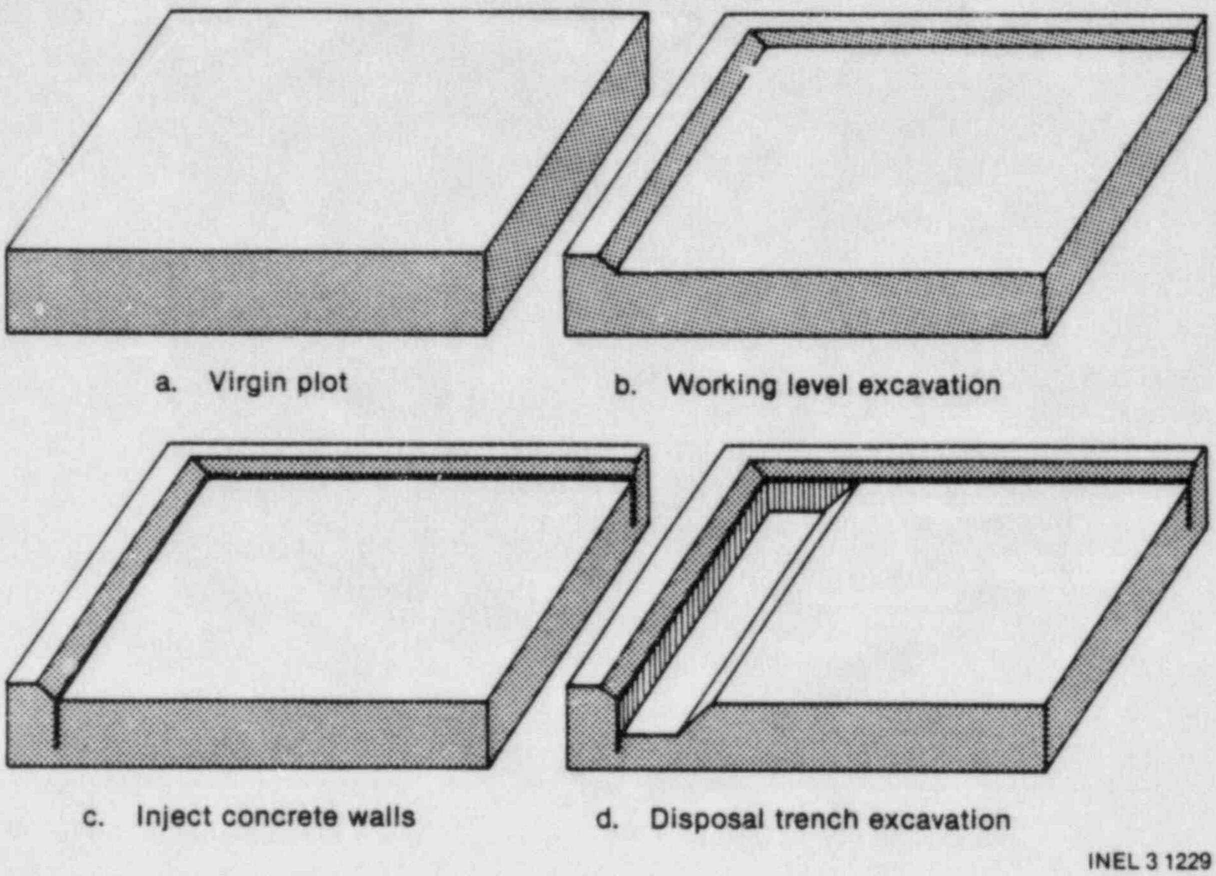
And then as shown, a deeper trench is excavated. At that point, the waste is mixed into a concrete grout slurry and poured into a monolithic structure in the bottom of the trench.

(Slide 19)

The second option they're presently investigating is very similar to the Nevada concept. It's also a bore hole design. There are significant differences between what Savannah River is doing and what was done at the Nevada test site.


WELLHEAD TOWER
WASTE STORAGE TANKS
SOLIDS FEED TANK
MIXER CELL
INJECTION PUMPS
BULK STORAGE TANKS
EMERGENCY WASTE PIT
BLENDING TANKS
GRAY SHALE
RED SHALE
INJECTION WELL
GROUT SHEETS
OBSERVATION WELL
(TYPICAL)
0
40
800
900
1000
1100
FEET
244
274
305
335
METERS

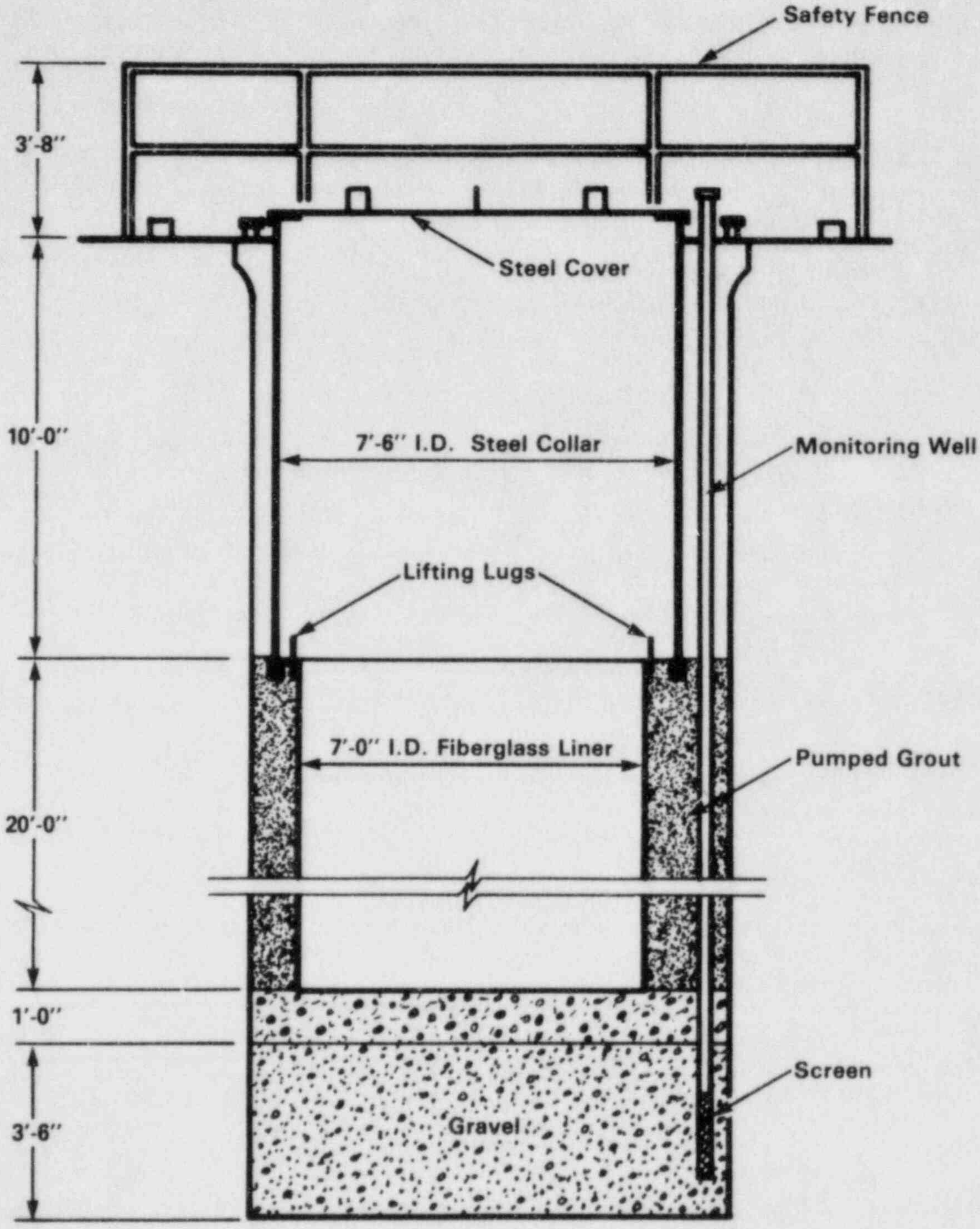
Slide 17



GCD trench design.

Slide 18

BOREHOLE DESIGN



Slide 19

One, the hole is much shallower. They are looking at depths of only 30 feet compared to 120 feet. Also the diameter is smaller. It's about a 7-foot-diameter hole instead of 10 foot. The hole is lined with a fiberglass liner over its entire length.

The area between the liner and the earth materials is backfilled with a pumped grout, as you can see. The overall approach is to provide much more enhanced containment because it does not rely on the geologic features.

(Slide 20)

The auger rig used to drill the holes at Savannah River is a smaller rig than that used at Nevada. It's conventionally available technology.

(Slide 21)

After the hole is drilled, the fiberglass liners are lifted and placed into the hole.

(Slide 22)

A collar is placed on it to provide a stable working platform so that there's no sloughing from the top of the hole, and to prevent damage to the fiberglass liner.

(Slide 23)

Looking down into the hole, one gets a perspective for both the outer unit, the collar, and the inner unit or the fiberglass liner.

(Slide 24)

Savannah River plans to employ this technology on a routine basis for some of their waste and they've already drilled a fairly large number of these bore hole facilities.

(Slide 25)

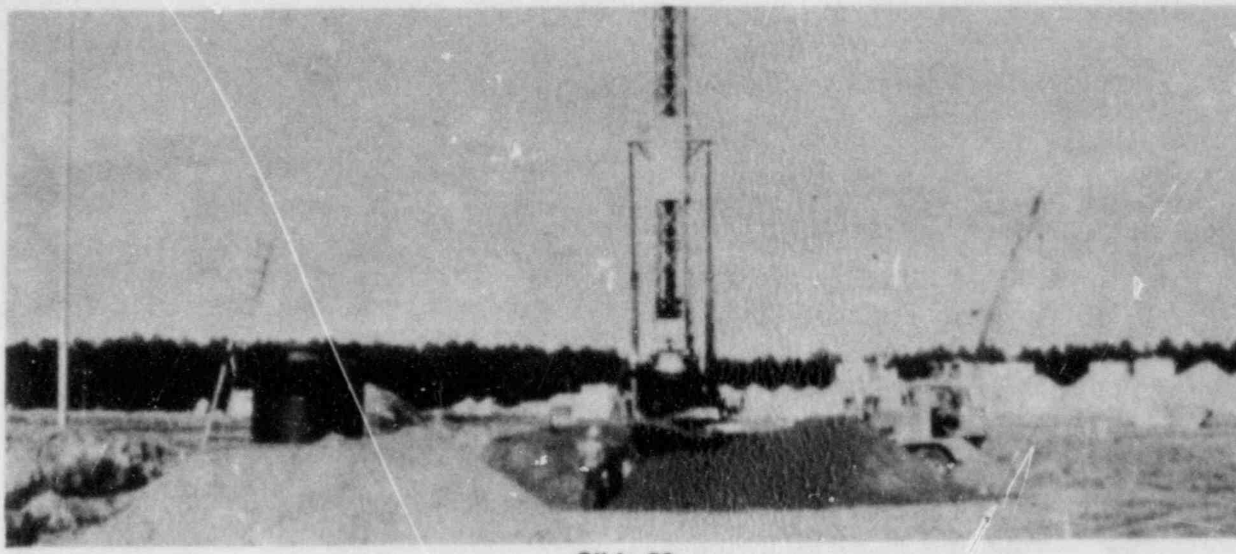
Routine operation calls for the use of a pneumatic lift to lift the barrels and place them into the caisson.

(Slide 26)

Wastes which are not capable of being emplaced using that technique will be loaded on a pallet in a six-pack kind of form and lowered into the hole.

(Slide 27)

Once the waste is placed in the hole, the hole will be backfilled with grout in lifts to prevent any problems associated with floating of the waste packages and ultimately the liner will be filled. At that point, a final cover will be applied to the site.



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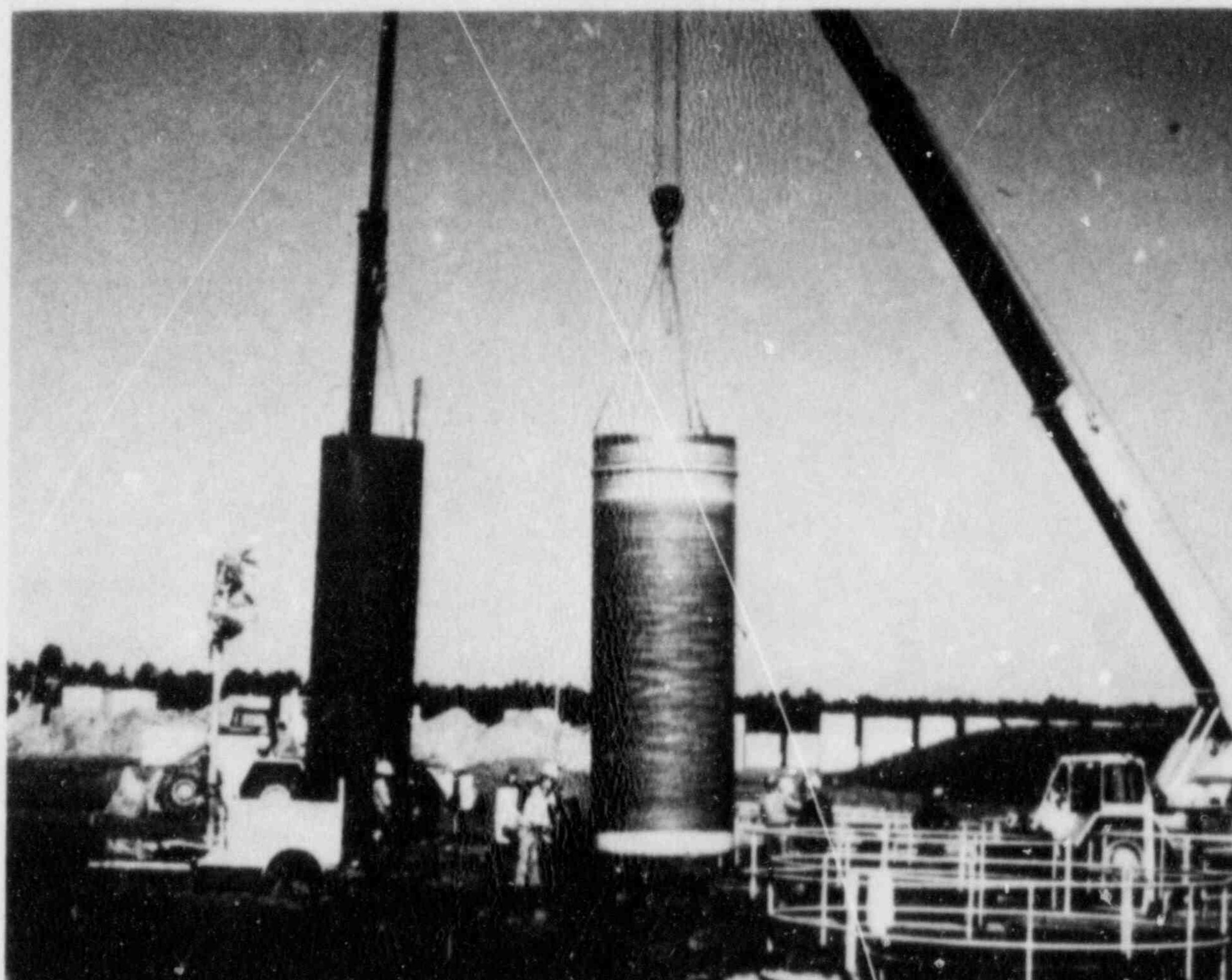

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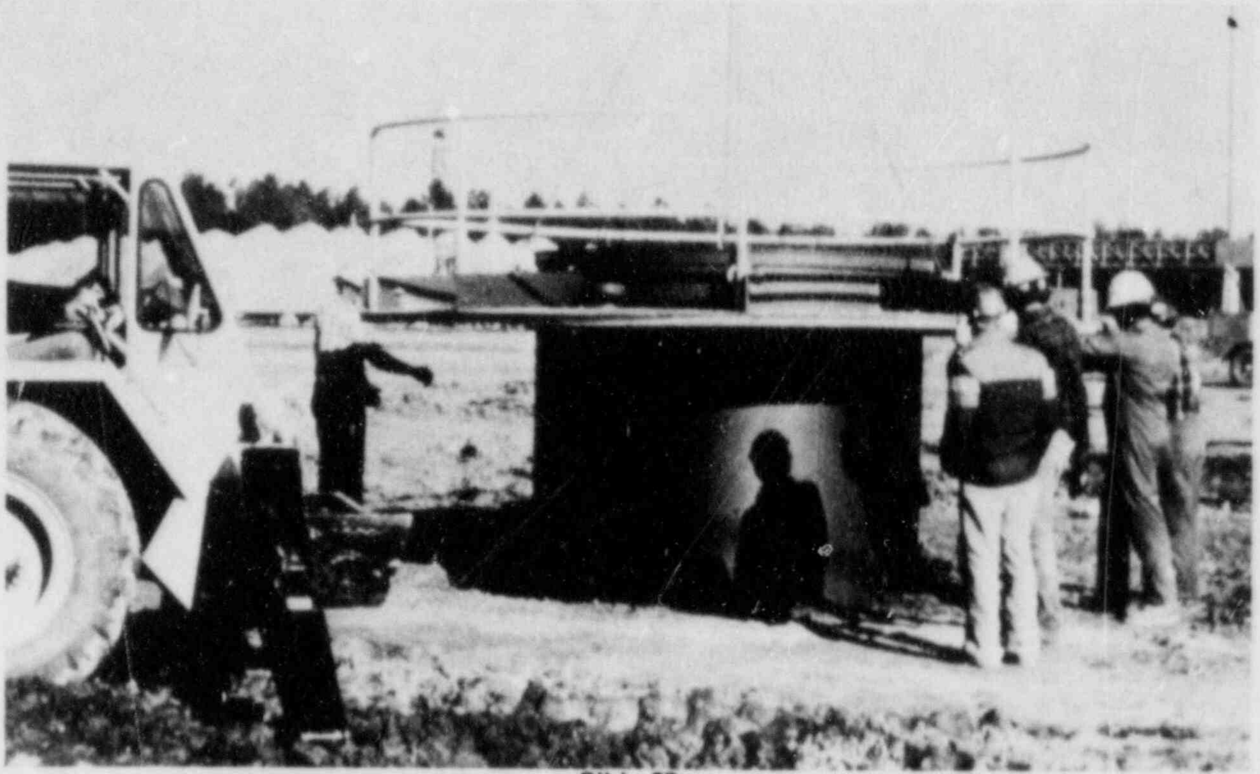

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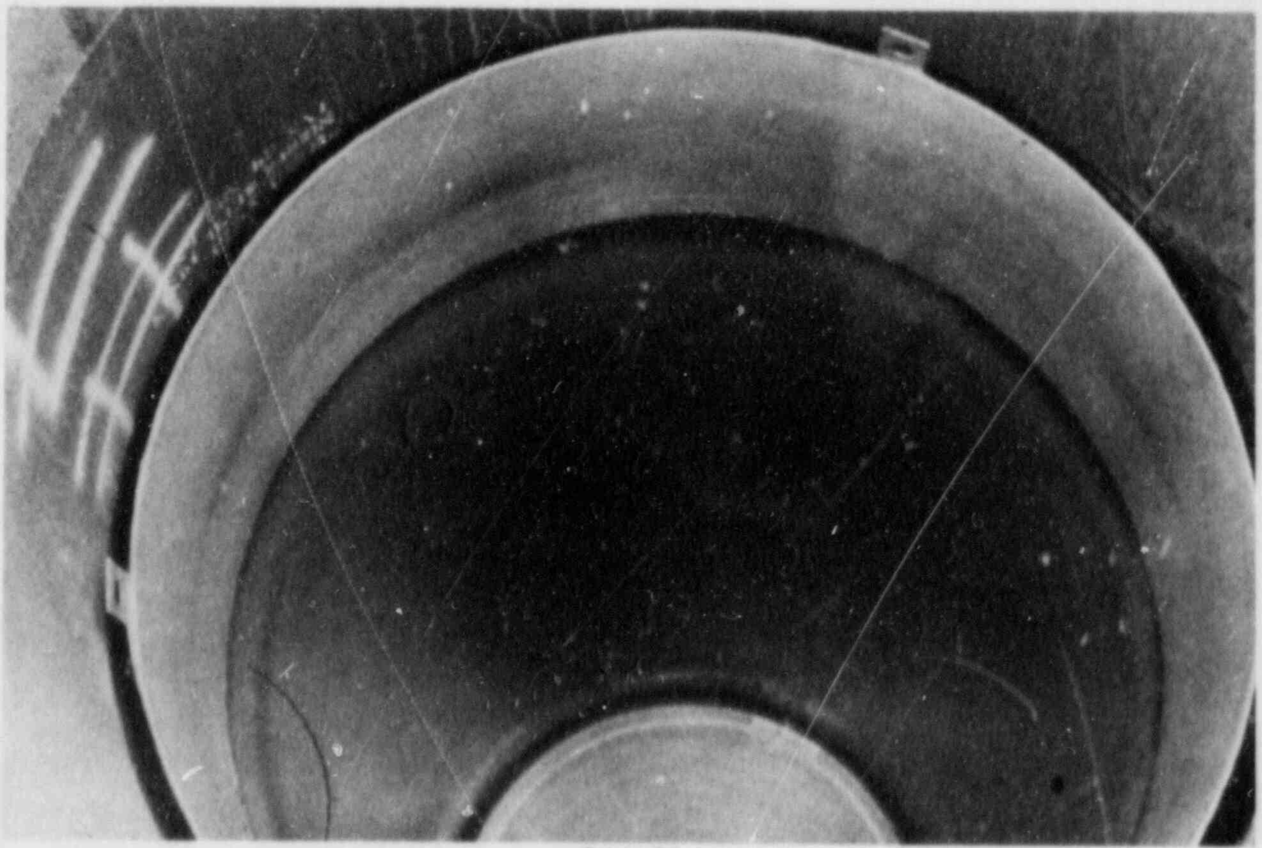

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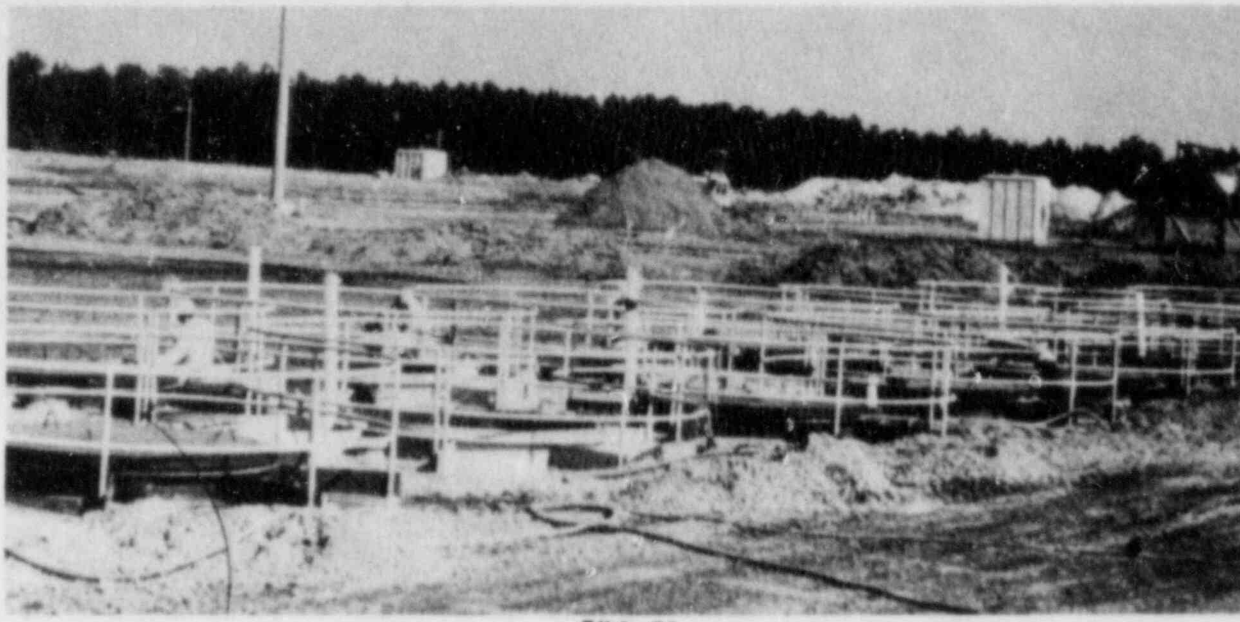

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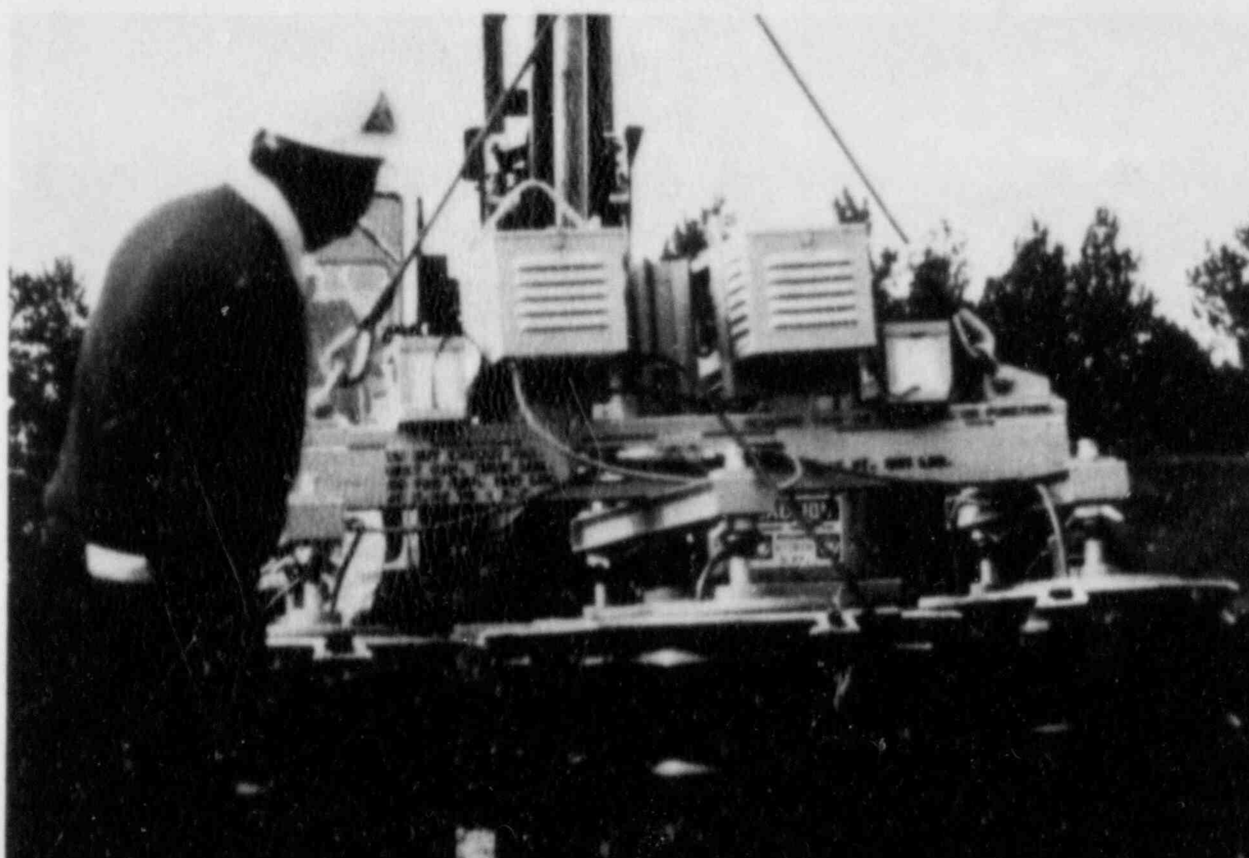

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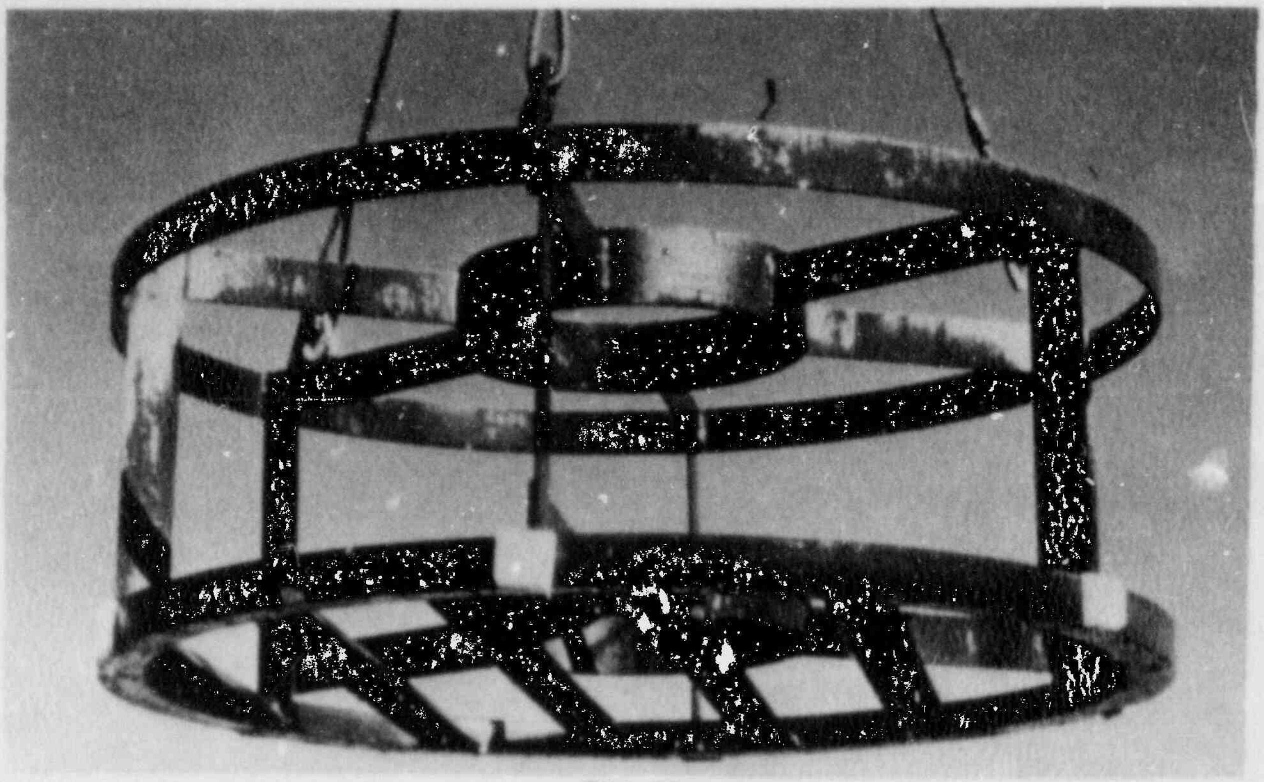


Slide 26

Slide 27

(Slide 28)

In summary, the department feels that shallow land burial provides a safe and cost-effective disposal option for most low-level waste. There is a smaller volume of waste that might require greater confinement because of its hazard.

The department assesses the need for greater confinement on a site-specific basis, in part because of the differences in waste streams and facilities and the differences in geology from site to site, using a total systems approach that considers waste, waste form and environment.

MR. SALTZMAN:

Thank you, Mr. Mezga. Are there any questions?

VOICE:

In the improved shallow land burial in which large areas are excavated and then a trench is subsequently over-excavated, you said sheet piling was used to exclude groundwater. Is this to say the disposal of the actual low-level waste would be below the permanent water table, within the secondary trench?

MR. MEZGA:

This question deals with the trench, the greater confinement trench design at Savannah River, in which a sheet pile cutoff was used to cut off some lateral migration of groundwater into the trench. No, it's not below the water table. But in some instances they have noticed that right after a rainfall event there's some filtration that occurs that flows to the edge of the trench.

The real purpose is to provide structural stability to the trench. The trench is located 30 to 50 feet above the water table.

MS. KANY:

I have several questions. The first is at Savannah River, this 30-feet depth above the permanent water table.

MR. MEZGA:

Yes, it's 30 feet above the depth of the permanent water table.

MS. KANY:

What is the experience with the horizontal migration of tritium?

MR. MEZGA:

We have not seen it. We have not seen it at DOE sites particularly. We do have some experience with it at several other sites: Sheffield, Maxey Flats. At Nevada most of our tritium is going upward, because it's the shortest pathway.

ORNL WSC-33004

SUMMARY

- SHALLOW LAND BURIAL PROVIDES SAFE AND COST-EFFECTIVE DISPOSAL FOR MOST LOW-LEVEL WASTE
- A SMALL VOLUME OF WASTE MAY REQUIRE GREATER CONFINEMENT THAN PROVIDED BY SHALLOW LAND BURIAL BECAUSE OF ITS LONGER-LIVED HAZARD
- THE DEPARTMENT OF ENERGY ASSESSES THE NEED FOR GREATER CONFINEMENT ON A SITE-SPECIFIC BASIS USING A TOTAL SYSTEMS APPROACH CONSIDERING THE WASTE, WASTE FORM, AND ENVIRONMENT

ornl

Slide 28

MS. KANY:

Thank you.

MR. MEZGA:

Perhaps some of the other people in the audience would like to address that point.

MS. KANY:

And thirdly, I was wondering what the experience is with the defense facilities other than Savannah River, and perhaps including Savannah River as far as the length of the time that you actually had to observe the facilities. And I'm wondering what your experience is in the East particularly with shallow land burial.

Did you have other facilities in the East?

MR. MEZGA:

Basically the question is: What other experience have we had besides Savannah River in the humid East in low-level waste disposal? When you said Savannah River, you triggered my memory; they do have a tritium migration situation at Savannah River. I'd forgotten about that one.

MS. KANY:

I remember that, because there was a commercial facility right next door, and they also had a problem with tritium.

MR. MEZGA:

At Savannah River, because of the size of the buffer zone, it's not a threat to the site's performance. There has been a migration from the trench though, and they have that mapped. We also have a great deal of experience at Oak Ridge. We have a wealth of experience and we've learned to do the job right, and that is why we assess performance on a site-by-site basis and a waste basis as well.

MS. KANY:

How many years' experience do you have?

MR. MEZGA:

Since 1945 at Oak Ridge. We also have facilities at Portsmouth and Paducah, which have operated as well, Savannah River, plus the commercial experience. We've also disposed of some waste at Argonne, which is a very small amount in the past.

VOICE:

I wondered about DOD waste. In particular, resins. Do they go to Savannah River, or do they go to commercial sites? And let me add on to that, in the future do you expect that wastes like that will go to commercial sites at various locations?

MR. MEZGA:

I just don't know the answer to that one.

MR. SALTZMAN:

Anyone else who can add to that?

MR. ENGLERT:

John Englert from the West Valley demonstration. At Savannah River, what kind of packing can you get from that until you put some kind of engineered bottom?

MR. MEZGA:

What kind of close packing do we get and do we put something in the bottom of the caisson for structural support? Is that basically the question?

It's a fiberglass liner which does have a bottom. Gravel is placed underneath that for part of the monitoring system to also provide some support. And then the whole unit is grouted in cement. So it's a very strong unit.

I really don't know what the density is that's achieved with that approach, but Savannah River is fairly pleased with it. They go through volume reduction before they put it in the drum. So they feel it's acceptable to them.

MR. SALTZMAN:

One more question, if there is one. Well, good.

We'll take a 15-minute break now. I'd like to remind you again that luncheon tickets are available for $7.30.

(Recess.)

3. STATE STUDIES OF SHALLOW LAND BURIAL AND ALTERNATIVE DISPOSAL CONCEPTS

The State Workshop reconvened after recess.

MR. SALTZMAN:

If you could all take your seats, we'd like to get started on the second portion of the program. We have six speakers before lunch, just to give you a fair warning, so we do have to get moving or else we don't eat.

Once again, if it gets too warm in this room there is an overflow room that is much cooler and you can hear perfectly well there, and we will remember to ask all the -- we'll repeat all the questions that are asked, as they have trouble hearing the questions in the other room.

Our first speaker in this session is Mr. Robert Avant. He is the Assistant General Manager of the Texas Low-Level Radioactive Waste Disposal Authority. He is a registered professional engineer and a Texas Aggie. He's going to speak to us today on the economic and political framework for alternatives that have been developed in the State of Texas.

3.1 Economic and Political Framework for Alternatives

MR. AVANT:

Thank you. There's a high degree of public concern, public suspicion -- can you hear me?

VOICE:

No, there's too much noise back there.

MR. AVANT:

There's a high degree of concern regarding alternatives. That's one reason why we're here today, and why many of us in our home States are taking a very serious, good-faith look at alternatives. In Texas, we have been working on alternative concepts for a little over a year. What do alternatives mean to operations not only in terms of the politics, but also in terms of the economics?

I'm with the Texas Low-Level Radioactive Waste Disposal Authority, an authority of the State of Texas. We are not a regulatory agency, we're an operational authority similar to a port authority.

(Slide 1)

TABLE 1

Texas Low-Level

Radioactive Waste Volume Projections[a]

Generator	Volume m^3	(ft^3)[b]
Institutional	651	(23,000)
Industrial	227	(8,000)
Federal Facilities and NRC Licensees	85	(3,000)
Remedial Action Sites[c,d]	198	(7,000)
Commercial Power Reactors	2,973	(105,000)
TOTAL	3,936	(139,000)

[a]Approximately 850 m^3 (30,000 ft^3) of waste per year is currently generated in Texas.

[b]Numbers are rounded off and do not add exactly.

[c]Assumed.

[d]Not included in total.

Slide 1

In a few slides to follow I'm going to give you a brief recap on the status of the Authority. Some of you may have seen a few of these slides at Waste Management '84. I basically want to let you know where we are and what we intend to do in the future.

All of these are in my paper. I think copies are available on the table. If they are unavailable, put your name on the back of your business card and hand it to me and I'll be happy to mail you a copy. (Editor's note: See Appendix D.)

We performed a source term evaluation when we first started about 2 years ago, and the bottom line is, we're projecting about 139,000 cubic feet of waste a year. The big actor in that play, of course, will be the commercial reactors when they get on line.

This assumes four reactors. If we have three on line, of course, volumes will be proportionately reduced.

(Slide 2)

We have prepared a conceptual facility design. It's basically a shallow land concept. We did this to spec out the buildings and to determine the amount of land needed so that we could evaluate the economics.

(Slide 3)

We performed an economic analysis using the following assumptions, a 5-year startup period, a 20-year operating period, a 5-year closure period, and a 100-year institutional care period.

We came up with some of the following figures. You will note there are some interesting conclusions in these figures compared to some of the other economic projections you have seen that indicate that it takes 500,000 cubic feet of waste a year to even consider a facility being economical; using 139,000 cubic feet per year, several economic scenarios were used. One was there is no cost of money involved -- a government entity. A second variation was an 8.5-percent cost of money and a 4-percent inflation rate.

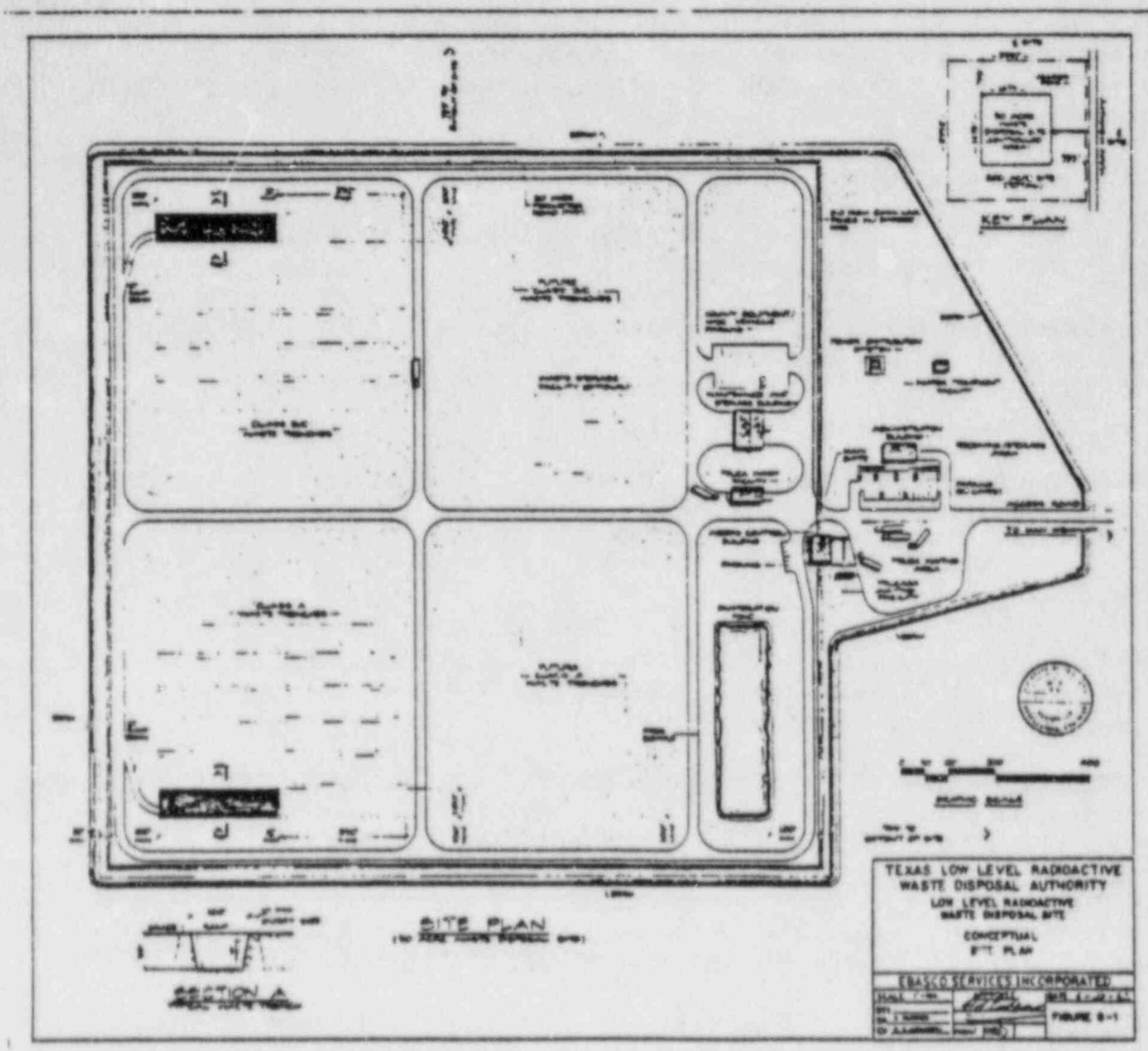
The average disposal fee for a State-operated facility is about $26.50 per cubic foot. Then, if we factor in the cost of money, the fee is about $30 a cubic foot.

I'd like to also point out that you heard me quote French figures ranging from $300 to $1000 per cubic meter. Our prices then would run about $935 a cubic meter, to about $1084 a cubic meter. So $1000 a cubic meter is about $30 a cubic foot. So to place that in perspective. Next slide please.

(Slide 4)

We entered into the siting process, and as we narrowed down the State we used 24 site selection criteria -- hydrology, geology, demography, all the considerations that are in 10 CFR 61. We also added a few of our own, such as the facility would be in a county that had a population not to exceed 400 people per square mile. It would be in a dry area of the State. And other

Figure 1. Sketch of Conceptual Design



Source: Ebasco Services Incorporated, 1983.

Slide 2

Table 2

Summary of Projected Unit Cost of the Texas Low-Level Waste Disposal Facility[a]
[$/m³ ($/ft³)]

Category	Base Case #1 Contractor-Operated Facility		Base Case #2 Authority-Operated Facility	
Average Base Price	1,035.07	(29.31)	847.91	(24.01)
Post-Operating Fund Surcharge	96.76	(2.74)	87.93	(2.49)
Total Average Disposal Cost[b]	1,131.83	(32.05)	935.84	(26.50)

Category	Variation #1 Contractor-Operated Facility		Variation #2 Authority-Operated Facility	
Average Base Price	1,190.28	(33.70)	996.93	(28.23)
Post-Operating Fund Surcharge	96.76	(2.74)	87.93	(2.49)
Total Average Disposal Cost[c]	1,286.87	(36.44)	1,084.87	(30.72)

[a]Units of $/m³ ($/ft³) based on 3,936 m³ (139,000 ft³) per year.

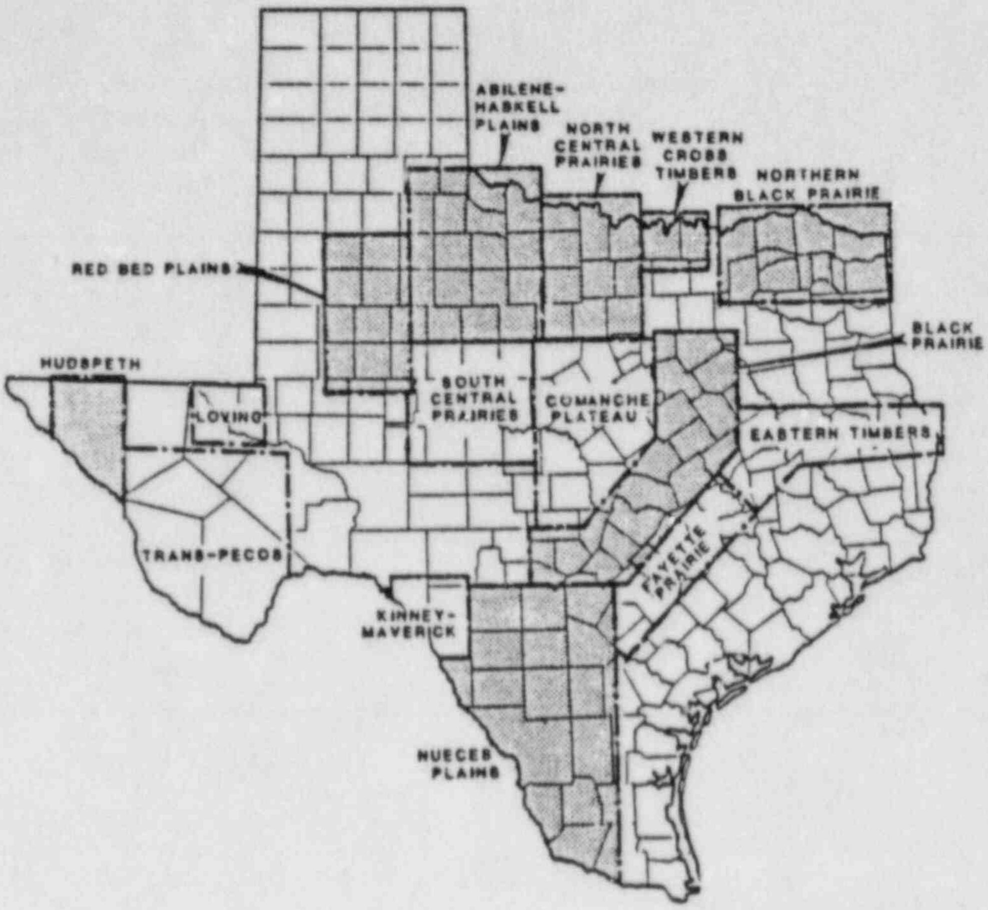
[b]Base cases used in zero percent cost of money.

[c]Variations used an 8.5 percent cost of money.

Source: Avant, R.V., Alvarado, R.A., and Dehmel, J.C., 1984.

Slide 3

Figure 2. Preferred Siting Areas



Source: Alvarado, R.A., Avant, R.V., and Hussey, J.R., 1984.

Slide 4

considerations such as preference for an area where an EIS had already been proposed, government lands, and/or look at an area where possibly there was some modicum of public support.

We did not come close to achieving a modicum of public support.

(Laughter)

(Slide 5)

What happens when you enter into a site selection process, you start getting close to home, and people start to realize this facility might really end up in my backyard. What type of behavior can be expected?

Our philosophy of how the public responds when you start narrowing down the area is on this slide. A press release is issued that you're looking at Podunk, Texas. Individual letters of concern arrive saying, "We don't want you here." "Why are you picking on us?" "It needs to be in downtown Houston."

The second stage is, people begin to organize formal petitions. Resolutions from the county commissioners, the court, the city council and chamber of commerce are submitted.

In the third stage, special interest groups are formed with catchy acronyms like South Texans Against Nuclear Dumping.

The fourth stage involves lawyers. You see threats of legal action saying "We're going to sue you; we're going to get an injunction against you to stop your siting activity." Those sorts of threats and those sorts of tactics are prominent. In Texas, this is a real problem, and I'm going to restate what I said in Waste Management '84 that Texas graduates 4000 lawyers a year. We need 4000 lawyers in Texas like we need 4000 armed robbers a year.

(Laughter.)

The fifth stage is political action. You begin to get either informal contacts from politicians saying, "I'm going to gang up on you in the next session if you don't get out of my area, or my district." Also, you may begin to see some pressure coming from political appointees and various other sources of formal political action.

Intervention is a given. I think you can definitely expect this in the licensing process. Although we have not yet seen it, we fully expect to see some forms of public disobedience -- people lying down in front of trucks or bulldozers. Next slide.

(Slide 6)

Based on our experiences, we felt it would be appropriate to conduct a poll to see what the public attitude was. Here they are. They're discussed again in more detail in my paper.

Stages of Public Opposition

1. Individual Protests
2. Petitions and Resolutions
3. Special Interest Groups
4. Legal Action
5. Political Action
6. Intervention in Licensing
7. Public Disobedience

Slide 5

PUBLIC OPINION ANALYSIS

Site Planning and Management Issues

Physicians and Professors Most Trusted

News Media and Businessmen Least Trusted

State Officials Trusted

Private Business Not Trusted

Management is an Important Issue

Slide 6

Approximately 1000 people were polled in three areas of Texas. People polled tended to trust physicians and professors the most. The news media and business were the least trusted. State officials were trusted at about 57 percent ratio compared to about 70 for physicians and professors. So I guess it could have been worse; I'm pleased to see that at least a little over half the people trust the State officials.

Private business was not trusted. I think the lack of trust for business and management is a very important issue. Also, since this is an NRC-sponsored session, other polls indicate that if you ask a person in a locality who they like the most, they respond that they like the good-old-boy State bureaucrat the most. If you ask them who do you rely on the most for scientific information -- scientific credibility -- they respond that they trust the feds more than they trust the States. I'm not sure what message is apparent in that opinion. But it was an interesting response.

(Slide 7)

This is the attitude toward waste disposal and this brings home the whole issue. Eighty percent oppose a site in their county. Fifty-three percent feel that low-level waste is one of the more serious problems facing the world, and we laugh at that, but it is a valid concern on the public's part. A 50-percent confidence in future technology is shown. That means there's a 50-percent lack of confidence in future technology also. There is a 29-percent confidence in the current technology.

In other words, of everyone that was polled, about 29 percent of the people felt that shallow land burial was an appropriate means of disposing of low-level waste. That means there is quite a bit of difference between the technical community, the scientific community, the regulatory community, and how the public perceives the technology.

A lot of that perspective can be traced to Love Canal, Times Beach, Maxey Flats, and Sheffield, and the type of publicity that's been generated regarding these activities. It's very hard for the general public to relate why we've had problems at these facilities.

There is a safety concern over living near a facility. The general public feels that they would need to live 80 to 100 miles away from a facility. They fear environmental contamination and health impacts.

(Slide 8)

To wrap up, the conclusions of the survey, college-educated people generally were undecided. They had heard the rhetoric. They had heard the major demagoguery that prevailed at the local level, but they didn't buy it all. They wanted more information.

The Hispanics also were undecided more than the Anglos were, for several reasons. There were some language barriers I think, and some of them simply do not get information like some of the Anglos -- radio, television, news service, etc.

PUBLIC OPINION ANALYSIS

Attitude Toward Waste Disposal

80% Oppose Facility in County

53% LLW Serious Threat Facing World

50% Confidence in Future Technology

29% Confidence in Current Technology

Living Near LLW Site as Dangerous as Near a Nuclear Plant

80-100 Mile Safety Zone

Fear Environmental Contamination and Health Impacts

Slide 7

PUBLIC OPINION ANALYSIS

Group Differences in Attitudes

College Educated Undecided

Hispanics More Undecided than Anglos

Persons Who Think They Know the Most Are the Most Strongly Opposed

Hudspeth County Less Opposed

Slide 8

Persons who think they know the most are generally the most polarized in their opposition. Hudspeth County came out a few percentage points lower, about 5 percent less than the other two counties. I'm not sure there's any real reason for that, possibly the population of the county had some play in that. Next slide, please.

(Slide 9)

You have already seen most of the following slides on alternatives. This is a slide depicting the various alternatives, ranging from shooting to the sun to injecting into the magma. I'm not going to go into this. It's well described in NUREG/CR-0308. (Editor's note: "Screening of Alternative Methods for the Disposal of Low-Level Radioactive Wastes," October 1978.) These are some of the things that we're aware of, and we have looked at through our process. It's covered in brief detail in the paper. Next slide, please.

(Slide 10)

These are some of the near-ground alternatives that Jim presented earlier, and I won't get into in any detail other than just to acknowledge that they exist, and that we have looked at them.

(Slide 11)

These are the economics of the aboveground and belowground concepts. This is from a paper that Dr. Takamura of our staff put together as part of his master's thesis. He is now with Martin-Marietta at Oak Ridge. He came up with these figures from literature that showed the orders of magnitude of various costs. That's the only thing that's important to point out here, that land disposal is on the order of $1 to $10 a cubic foot. That does not include some of the costs that are very significant, that drive up the cost to $20 a cubic foot, like surcharges.

But you can see a range of $1 to possibly $1 million, if you're looking at space disposal. Next slide, please.

(Slide 12)

The French concept that Jim also presented earlier, we took a look at this concept. Next slide.

(Slide 13)

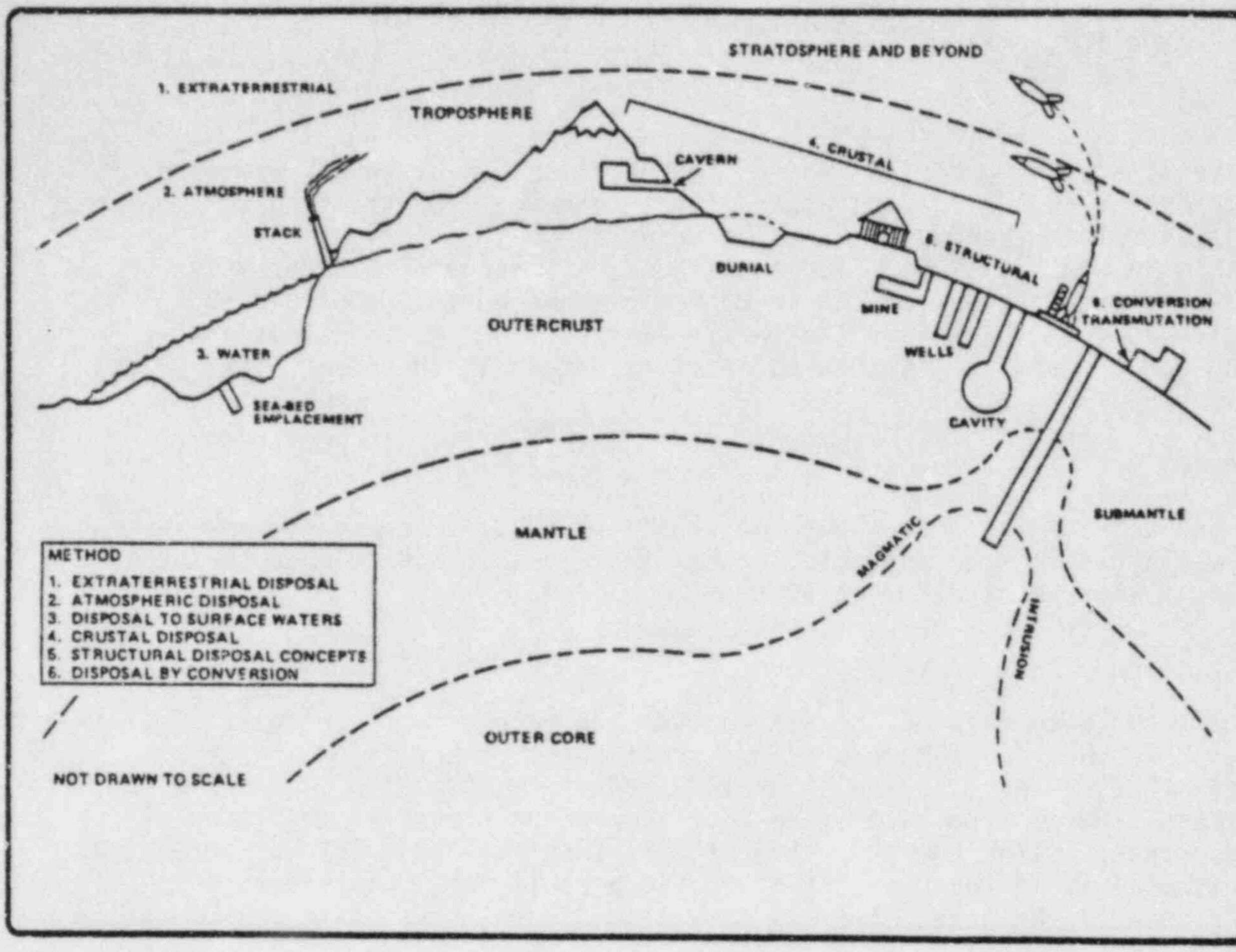
Also the aboveground bunker that Jim discussed earlier.

(Slide 14)

Same comment on the inflatable balloon over one of the belowground vault operations.

(Slide 15)

Figure 3. Schematic Showing The Relation of Various Low-Level Radioactive Waste Disposal Alternatives to the Earth and its Surroundings



Source: NUREG/CR 0308.

Slide 9

Near-Surface Disposal Alternatives

Belowground Vaults

Aboveground Vaults

Earth Mounded Concrete Bunkers

Mined Cavity

Augered Holes

Slide 10

Cost of Various Low-Level Radioactive Waste Disposal Concepts

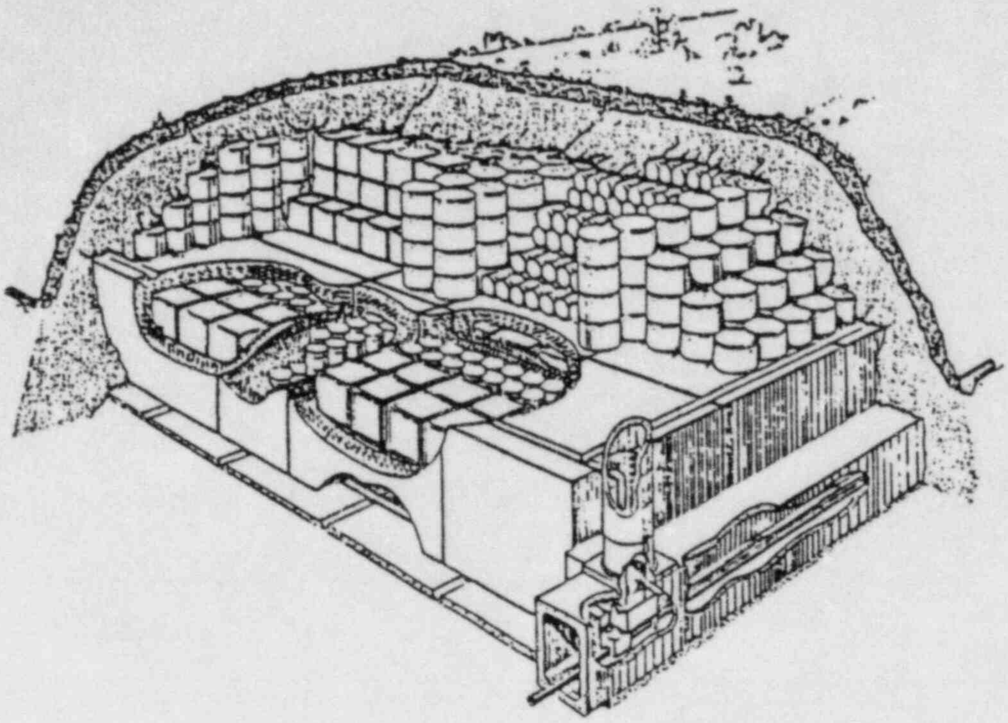
Concept	$/ft^3 of Wastes[a]
Ocean dumping	3 - 4
Geologic disposal	
(a) Mined or drilled shaft	2 - 3
(b) Hydrofracturing	6
(c) Mined vault	5 - 15
Sea-bed disposal	3335 - 7410
Ice-sheet disposal	1000 - 10,000
Structural concepts	7.5 - 37
Space disposal	10^5 - 10^6
Land disposal	1 - 10

[a]1979 cost does not include pretreatment, conditioning, handling, transporting, and efficiency of disposal trench utilization.

Source: Takamura, E.S., 1979

Slide 11

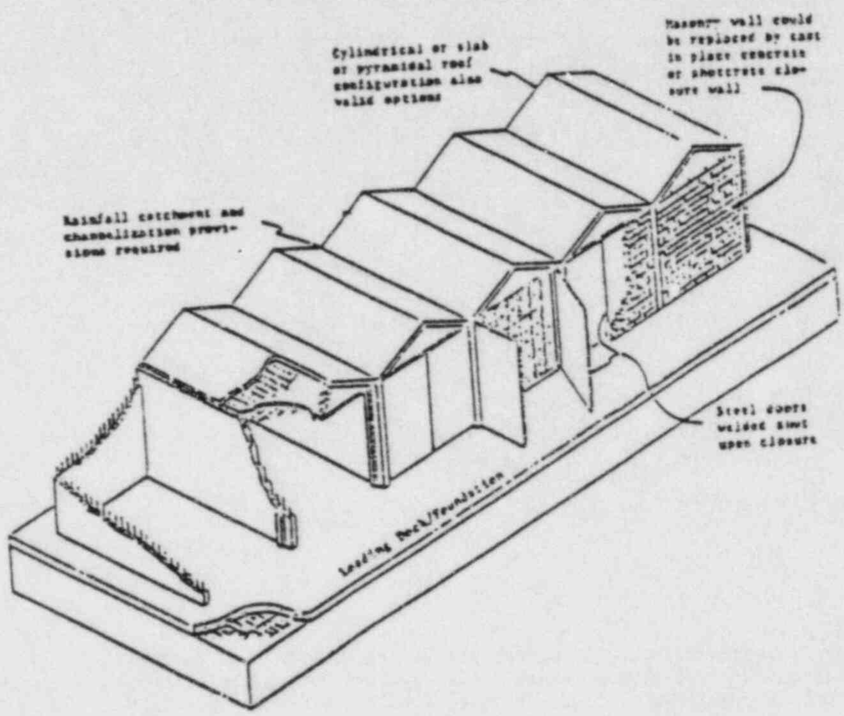
Figure 4. Permanent Waste Storage/Disposal Facility in France.



Source: New York State Draft Report, 1984.

Slide 12

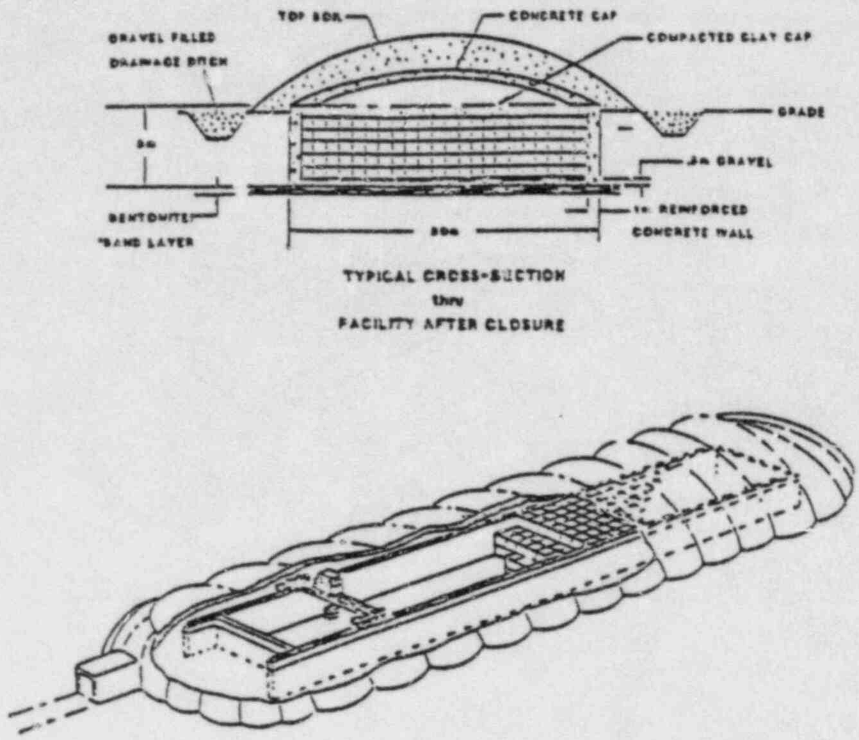
Figure 5. Conceptual Sketch of Cellular Aboveground Vaults for Low-Level Waste Disposal.



Source: Bennet, et al., 1984.

Sl:de 13

Figure 6. Earth Mounded Concrete Bunker with an Air Supported Weather Shield.

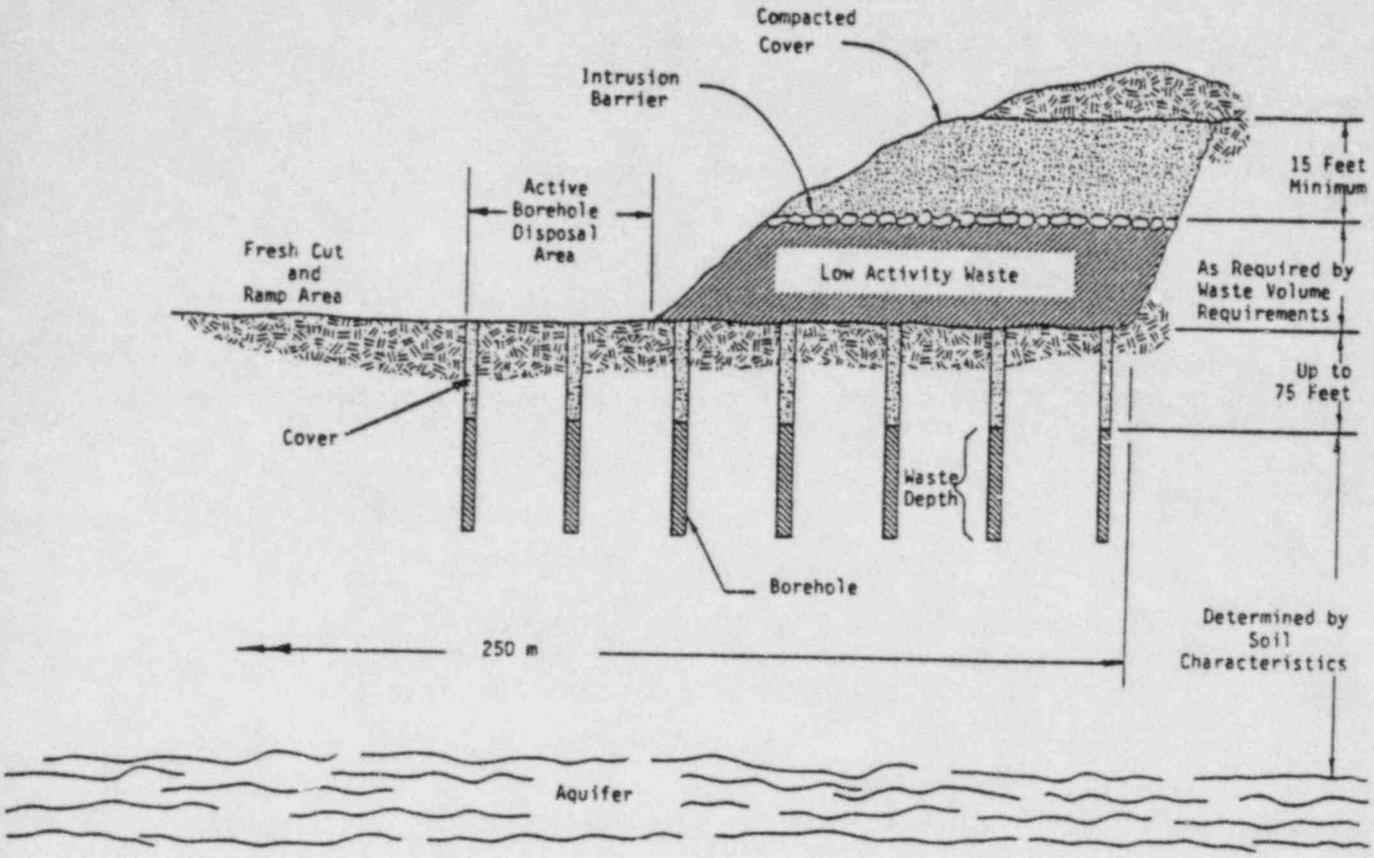


The conceptual drawing of a concrete walled disposal vault depicts an air supported weather shield which is used during the operational stage. The facility represents only one of many possible variations to the Earth Mounded Concrete Bunker concept. The use of an air supported weather shield has potential application to most of the alternative disposal methods considered in this report.

Source: Bennet, et al., 1984.

Slide 14

Figure 9. Cross Section of a Pit and Borehold Design.



Source: Ebasco, 1983.

Slide 15

These are some of the approaches that we looked at -- variations on shallow land burial -- that EBASCO did for us in our study on the conceptual design. This is a combination pit and bore hole design where a trench with bore holes in the bottom is constructed. This is nothing new, but is a variation we looked at.

(Slide 16)

This is a caisson design that Lance talked about.

(Slide No. 17)

This is cylindrical concrete tank -- basically a poured-in-place type of concrete facility.

(Slide 18)

This is the conventional shallow land trench. All of the previous approaches that I pointed out certainly have their advantages and disadvantages. I don't think that we necessarily need to get into these right now, but I think many of the advantages are fairly obvious.

Next slide, please.

(Slide 19)

Some of the variations on shallow land burial that we looked at would be lining the wall with a concrete type of barrier, and then either soil or concrete slab in the bottom very similar to the concept Jim presented.

(Slide 20)

Also, a slip poured concrete canal design is a variation on a concrete-lined trench.

These are some of the approaches that we took a look at. I'd like to make a few comments on how all this ties together.

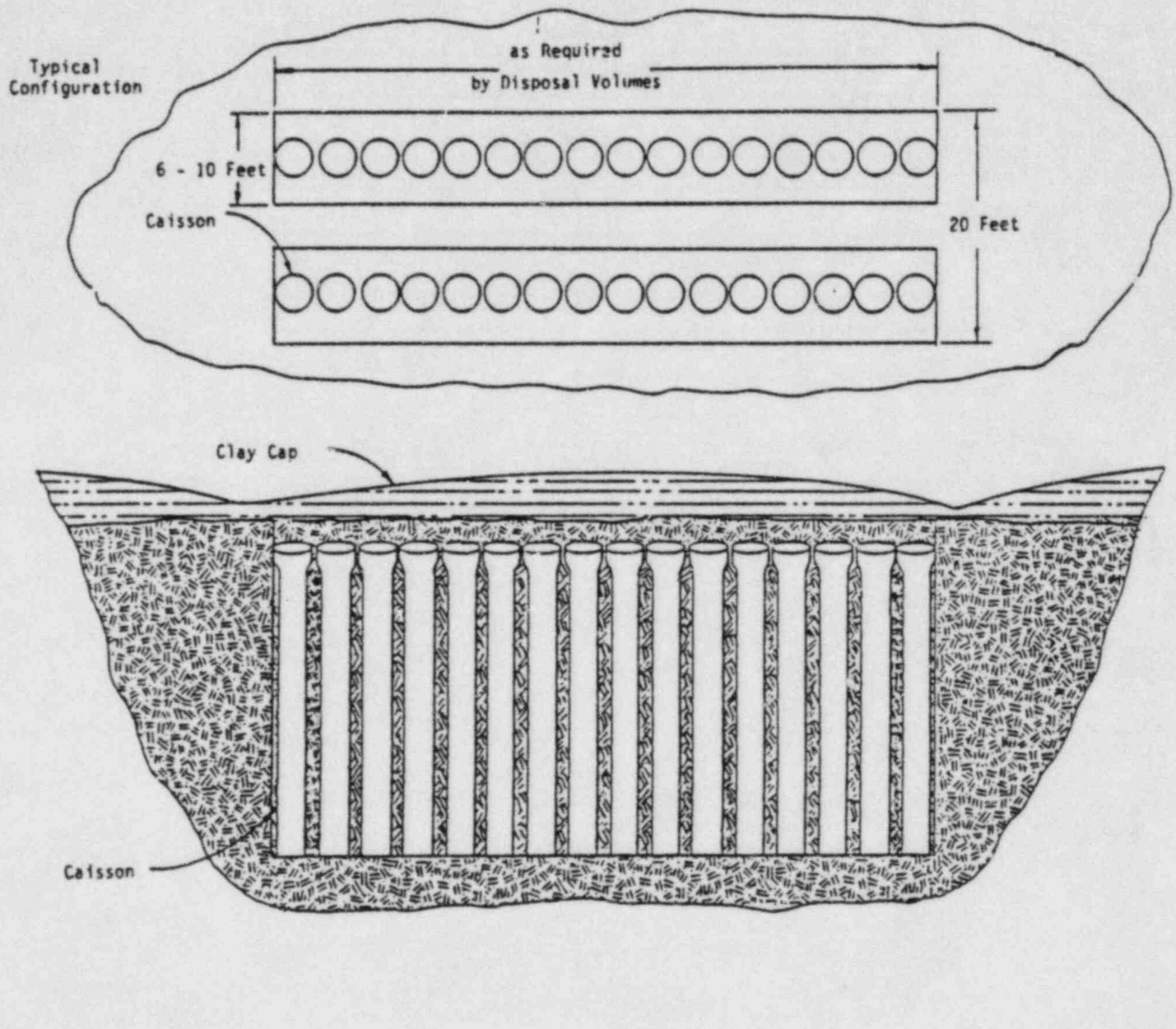
When is it appropriate to look at alternatives? Should you look at it up front before you begin your siting activity? Should you look at it say, in facility design, prior of course to licensing? I think that we need to have a good natural site above all, so it is essential to go through site selection. If you have the luxury of doing that, as we do in Texas and attempt to identify the best naturally occurring 10 CFR 61 site, more flexibility is allowed in considering alternative designs.

In other words, designate a good site. Then come in and introduce alternatives that might be desirable or acceptable in the area.

What that does for you, I think, is introduce an additional level of protection. It also introduces an additional layer of cost. We are in the process now of evaluating these concepts to determine cost impacts.

The following is a case in point. Two million dollars per year may be added to operating costs for simple alternatives. A more complex mausoleum may cost $5 million. Some of the utilities are looking at putting in temporary storage buildings at a cost of $3 to $5 million.

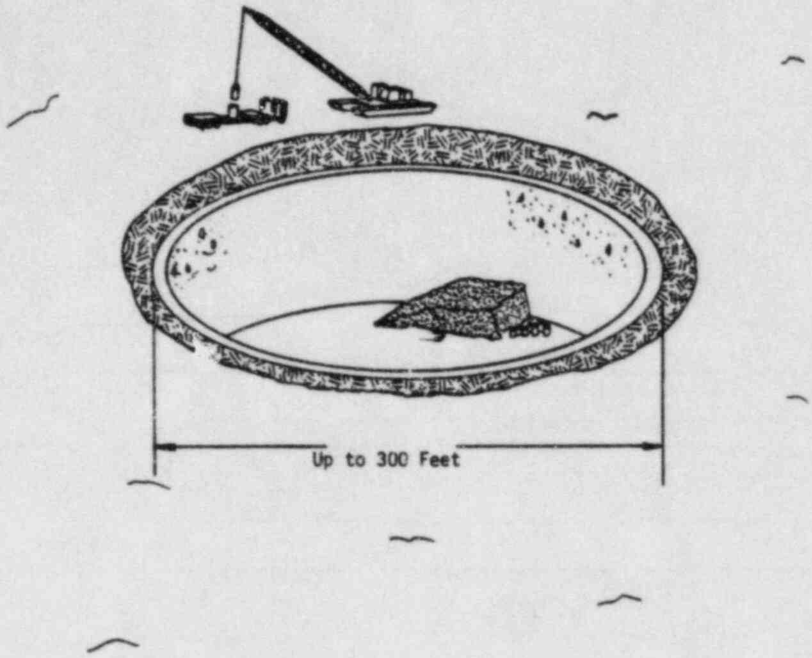
Figure 10. Caisson Trench Disposal.



Source: Ebasco, 1983.

Slide 16

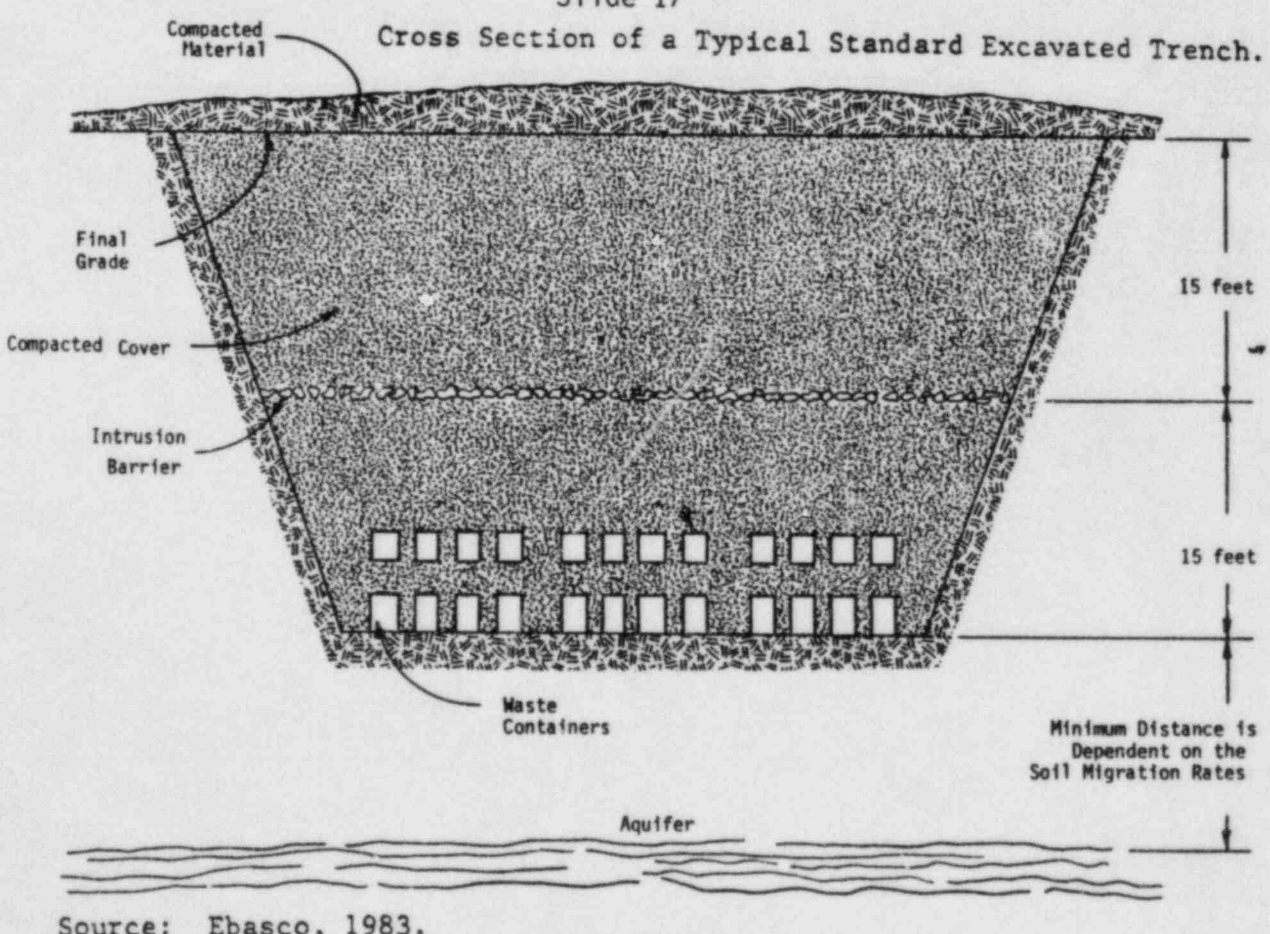
Concrete Cylindrical Tank.



Source: Ebasco, 1983.

Slide 17

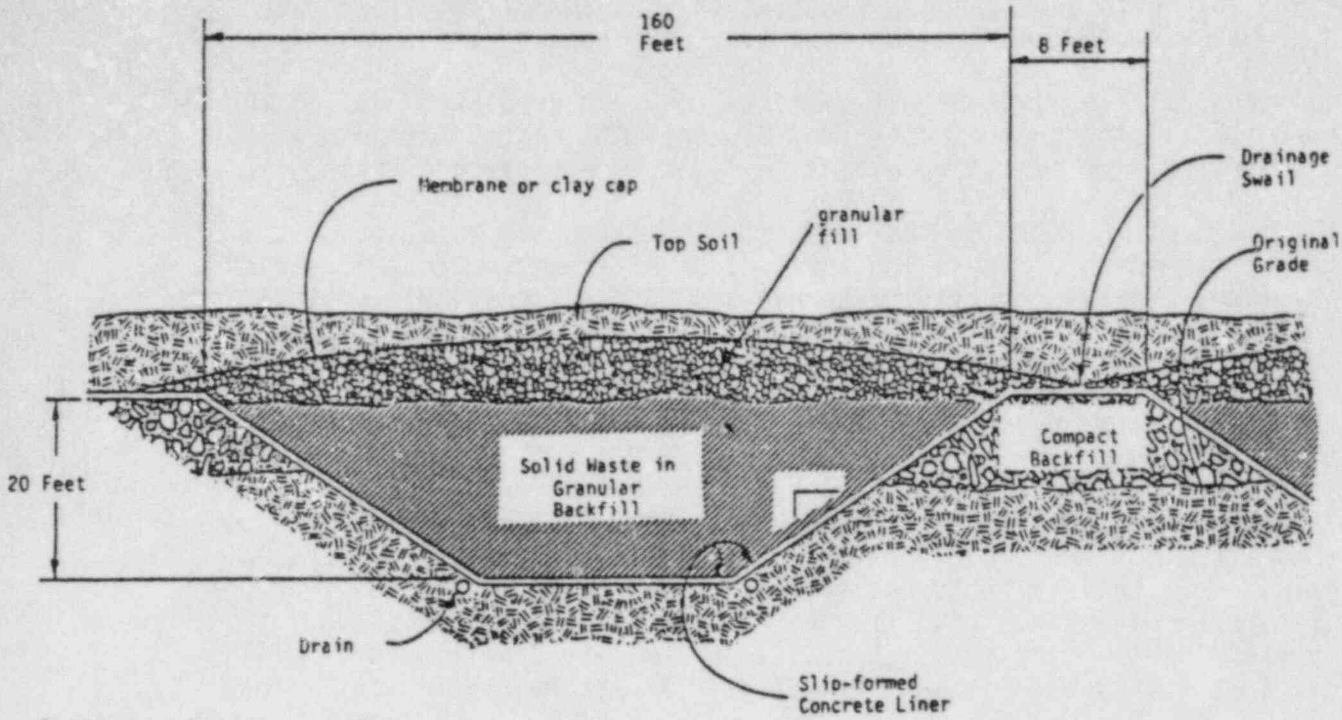
Cross Section of a Typical Standard Excavated Trench.



Source: Ebasco, 1983.

Slide 18

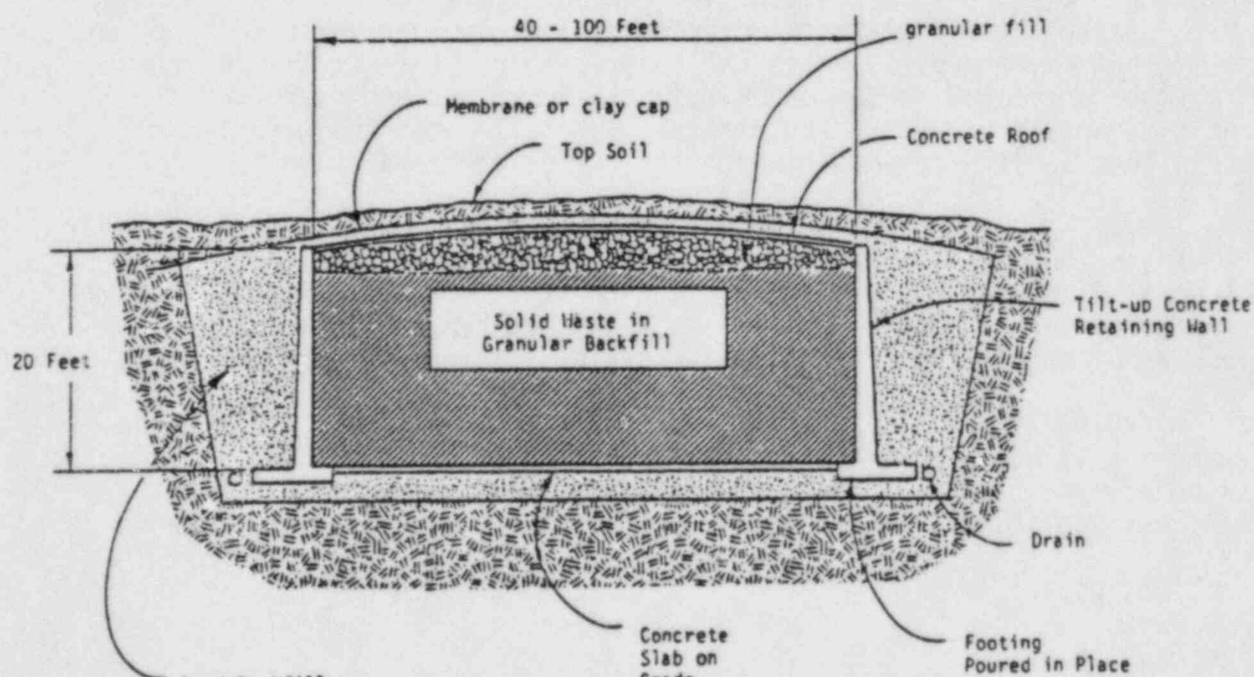
Figure 11. Generic Concrete Canal Design.



Source: Ebasco, 1983.

Slide 19

Figure 12. Generic Rectangular Concrete Trench Design.



Source: Ebasco, 1983.

Slide 20

Take a number out of the blue sky. Possibly some of the alternatives would not have to be as complex as a mausoleum and would cost $2 million a year in operating costs. Our preliminary evaluations indicate that this would result in an increase of $20 per cubic foot. When you factor in the time value of money and carry it back to the present value in 1984 dollars, that amount would probably be more in the range of $30 incremental costs.

Many of these alternatives do not escalate the cost completely out of the ballpark. They do not take costs from $30 to $300; although some may. Alternatives must be evaluated economically on a case-by-case basis.

The point I'm making here is that economics is certainly a factor, but I do not think, depending of course on the type of alternative, that economics is a fatal flaw. Certain types of alternatives may well be viable. It depends a lot on the public acceptance. If you can license your facility much easier, and gain more public acceptance and political acceptance for the facility, the additional money might well be a good investment not to drag out the licensing process.

The importance of public acceptance is something that needs to be factored into the whole debate. If alternatives cost $30 more, total disposal costs will be around $60 per cubic foot, rather than $30. I think the implied statement might well be that some sort of governmental subsidy will be required, otherwise users will try to shortcut the process if the price become exorbitant. People will try to slip low-level waste into landfills and try to get away with it, as has happened in the hazardous waste area.

So, disposal fees will have to be reasonable for alternative systems and consistent with the going rate. It becomes a political decision in that the legislature must determine if it is preferable to establish something that's more politically acceptable and pay the additional price out of the general revenue fund, with user fees supporting general operations of the facility. The alternative is to implement a conventional technology which would be cost effective but may not be as politically acceptable. This is the question that must be addressed in the political arena. We, as engineers and scientists, should have a can-do attitude and build what the general public wants so long as it's consistent with the performance objectives in 10 CFR 61.

There will be a price tag by inserting additional alternatives, and there might well be some health and safety concerns that are not perfectly obvious such as occupational exposure to the workers, greater public exposure, and various other concerns such as airplane crashes, tornados, etc.

What I'm trying to say is, alternatives aren't a panacea, and in some cases they might well be a Pandora's box. These concerns are something that we must be aware of. We need to approach alternatives with our eyes open. But I do think the scientific community needs to approach it with their eyes open.

Last slide, please.

(Slide 21)

MAJOR CONCLUSIONS

1. Waste Characteristics, Conceptual Design, Economics, Siting

2. Public Does Not Have Confidence in SLB

3. Public Fears Health Impacts, Environmental Contamination & Transportation Accidents

4. Have Big P.R. Problem

5. May Have to Compromise in Favor of a Hybred SLB/Alternative Concept

6. Technical and Regulatory Problems Solvable

7. Economics will be a Significant Factor

Slide 21

You've seen our Texas waste characteristics, the conceptual design, the economics, some comment on our siting. The public does not have confidence in shallow land burial. They fear health impacts and environmental contamination, transportation accidents. We have a big PR problem.

I think the scientific community lacks credibility in the eyes of the general public. We feel, based on all of our technical and scientific backgrounds, that shallow land burial is an appropriate means of handling low-level waste. But the general public does not buy shallow land burial, and we may well have to meet on some mutual ground.

We may have to have some sort of a hybrid shallow land burial alternative approach, whatever that may be. I think this hybrid is yet to be determined and will be sitespecific on a case-by-case basis.

Technical and regulatory problems may exist, but most of them are fairly easily solvable. Economics will be the more significant factor because it's a political factor and an operational factor that we all must consider.

Let me sum up my perspective of this whole situation with a homely analogy that we've all heard before. That is leaving the gate open. We've had the cattle in the pen, and the gate's been left open. The cattle have gotten out. We've waved high-grade alfalfa hay at them and we haven't been able to attract them back. The open gate is Love Canal, Times Beach, Maxey Flats, Sheffield, and so many of the other areas that the press has reported, were widely exposed, and created a large amount of public concern.

The task that we now need to consider is to ensure that we get to the pasture gate so we don't lose the whole herd. That task, I think, is to make sure that we not bog down the progress that we need to be making towards siting and operating low-level radioactive waste disposal facilities. The objective is to get this problem solved and to move forward. I think that's the gate we need to make sure is closed before the herd gets out. I'll open it to questions now.

MR. SALTZMAN:

I might mention that Mr. Avant's talk is being reproduced and should be available this afternoon or tomorrow outside.

Any questions?

MR. PITTMAN:

Jim Pittman from Maryland. Does Texas have any shallow land burial sites with leachate underdrains? And if it does, how are the drains monitored, and what's done with the leachate that collects?

MR. SALTZMAN:

The question is whether there are any leachate underdrains in the Texas facilities.

MR. AVANT:

We do not have a facility and will not have a facility operational until probably late 1988. We are at the end of our siting process.

The standard design would of course include leachate monitoring systems below the trenches in a shallow land burial design. I don't know if that answers your question. These are conceptual approaches that we have studied.

MR. JAGER:

Jager from Michigan. In Texas, are you considering segregation of waste and including certain types of waste if you ultimately have shallow land burial? And if so, how are you going to handle the waste that you might segregate out of that waste stream?

MR. AVANT:

Lee's question basically is a volume reduction/de minimus type of question. What type of --

MR. JAGER:

I meant it on the other end of the scale. Segregating waste that may be particularly high in activity or long life, and whether you're just going to bury those and maintain some sort of institutional control over their danger period, or whether you're going to segregate them out to shorten your control.

MR. AVANT:

The segregation would depend a lot on the waste stream, where we're getting it from and how it comes to us. We would certainly prefer to have the waste segregated isotope by isotope. That might be very difficult for our generators. I can imagine what type of problems might be faced in a reactor waste stream where it could be difficult to completely segregate the waste.

To the extent it's practical, I think it would be nice. Segregation is a concern, because you may have to inventory your waste in order to effectively manage certain alternative systems. In these approaches it is important to know when a drum has decayed to background. That's a very valid concern.

Some management approaches could be applied here certainly on the dry active waste, but some of this hotter stuff like resins may be a larger problem. We recognize the problem, Lee; I'm not sure we have a real good answer.

With regard to the volume reduction, I think that might well be an important consideration, especially in terms of alternatives, because the smaller you can make these facilities, the more economical they will be. For example: supercompaction and incineration could allow you to utilize less space in a much more high-dollar facility. Of course, as you add on the cost of these systems, the dollar comes back to be a very important part.

Lee, I'm not sure I was very articulate in answering your question, but that's about as good as I can do at this point in the game.

MR. KUCERA:

Ron Kucera. I was wondering, following up on what Lee said, have you considered the possibility of additional engineering protection in a burial facility for perhaps the higher activity waste, and then just standard shallow burial for the lower activity waste?

MR. AVANT:

That's a consideration that we have thought about. This is basically a variation of the pit and bore hole concept where you would excavate a deeper section for higher activity waste and then cover it with concrete. Those concepts have been considered. We do not have a final facility design. We haven't even begun that yet; it's all in the conceptual stages.

Our larger problem is to get the siting behind us. Once we have the siting behind us and have picked the best site we can, then, of course, we will move into the next phase, which is a facility design and the characterization of the site itself.

MR. KUCERA:

Have you conceptualized about changes in waste form that could result in some economies? For instance, if you went to rectangular solid barrier for your resins, instead of cylinders, you'd save 20 percent there.

Have you all gone into an engineered facility? Maybe that makes some sense.

MR. AVANT:

It certainly does. We have been holding quarterly meetings with our utilities to try to get some degree of standardization on the types of packages we'll be receiving from them. That's going to be a very tough nut to crack because some of them are in wooden plywood boxes, for example -- large pumps. Also spent resins come in 50-cubic-foot round containers.

We're working with the utilities on that now. We don't have any specs, per se, at this point in time. We're working toward that goal though.

The problem is, depending on the designer of the nuclear reactor, the waste management system may not be very easy for them to standardize. Especially if part of the plant is built, as the Texas plants are.

MR. SALTZMAN:

Last question, way in the back.

VOICE:

I wonder if you could tell me what Texas rating of a Low-Level Radioactive Waste Policy Act is on the (inaudible) and have there been any significant (inaudible).

MR. AVANT:

I guess that's the most-asked question I receive. The question was, Texas is a go-it-alone State with regard to the Low-Level Radioactive Waste Policy Act. How do we feel we stand with regard to the challenge of the Commerce Clause and being able to go alone and prohibit waste from coming to Texas?

We follow very closely the South Dakota decision that says you can build a concrete plant for the use of your own people, if it's within legitimate police powers of that State. We will be running this facility as a State-agency-operated facility. It will be for the people of the State of Texas, operated by our people.

That's consistent with the police powers that Texas has, or for that matter any other State in the Union has. That's our position. It is supported by a number of legal scholars, and we feel that our position will stand.

Of course, I will not second guess what the Supreme Court of this country will do. I fully anticipate that the first truck we receive will have two people in it. One will be the driver and the other will be one of those 4000 lawyers.

(Laughter.)

MR. SALTZMAN:

Thank you very much.

3.2 Shallow Land Disposal Options for Pennsylvania

MR. SALTZMAN

Our next speaker is Bill Dornsife, Chief of the Division of Nuclear Safety in the Pennsylvania Bureau of Radiation Protection, a graduate of the Naval Academy and Ohio State, and a professional engineer. Also, he is the Chairman of the Conference of Radiation Control Program Directors (CRCPD) Low-Level Waste Committee.

MR. DORNSIFE:

Thank you, Jerry.

I'd, first of all, like to express appreciation to NRC for having this type of meeting. I think you all agree it's a topic that certainly is necessary for discussion right now.

At the DOE information meeting last September -- in Denver, the State people made their concerns very strongly known to DOE, that we would like DOE to do some additional research for us. But unfortunately, the initial response was much like you heard this morning. Shallow land burial is good enough, you don't need anything else.

I'm glad to see they are doing some additional work, but I think they could do some more.

Obviously, some people don't understand the problem, the public has no confidence in shallow land burial.

I'll come back to that. First of all, I'd like to talk about, what I've been asked to discuss, and that is what little bit Pennsylvania has done to evaluate the alternatives.

A very superficial evaluation -- I admit it's very superficial -- was performed in a study done for us by Penn State, entitled "Low-Level Radioactive Waste Disposal Siting, a Social and Technical Plan for Pennsylvania." (Editor's note: edited by Warren F. Witzig, William Dornsife, and Frank Clemente, 4 volumes, LW 8303 -I, II, III, and IV, 1983) I participated in that study. And the purpose was not to evaluate the alternatives, but to provide some sort of road map for decisionmakers to use to address the important issues that are involved in siting a low-level waste disposal facility. We included a position on the alternatives, recognizing that was one of the decisions that needed to be made. I will run through the very qualitative analysis that we did.

Basically, we looked at three or four different types of technology: belowground disposal cells or basically what you know as shallow land burial. Mound burial cells which are aboveground trenches. Hillside burial cells use the natural topography with cutting trenches in hillsides and covering up to the same topography as they originally were. The deep, vertical pits are the same thing as the augered holes that NRC talks about.

A horizontal gallery --

(Slide 1)

-- is basically a tunnel, if you will. In fact, some people in Pennsylvania have talked about considering some of the old turnpike tunnels for low-level disposal.

(Laughter.)

(Slide 2)

The next two are similar. They're concrete silos, but basically engineered disposal concepts. There are two different concepts, though one being exposed aboveground, the other being belowground.

Let me go to the third slide.

(Slide 3)

This is basically what we're talking about for concrete silos. It would be a cylindrical shape, with pie-shaped lids that you could place as you filled the facility. We're talking about a diameter of probably no more than 40 feet at this type of facility. So, you'd have quite a few of these at a disposal site.

(Slide 4)

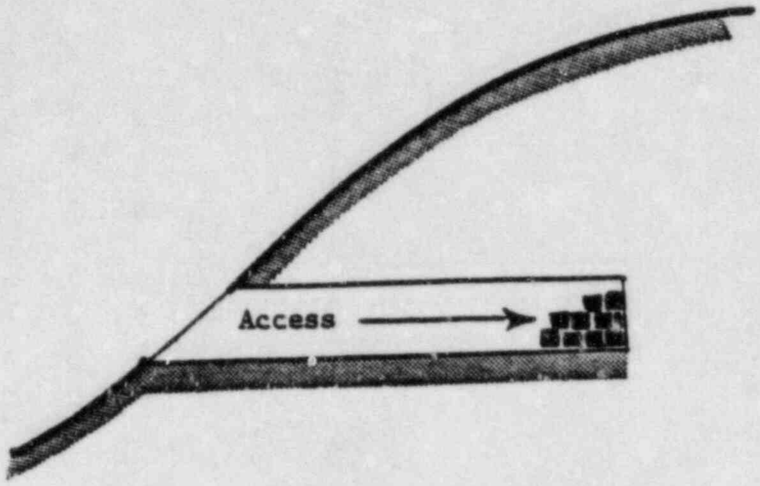


Figure 3. Hillside Galleries

Slide 1

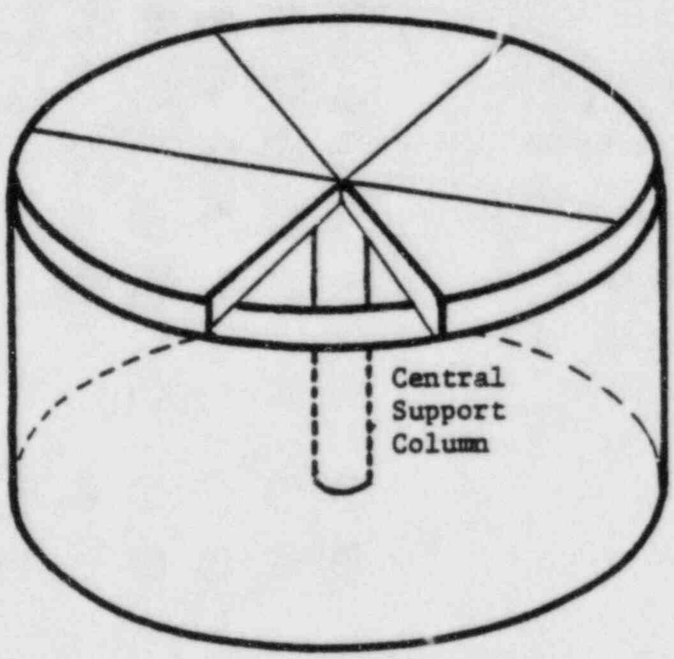


Figure 4. Concrete Silos

Slides 2 and 3

Radiological Hazards and Cost Comparison of Waste Disposal Alternatives

Impacts	Below-ground disposal cells	Mound burial cells	Hillside burial cells	Deep vertical pits	Horizontal galleries	Concrete silos, exposed	Concrete silos, soil covered
1. Access by surface water	◓	◯	○	○	○	◯	◯
2. Access by groundwater	●	○	○	⬤	◓	○	○
3. Migration to groundwater	◓	○	○	●	◓	◯	◯
4. Structural subsidence or deterioration	◓	○	○	○	○	◓	○
5. Bad-weather operation	⬤	●	●	○	○	○	○
6. Animal and human intrusion	◓	●	●	◓	○	◯	◯
7. Earth cover erosion	◯	●	●	◯	○	◯	◯
8. Occupational exposure to radiation	◓	◓	◓	○	●	○	○
9. Operational quality control	◓	●	◓	○	◓	○	◯
10. Ease of access for waste inspection and retrieval	◓	●	●	⬤	⬤	○	○
11. Access to and need for required materials (sand, clay, fill, etc.)	◓	●	◓	○	○	○	○
12. Capital costs	○	○	○	○	●	⬤	⬤
13. Operation and maintenance costs	◓	●	◓	◓	○	◓	○

◯ minimum adverse impact, or maximum implementation ease

○ minor adverse impact, or relative implementation ease

◓ average impact or implementation ease

● appreciable adverse impact or implementation difficulty

⬤ maximum adverse impact or implementation difficulty

Slide 4

What we basically did, in a very qualitative manner, is to evaluate these alternatives against various impacts that we thought were important. Those included access by surface water, groundwater, migration, structural subsidence, bad weather operation, intrusion, erosion, occupational exposure, quality control, ease of access for retrievability, needs for materials -- this is a very important consideration. How available is the concrete? Do you have to truck it in from 50 miles away? That's a very big cost factor. Obviously, capital costs are important -- and finally, operation and maintenance cost.

As you can see, the concrete silos, the engineered types of disposal looked much better than shallow land burial from a qualitative standpoint.

We did not do any detailed quantitative analysis. The only quantitative analysis we did was to look at the cost for some of the alternatives.

Let me give you some idea of what the costs were. All we looked at were constructions costs, not licensing costs or any of the other associated costs. Construction costs only involve what it takes to build these facilities.

Shallow land burial had a basic cost of about a dollar per cubic foot - so somewhere, somebody is making a few bucks.

The mound burial would add less than $1 additional cost to shallow land burial. Hillside burial, also less than $1 additional cost for construction. Burial pits, also less than $1. Buried silos, $4 additional cost, not very much more expensive from the construction standpoint. And shallow silos would be $3.5 per cubic foot extra above shallow land burial cost.

We also looked at the cost of a concept that I feel is very promising toward improving the stability of waste, and that's grouting the waste in place. The cost for that concept was about $1 per cubic foot based on our very rough estimate.

By the way, we have copies of this report available in our office if anybody is interested. We sent them to a number of States. Give me your name and I can send you a copy, at least of the summary report.

As you can see, this was like I said, a very qualitative analysis, and I think it shows that if NRC thought this information was important enough to share with you, how little information there is on alternatives to shallow land burial.

What I'd like to do with the rest of my time is basically talk about some personal observations I have about alternatives to shallow land burial, and some of the potential problems.

First of all, one of the important conclusions from the Penn State study is that if you look very carefully at the final EIS on Part 61, it shows that if you try to dispose of unstable Class A waste in a site that has impermeable soil -- which you'll probably find in the Northeast -- that the trench cover, as you're probably aware, will eventually subside and will fill up with water. If you don't continually pump it, it will overflow, and could cause a release that exceeds the performance objectives.

So, obviously, in impermeable soil, you're not going to be able to meet all of the Part 61 criteria. You can't dispose of unstable waste properly.

This leads to a very strong feeling on my part that when you're looking at alternative concepts for disposal, you really ought to look at the whole waste management system, not just disposal but the whole concept of waste management.

Some of the things I think you ought to consider when you're doing this are the following. These things should be done by regulations and cost incentives, not just hoping that the generator does it, but by including in regulations and using very stiff cost penalties to implement it.

First of all, there should be a further requirement for segregation of waste and storage for decay. This is done to some extent now, but it can be improved upon.

The second point is the requirement for incineration of certain types of waste that just are not acceptable for disposal. The types I'm talking about are scintillation fluids and animal carcasses -- you shouldn't be disposing of that material in the ground.

I think to implement any of these waste management concepts you need some kind of de minimus levels.

The mistake I think that ought to be avoided here is the mistake that was made with the biomedical rule for scintillation fluids and animal carcasses is that it's not just acceptable to make this material below regulatory concern from a disposal standpoint, because nobody is going to accept something that's labeled radioactive. They don't care how little radioactivity is in it; no land fill is going to accept it.

So, unless you make it below regulatory concern from all aspects, the system is not going to work.

The next point I'd like to try to get across is additional requirements for the maximum amount of volume reduction. Obviously, that gives you the most stable waste form, so there ought to be some improvements, both from regulation and cost incentive, to maximize volume reduction.

The next and last point I'd like to make in this part of the talk is that there should be further segregation of the waste and also there ought to be considerations of further improvements in waste form techniques. These ought to be suited to the disposal concepts you're using. For example, it ought to be based on a total hazard concept: Is it leachable? What's the concentration? Based on this some waste may require such methods or grouting in place. Those wastes that contain highly mobile isotopes, like tritium, ought to be in high-integrity containers that wouldn't allow significant leakage for their lifetime. These considerations ought to be included in any evaluation of alternate disposal concepts, because they're part of the system.

The next thing I'd like to talk briefly about is aboveground concepts.

Could I have the last slide, please.

(Slide 5)

This shows you that all of Pennsylvania reactors have built or are planning to build an interim, 5-year engineered storage facility. You can see the costs are very high, and they average about $90 a cubic foot for interim storage.

This, of course, assumes that the facility is fully utilized, which it probably won't be. For comparison, I can't imagine any disposal concept costing any more than probably about half of $90 a cubic foot.

And I think any analysis of cost-benefit will show that disposal concepts are superior to storage concepts from many standpoints.

Another thing I'd like to bring up, concerning aboveground storage is something I don't think has received adequate consideration that is the potential for fire. I think this is particularly troublesome to me because, it's the only way you can release significant quantities of radioactive material.

This is probably a worst-case example but if you had a curie of iodine-125 in storage and you assumed it was all burned up in a fire and released -- in an hour, it would give a dose of 250 millirem to an adult thyroid at one-quarter mile away.

So, I think you can see it would be very easy to get very close to the EPA protective action guides at the site boundary for a fire in a storage facility. So, that's something I think needs a closer look. Fire protection is one of the things that drives up the cost of these reactor storage facilities. Also other external events such as airplane crashes, tornados, and earthquakes also drive up the cost of these storage facilities.

I think, in closing, although we appreciate NRC's effort in doing this particular study of alternatives, unfortunately an evaluation of what new criteria may be needed is not what is necessary at this particular time. What we need is a cost-benefit analysis of the alternatives, because that's the debate that's really going on out there: What is the real cost? What is the real benefit of these alternatives?

And I'm afraid to say if we don't get that information very soon there are going to be some politically motivated decisions which are not based on technical analysis. And I think you all agree we can't live with many more of those.

Thank you very much.

Any questions?

Status of Pennsylvania Nuclear Power Plant Interim LLRW

	STORAGE		FUTURE PLANS	
Plant Site	Current Available Storage	Capacity	Expected Completion Date	Estimated Cost
Beaver Valley	< 30 days	~90,000 ft³ (at least 5 years with both plants in operation)	late 1985	$ 8 million
Limerick	Designed for 30 days		(to be determined in 1984)	
Peach Bottom	< 30 days	100,000 ft³ of dry waste 65,000 ft³ of resin modular construction (about 2.5 years for both units)	early 1985	$15 million
Susquehanna Steam	< 30 days	240,000 ft³ (about 4 years for both units)	early 1984	$22 million
TMI-1	28,500 ft³	90,000 ft³ (modular design)	mid 1985 (if restart approved)	$5.5 million
TMI-2	50,900 ft³	(to be determined)		

Slide 5

VOICE:

Point of information. DOE is in the process of finishing a cost analysis, and it should be available through EG&G in the future.

MR. DORNSIFE:

The comment was that DOE is doing a cost-benefit analysis of the alternatives. I think that would be fairly simple to do, because most of these concepts already exist in foreign countries, and it's just a matter of getting the information.

I also understand that EPA is going to be doing a cost-benefit analysis of the alternatives. And we made a very strong point in our meeting we had a couple of weeks ago that they ought to include engineered disposal concepts as one of the concepts they're evaluating.

VOICE:

Have you looked into where you're going to apply these various concepts? In other words, have you looked at the various sites in Pennsylvania? In particular, have you looked into (inaudible)?

MR. DORNSIFE:

Have we applied any of these concepts in Pennsylvania? And the answer is no. There is no current ongoing program to evaluate any specific sites in Pennsylvania. In fact, nothing has gone on besides the very generic analysis that was performed in the Penn State study.

The thing you talk about at Freeland is a facility, a broker who wants to process waste, not dispose of it.

VOICE:

Will the Pennsylvania facility be a State-funded facility, owned and operated?

MR. DORNSIFE:

Will the Pennsylvania facility be a State-run facility? That's one of the decisions we're waiting for.

VOICE:

And also, you mentioned you were (inaudible).

What steps were you taking (inaudible)?

MR. DORNSIFE:

The question was I mentioned we were doing some -- I mentioned -- she claims I mentioned we were doing something to improve volume reduction. I threw those concepts in as something I think would be good to be further strengthened by regulations and cost incentives.

Pennsylvania is not an Agreement State, so it has no authority right now to require anything.

I was just throwing out concepts that I think ought to be worked into a waste management system, not just a disposal concept.

MR. SALTZMAN:

Thank you, Bill.

3.3 Alternative Disposal Facilities for New York

MR. SALTZMAN

From the Empire State, we have Jay Dunkleberger. He's a graduate of Bucknell and Rensselaer and is a professional engineer in New York.

MR. DUNKLEBERGER:

Thank you.

I brought a lot up here, but I'm not going to read the whole thing.

The State Energy Office was mandated by the legislature last summer to do a report to the Governor and legislature on low-level radioactive waste. We did do a draft, which was published in January. Many of you probably received a copy of that. (Editor's note: "Low-Level Radioactive Waste Management Study," New York State Energy Office, 3 volumes, January 1984.)

That report was subsequently sent to an advisory committee that was appointed by the Governor. The Advisory Committee was mixed. There were State agency officials. There were people who were waste generators -- power plants, medical, and industrial. And there were environmental groups and health physics and medical people -- all on this committee.

The draft was done by the Energy Office, with assistance by Envirosphere, which is a division of EBASCO.

That draft report did a number of things. We analyzed by source, by volume, and curie content all of the waste generated within New York during 1979 through 1982. We made projections through the year 1993.

We investigated various technologies for volume reduction, processing, interim storage, permanent disposal. We analyzed various options that were available for interim low-level waste management for New York.

We investigated the social and environmental health and safety impacts of the various institutional options that New York faced for going along with the provisions of the Low-Level Radioactive Waste Policy Act.

We evaluated the legal issues associated with management in New York, particularly the go-it-alone option. We looked at the status of actions being taken by other States, particularly in the Northeast, and we evaluated the proposed Northeast Interstate Management Compact, otherwise known as the CONEG Compact.

Once the report was finalized, as I said, it was sent to an advisory committee. They held hearings on it around the State -- five hearings that started in the afternoon. Supposedly there was a break for dinner. Usually it went right on through until about 11:00 o'clock at night.

There was a lot of interest, and there was also a lot of opposition, as we've heard in Texas. And I think Pennsylvania has found the same thing, and so have many other States.

We did get comments back from that Advisory Committee as a result of those hearings, and we have revised the report and finalized it. And it wasn't supposed to happen this way, but it did. It is being released today.

So, those of you that did get the draft will have -- or it's already in the mail to you -- a copy of the final report. These three volumes are the final report. (Editor's note: "Low-Level Radioactive Waste Management Study," New York State Energy Office, 3 volumes, April 1984)

If you can't wait, I brought about 25 copies or so of the executive summary with me. It contains our recommendations and also contains the results and the recommendations that the Advisory Committee made to the energy office that we used in revising the report.

One of the things that we did do in the revised final edition was we included 1983 data that we obtained from the disposal sites and what we got from the Conference of Radiation Control Program Director's Survey.

We also made revised projections through 1993.

I might indicate that the Conference Survey -- which Bill has mentioned, being the head of part of that effort -- was very helpful to us, despite the fact that the Conference appears to have misplaced one power plant response form and that one of our facilities that manufactures a lot of radioisotopes, a large amount of B&C waste, did not respond. We still got up to approximately 80 percent of the volume of low-level waste that was reported by the disposal sites.

If we include approximations for those two -- and this is as of -- I believe it was the beginning or the middle of March, the date I am giving you -- some of them may have been incorporated by now -- we came pretty close on volume, at least getting most of what has been reported as shipped to the facilities.

What I'm going to do now is give you a quick rundown of the basic recommendations that we have contained in the report. I'll try to answer questions at the end as to why we have gone this route, and I'll give you a very quick summary of the very cursory look that we had at alternatives to shallow land burial and where we stand there and a couple of the problems that we see for any facility.

The first thing in our recommendations with respect to regional compacts is our recommendation that a large compact such as the Northeast Compact is not in New York State's best interest. This is as it is now and we're also recommending that New York not participate in renegotiating it.

We have recommended that New York concurrently pursue negotiations both with a large generating State and with one or more small generating States to develop the best compact for New York.

Secondly, we have proposed a siting study to identify a site for a permanent repository in New York within 2 years and specified a State agency both to do that and to pursue a license for such a site when the site is determined -- separate agencies for these two efforts.

We have proposed that the Department of Environmental Conservation do the siting study and that the Energy Research and Development Authority pursue the licensing. The reason for this is relatively simple. The Energy Research and Development Authority owns the West Valley site now; we do not want their ownership of that facility to, in any way, prejudice or bias a site-selection process.

The Department of Environmental Conservation would, under the current regulations in New York, be the ultimate licensing authority, along with the State Department of Labor. Giving them the siting study and the requirement to mandate a site or specify a site, and then give that site to the Energy Research and Development Authority and tell them to go ahead and license it, propose it, and develop a facility, takes the bias out of that decision, or at least it's an attempt to.

Thirdly, we recommend that New York negotiate with existing facilities for continued access, pending the establishment of adequate storage or permanent disposal capacity within New York.

Going along with this, we recommend that a temporary engineered storage facility be built by the State for nonutility, Class A waste at West Valley. The reason we're recommending this is that we have serious reservations about the ability of the State to negotiate a long-term agreement with the existing sites to accept the waste that New York has and will need to dispose of or store in the interim period.

We're starting a process now. We have a management plan in the report with timetables. Those timetables still have to be mandated by the legislature and Governor, and then there's the problem of being met once that happens.

This could take quite a while. And while we believe that there may be possibilities for getting some agreements with the existing States, we have some serious reservations that, over a long-term period, we'd be able to have a stable way of disposing or handling this waste without the State doing something. A proposal is here to do something about it.

It will be expensive -- we don't know how expensive. As Bill said, we need some money data. We need some costs. We have done an initial look at it and the costs, depending on what you do, could range up to $100 per cubic foot.

And it all depends on how much has to go into it. And we'd really like some help in this area.

With respect to alternative technologies, these are discussed in Volume 2 of the report, which is the main report itself. It basically discusses some of the options, many of which you've seen here today already. We have looked at them. I think they have been discussed pretty much as thoroughly as we have any information on them.

One of the biggest problems we have, as has already been mentioned, is obtaining reasonable cost estimates. A lot of options are here, and it is going to affect decisions, political decisions and other decisions.

We are concerned, and we need this data.

We've looked at monitored engineered storage and the concern that the NRC has with it. Some of the State agency people have concerns that a long-term storage process for many of these products is not disposal, and it puts off a decision until sometime later, where somebody else is going to have to deal with it.

Storage for some materials, particularly some of the short half-life materials, where they can be disposed of as nonradioactive may be a feasible solution.

We do support the use of the engineered monitored concepts, particularly with provisions for retrievability going along with disposal. The intent would be to then dispose of it permanently. We would have facilities such that it can be retrieved if we run into a problem. It could be repacked; it could be rehandled.

10 CFR 61 goes into this. It helps in a way. But our general recommendation is that more effort go into this area to find out the cost, the benefits, and exactly what can be done and in which way can we best do that.

The other major alternative that we felt to be potentially feasible is mined cavity disposal. There are mines in New York; we have not looked specifically at any of them. We know there are large mines. We know some have water in them. We know some are dry. Some of them are in use, and some of them are not.

Basic concerns we have are how well they're constructed, whether they're usable, whether there is room in them, and whether we can obtain their use.

And the other major concern is what is the cost, what is the impact -- as far as occupational exposures -- of retrievability, and how would you design such a facility.

Well, again, what we have done is we're identifying a number of technologies that are feasible -- potentially feasible for New York, going along with the siting study. We're asking them to look at the technologies to do the siting study and come in with a recommendation at the end of this 2-year period for siting.

We're going along with siting and, to the extent possible, to mention technologies that would be feasible at that site.

One alternative that we have mentioned, in the draft, that we're clearly discarding is ocean disposal. And I think the reasons for that are relatively clear.

We do have a few concerns with the operation of any disposal facility, which goes along, also, with storage facilities.

The first thing is we're concerned not so much from a safety standpoint, but from a public acceptance standpoint, with disposing of biodegradable Class A waste.

Decomposition generates gases which can escape from the facility and also creates voids which jeopardize the integrity of any facility.

Yet, for a Class A facility, when there is very low radioactivity, there will be very little, if any, health impacts. The failure of one part of the facility may be interpreted by the public as a failure of the whole facility.

Even if you tried to separate and put Class A in one section, one area of the facility, and Class B or C in another section, if the public sees pictures of cave-ins and water pumping and various other things in a trench in a facility, you've got a real problem, a public relations problem.

Secondly, we are also concerned with the disposal of organic materials. These materials can severely degrade a geologic medium, as I believe we have experienced at West Valley. Absorption on materials such as kitty litter may be satisfactory for transportation but not for disposal.

If you place this stuff in a geologic medium, if you get water into that medium, these materials will float off of the kitty litter and then be available for attacking the clay or whatever medium you have there.

We're concerned with this. We're concerned with storage of materials, such as the organics and biodegradables, inflammable materials. That certainly drives up the cost and the hazard, and it is a real concern to many of the people in the State of New York. And we think these issues need to be further addressed by NRC, by DOE, and by each of the States as we start thinking about how we're going to handle this.

Paul Merges was going to be here today to speak on 10 CFR 61 and some of their experiences in trying to look at the impacts on alternatives. Unfortunately, he can't be here. We're having a problem with an americium manufacturer who has gone out of business and left an awful lot of contamination in sewers and incinerators and various other things in the State which he has to work on, so he's not here.

But I'd be happy to answer any questions I can on the report. We have copies -- as I say, I have about 25 or so copies left. You can see me at lunchtime.

Those of you who need it now or did not get a copy of the draft report, I can give you a copy of the Executive Summary if you give me your name on a card -- name and address on a card, business card or something else, and whether you want the complete report or the Executive Summary. We'll see that it gets mailed to you as soon as I get back.

Any questions?

MR. RESNIKOFF:

Well, I think we can go a long time. I'm from the Sierra Club. I wanted to ask you about this engineered structure at West Valley. You probably are aware it is going to be vigorously resisted in the State of New York, because, for instance, that americium spill was at West Valley and there are a lot of toxic chemical dumps in West Valley itself. And there's a feeling that West New York is being dumped on.

MR. SALTZMAN:

Could we get to the question.

MR. RESNIKOFF:

For example, Union Carbide is radiating 5000 rads per hour in some of the drums that they send down to Barnwell. Are those wastes going to be in the engineered structure at West Valley?

If they are, then the next question is: Why don't the utilities, then, ask that (inaudible) have material that's (inaudible) -- why not (inaudible)?

And then the next question is: If you're going to negotiate with a State like Pennsylvania, for example, why not have their reactor waste come to West Valley as well?

Is a --

MR. SALTZMAN:

You have three questions. That's enough. That's enough.

Would you answer them, please?

MR. DUNKLEBERGER:

The basic question is rather radioactive material from a facility like Union Carbide, whether that would be accepted at the storage facility; and if it was, what happens relative to the radioactive materials at power plants in, potentially, Pennsylvania or other States.

The first comment is I have a chart -- which I did not get a chance to make up on an overhead or to pass out -- but basically 90-some percent of the materials, low-level waste in New York, are Class A materials. And the engineered storage facility would take Class A materials from nonpower plants.

Also, as far as activity is concerned, only 9 percent of the activity is Class A materials. The Union Carbide materials that he was referring to are Class B materials, typically, and hence would not be going to that facility.

This would take some materials from Union Carbide -- Class A type materials -- and Class A materials from any other nonpower plant.

In general, we would require the power plants to store their materials on-site, or we would arrange agreements with the existing facilities. If a power plant does not have the capability for the full period of time needed to get a disposal facility in the State, we would attempt to negotiate continued access for them for the period of time that they need. And we would also attempt to negotiate with the existing facilities for the Class B or C materials from nonpower plants.

MR. KUCERA:

I have a shorter question. What were the main reasons why you didn't want to go along with the Northeast Compact?

MR. DUNKLEBERGER:

The question was: What are the main reasons we did not want to go with the Northeast Compact? It's a short question to ask, possibly a longer one to answer.

One of the main reasons -- there are a lot of main reasons that we have objections to the compact as written that are in the report and are in the draft report.

Some of the main objections we have with renegotiating it -- one is time. One is trying to reasonably get an agreement in a relatively short period of time between three major generating States, three or four middle generating States, and a bunch of small generating States. New York sits in the middle of the compact region and is a large generating State.

It looks pretty much like it would be three States taking the burden. It looks like in order to be able to generate and get an acceptable compact that would satisfy New York would take an excessive amount of time.

And there was a unanimous agreement of all of the Advisory Committee not to go with the compact. And that was the public perception. It was very strongly that way.

We realized the Northeast Compact is about a third of the waste in the country.

MR. SALTZMAN:

Any others?

MR. DUNKLEBERGER:

Thank you.

MR. SALTZMAN:

Thank you, Jay.

3.4 The Ontario Hydro Experience and Engineered Structures for Maine, Vermont and New Hampshire

MR. SALTZMAN

Our last speakers, from the State group, are two speakers, Thomas Carter of Ontario Hydro, who is a professional engineer, a reactor-waste-management engineer, and a graduate of a number of universities in Canada and England. Also with him is Mr. Robert Eisengrein, a representative from New Hampshire, I believe, for 6 years who has been closely involved in the negotiations in the Northeast.

Mr. Carter and Mr. Eisengrein.

MR. CARTER:

Thank you, and good morning.

I have something like 30 slides to cover in 7½ minutes, so we'll be going very quickly. (Editor's note: The slides were not suitable for reproduction. However, some appear in Representative Eisengrein's preprint found in Appendix D.)

Ontario Hydro is the largest nuclear utility in North America. We do our own design, construction and operation of all our nuclear stations and radioactive waste management facilities and heavy water production facilities.

We're publicly owned by the government of Ontario, serving about 8 million people.

This is an aerial view of the Pickering generating station, 20 miles east of Toronto. It's an eight-unit CANDU station. The last two units will be coming in service next year.

This slide shows an example of what low-level waste is.

We talked a little bit this morning about waste segregation. This slide is taken in the station where the waste arises. We segregate in three bins for incinerable waste, compactible waste, and waste that can't be processed in any way.

The point about low-level waste is that it can be handled "hands-on," without any undue concern about radioactivity.

Here he's monitoring the collection cart for radioactivity before going to a different part of the station.

Here he's packaging it up for transportation to the Bruce Waste Operations Site. Wastes at this category are transported in 55-gallon drums or 1-cubic-meter bins.

Intermediate-level wastes could become as radioactive as irradiated fuel (reactor core components), but they don't have the same long-life characteristics as irradiated fuel. Intermediate-level wastes must be handled remotely and with shielding flasks to protect workers from radiation hazards. Low-level wastes don't require that.

I'll talk about our waste storage facilities. We've been operating our own -- radioactive site for over 15 years now at the Bruce Nuclear Power Development, which is about 150 miles northwest of Toronto. And these facilities -- there's a number here that I'll describe quickly. This is the low-level storage building, our newest facility -- radioactive waste incinerator and processing equipment is here; the radwaste incinerator has been in service since 1977. We're the only utility in North America that has a commercial radwaste incinerator.

We have in-ground concrete trenches of different sizes. We have facilities here called tile holes for intermediate-level wastes and then, aboveground, highly shielded facility called Quadricell.

There are the basic principles practiced by Ontario Hydro in our Waste Operations Program. (See Figure 1.)

The important thing to realize is that "storage" as practiced particularly by Ontario Hydro is different from "disposal." There is often confusion about the differences. (See Figure 2.)

We practice 50-year engineered retrievable storage. Those facilities are designed and licensed to last at least 50 years with absolute minimum maintenance over that time scale. We expect that they will last much longer, perhaps at least 100 years.

This is a schematic of the general concept of all the facilities at the site that are in-ground. You will note we have two aboveground concepts and two in-ground concepts, all of which are classified as "storage."

The basic reinforced concrete structure provides the containment and each in-ground facility has water sample drainage and collection systems; runoff is sampled as it leaves the site. The facilities are located in a very low permeability till in clay about 40 feet thick (to underlying bedrock.)

And then, of course, we have monitoring wells at different locations around the site in the lower aquifer in the rock, and also in the soil overburden.

I would certainly have to say that radioactive waste disposal (or storage) does not need to be above the water table. In fact, it's much easier to model if it's within the saturated zone of the soil.

I'll show some pictures of the operation. It's a large-scale operation handling about 4000 cubic meters per year increasing to 10,000 cubic meters per year by about 1992.

Storage Principles and Facilities

Ontario Hydro applies a conservative approach in the management of reactor waste. Although the practice of disposing such waste directly in soil at carefully selected shallow subsurface sites appears to be acceptably safe, at this time we have placed such materials in interim storage with multiple confinement envelopes between the waste materials and the subsurface environment.

The principles of the program are as follows:

1. All materials are stored in a retrievable manner in facilities having a design lifetime of 50 to 100 years.

2. No radioactive materials are placed directly in soil; engineered structures are used.

3. Only solids are placed in storage; liquids which are potentially much more mobile and hence more difficult to isolate from the environment are first immobilized.

4. All waste placement is treated as interim storage. A certain component of the waste stored may outlive the expected lifetime of the storage structures and hence may need to be retrieved and sent to ultimate disposal.

Figure 1

Storage

EMPLACEMENT of Waste in a FACILITY with the Intention of PERIODIC SURVEILLANCE and Waste RETRIEVAL at a Later Date.

Disposal

EMPLACEMENT of Waste in a REPOSITORY, without the Intention of RETRIEVAL, and Providing ISOLATION from ACCESSIBLE ENVIRONMENT Over a Period Commensurate with the HAZARDOUS LIFE of the Waste. Isolation does not Imply 100% Containment. Restricted Site ACCESS and USE may be Required for a Long Time.

Above-Ground Versus In-Ground

1. Freeze-Thaw damage.
2. Hydrogeological barriers.
3. Constructability
4. Site independence
5. 'Missiles' and sabotage.

Figure 2

It's a large-scale operation, larger than a lot of the State compacts that you're proposing in the U.S.; note that very heavy equipment is required. These are concrete trenches covered with 1-foot-thick concrete lids that are removable; when we are loading the facilities, we have these temporary metal weather covers that can be readily removed.

Up in Canada, as you're all aware, the weather can be pretty severe. At the Bruce site, it snows horizontally, not vertically.

So, weather condition and operability are very important factors for us.

Again, a typical shot of the site, 1-cubic-meter containers we use for transporting waste and handling it -- the heavy lids, again, for the concrete facility; big-lifting equipment (up to 120-ton cranes for some operations.)

If you notice the rectangular baled waste packages -- someone made the comment earlier: "Why not square packages because we've got square facilities?" That's a very good point, because when you put drums and other cylindrical packages in these high concrete facilities, which are rectilinear, you lose a lot of space efficiency.

Ash from the radioactive waste incinerator -- the offgas is filtered and sampled, and the ash from the bottom of the main chamber is dumped into the rectangular steel bins, and then placed inside the concrete storage facilities. (We started out with 55-gallon drums; but again, because they're so expensive, you conserve as much space as possible.)

Our next facility is one for handling waste remotely. They're called tile holes. We've got something like 180 of these in service at the Bruce site now. After you've placed two or three waste packages in, the tile hole is backfilled with concrete. All these wastes are retrievable.

In this case, this entire monolith can be removed whenever we wish to.

Here's a field of tile holes under construction. The ground has been cleared away. And they are all up ended, and tar coated. And when it's completed, it's backfilled right up to this level, and the working surface is right up here.

Soil drainage is down below this level.

Here's a picture of this remote loading, as I was mentioning.

This is a shielding flask. Here's a transportation overpack -- (Type B package) that came up from the Pickering station, and they're getting ready to set the shielding flask down over the tile hole. And then the crane will lower the ion exchange column down; so, these workers are perfectly safe in terms of radiation exposure in what they're doing.

This is the Quadricell facility. It's the highest integrity facility we have. That's for the hottest ion exchange resins or core components that we would get.

We wanted site independence, and certainly we had a lot of discussion with our regulators in the mid-70s about the in-ground structures "How well do you know the subsurface properties?" It's an excellent till which has very low permeability, good ion exchange capability, but there's always the problem of demonstrating an adequate level of understanding of the processes that are going on down there.

So, one of the reasons for going with the aboveground structure was such that it would be a totally capable facility, you could build it on the worst geology, hydrogeology, because all the containment capability is provided by the concrete facilities themselves.

This has 3 feet of concrete shielding overall, so it's heavily reinforced.

This is a cross-section through that facility. And what we have is the outer rectangular structure which you just saw the outside of.

And then, within that, we have a large cylindrical container, and in that go the waste packages -- in this case usually dewatered ion-exchange resins.

There's bentonite down here to absorb any residual water that may come out of the resin over the years and interspace monitoring between the two concrete barriers.

Here they are under construction again. You can see it's a big job, heavily reinforced. And pouring the concrete is not a job for amateurs. But, of course, our construction staff is used to building nuclear power stations, so something like this is not a high-technology job for them at all. But you pay a lot of attention to details; for example, we needed special forms for the concrete so we'd have an absolute minimum of penetration through the concrete barriers.

Here are the cylinders that are poured in place and then placed inside the outer rectangular concrete structure.

This is looking down inside one of those concrete cylinders. This is a dummy run that we had with an ion exchange vessel that would hold something like 100 cubic feet of resin. In this case, of course, this would not be radioactive.

There's some of the thinking we went through when we decided on aboveground versus in-ground facilities.

There was some mention this morning about these aspects. And indeed, the facilities that we have designed, the Quadricell in particular, took into account missiles, such as tornados and small aircraft crashing into them, sabotage, and this sort of thing. It was designed with that in mind.

Constructability -- of course, building aboveground is much easier than in ground, especially when you have our kinds of seasons, where we have an extensive wintertime, and freeze-thaw damage you have to consider when you go above ground, as opposed to other disposal concepts; for once you get below the freeze-thaw line in the ground, you'll get much better durability of any concrete facility.

This is the last facility -- or our most recent one. We call it the low-level storage building. It was designed for lowest level of waste, less than 1 rem per hour -- for a typical reactor, that's perhaps 85 percent of the volume of waste -- is in this low category that you can largely handle without shielded equipment.

We have a lot of containers for use with the waste. The ones here for bales, these are galvanized ones -- they're for ash. And the other ones are for other kinds of waste that cannot be processed before storage.

Here's a schematic of how it's used. The concept here is that you're in the facility for a short period of time in terms of operator exposure. That's how we minimize radiation dose -- in and out quickly -- by handling larger loads, self-stocking racks. This facility has a CO_2 fire-protection system. We're presently constructing a second building right now. They're all adjacent, and they all share common services and fire-protection systems.

Certainly fire protection is one of the major concerns in a building which can fall down. It's not such a concern in an in-ground facility; nothing is going to cave in and it won't become an industrial hazard.

Here's a picture inside the building. It has lighting, fire protection, drainage, and a low-capacity ventilation system on the inside.

All these bins and packages are commonly used; especially for parts inventory in automotive companies. Operations is very happy with the flexibility this building and other facilities have given to them.

These are the costs. (See Figure 3.) Everyone wants cost.

I've given it to you here in Canadian dollars per cubic meter in this column; in U.S. dollars per cubic foot here.

The storage building is the least expensive facility. I would doubt very much that you'll ever achieve a lower cost than that for this quality of facility.

Volume reduction is paying off, it lowers the storage costs.

Tile hole -- it's more expensive. Again, it's not a very good facility from the standpoint of space utilization.

And Quadricell costs a lot of money, but, of course, it's only for perhaps less than 10 percent of the volume of waste that we have to deal with.

There's the difference between storage and disposal. I don't believe the public really recognizes those differences. This is my own definition; other people may have slight variations.

ONTARIO HYDRO
RADIOACTIVE WASTE OPERATIONS
1983 FEE SCHEDULE*

FACILITY	CHARGES	
	CDN $/m^3	US $/ft^3
Storage Building (LLSB)	750	17.25
Concrete Trench (with processing)	840	19.25
Concrete Trench (non-processible)	1 380	31.70
Tile Hole	7 540	173.00
Quadricell	10 500	241.00

* Book Transfer Rates including Capital, Operating and Overheads.

The costs in the above table include all the capital (depreciated) and 1983 operating costs for the design, construction, commissioning and operation of the various types of storage structures at the Bruce Nuclear Power Development Waste Operations Site. Similarly, the costs for the waste processing equipment (radioactive waste incinerator, baler) are included in the fee schedule. All storage facilities are constructed in a staged fashion as the need arises. Interest expense during construction is included as well as a small fee for the 50 year maintenance, and monitoring of the facilities. About $17 M (as spent, Cdn $) has been invested in capital facilities since 1972. Ontario Hydro's activities in support of waste management (concept studies, disposal programs, research and development, etc.) are substantial but are not included in the above figures. Similarly, Ontario Hydro's in-station waste management costs are not included, nor are the costs for radioactive materials transportation.

In general, low and intermediate level radioactive waste management costs rate payers about 0.13 mills/kwh (1983) of nuclear electic energy. This includes in-station solid waste management, transportation and the centralized waste operations at the Bruce Nuclear Power Development Site.

Figure 3

I guess one of the earlier speakers said we would like to have a disposal facility that we can retrieve from at any time -- that's a storage facility.

If you can retrieve it, if you have any intent to retrieve it, you're not talking about disposal.

And I think we end up playing with semantics a lot, which in itself isn't important, other than it tends to confuse -- the experience I've had down here, I've been talking a fair bit Ontario Hydro engineered storage as an alternative to disposal. (And perhaps it is in a certain context!) There's a lot of confusion among the well-educated public I've spoken with: What is storage? What is disposal? What are the implications thereof?

And the other thing I think I hear from them is we, in the nuclear industry, may be trying to sell a better mousetrap (disposal) -- but there may well be no demand for the mousetraps: long-term engineered storage may be what is demanded.

And I think a lot of members of the public are saying: We want something that we can see, that we can go up and "kick the tires" on. We (the public) would rather take the legacy of: Okay, here's an aboveground storage facility or a near-ground engineered facility. We know where they are. We can go back and check, and we'll do that perpetually. From the reading I've had, they're not quite so concerned that they can walk away from it for all time. We're setting that standard for ourselves, and I'm just wondering if we should maybe check out a little bit more if that's what the public is really demanding right now.

I should certainly say that at Ontario Hydro what we're doing right now is not the complete answer; it is storage and it's a 50-year solution. It implies downstream costs. We have to go back and retrieve the waste. Some of it will be inactive at that time, but we're going to have to dispose of some segment of that waste.

So, indeed, in the last 4 years I've spent $1.5 million on designing and researching waste disposal facilities. We're completing right now the preliminary engineering for a shallow rock cavity facility for reactor waste and also an engineered near-service disposal facility for waste disposal (no sites are involved; "typical" sites are the basis for engineering.) We're working very hard on disposal in Canada with very similar concepts to what you've seen here today. We have evaluated them all and are now engineering two of them.

Thank you.

MR. EISENGREIN:

It's kind of hard to follow Tom, but I have followed his activities.

MR. CARTER:

It's my accent, that's all.

MR. EISENGREIN:

I appreciate the opportunity to share some of the thoughts that the potential Northern New England Compact has evaluated in terms of alternatives. Certainly the time is right and ripe. And a number of people have said this.

And I think of a quick story about a person who is concerned about just such a meeting as this. He wanted to come and present himself best and he thought about what he might wear, and he remembered a suit that he always received compliments on.

He put it on and was admiring himself at home and happened to reach in his pocket, and he found a ticket for a pair of shoes he had taken to the shoemaker 3 years ago. He had forgotten about them, but they happened to go well with his suit.

He said: "By gosh, I'm going to go down and see if they're still around."

He went down to the shoemaker, gave him the ticket and said: "Are they still here?"

The shoemaker went back and said: "Yes."

He said: "Great. I'll take them."

The shoemaker said: "They won't be ready until next Tuesday."

(Laughter.)

The point being, starting now, whether we get answers next Tuesday or the following Tuesday, I think this is an excellent forum to discuss concerns that a lot of people have.

In New Hampshire, when we talked with Maine and Vermont about a potential compact, the question came up of alternate structures.

And since I had a little engineering background, and I had some time, I agreed to review some pertinent reports. I read most of the literature; I pretty much confined it to material that went into a fair amount of depth that we could apply in northern New England in terms of alternate structures.

Some of the concerns that we had were based on the past experience with shallow land burial.

I agree with Tom's last comments that a lot of people are concerned about it, some of the poor management experiences; and I think the basic irreversibility of the process bothers a lot of people. They may not articulate this, but that was a concern.

And from some of the studies that we made -- and incidentally, copies of the paper, which is 3 or 4 months old now, I think, are outside -- we referenced some work which talked about another cost, the cost of exhuming waste in case there have been errors or mishaps along the way. (Editor's note: See Appendix D.)

But I think, finally, the thing that concerned us was the public's concern about shallow land burial. And this has come up again and again during the session this morning. We also heard a good bit of this over the 18 months that I was a member of the New Hampshire Task Force on Low-Level Radioactive Waste. We had hearings around the State. There were a lot of people concerned about this.

Incidentally, that 18-month task force operation produced a report. (Editor's note: "New Hampshire Task Force on Radioactive Waste Management Policy, Task Force Report/State Plan," New Hampshire Task Force, Representative M. Arnold Wight, Jr., Chairman, June 1983) And in New Hampshire, the responsibility for low-level waste has shifted now from the task force to two legislative committees.

One is concerned with the siting process. The other was concerned with the potential compact with which New Hampshire might become involved. And Representative Parr and Representative Chambers are here; it's in their bailiwick now. They're looking at this legislatively.

What did we do after we received all information? We reviewed the information, and I think the results that we come up with are evidenced by what Tom has shown and what others have talked about.

There are pragmatic, durable, doable engineered structures that can be used that are alternatives to shallow land burial.

A good bit of what we did in the report was based on studies, many of which were sponsored by NRC and DOE. In reviewing the literature, what we found was the Ontario Hydro experience concerned a "live" experience, they've actually built and operated a facility and have done all the good things that many of us have talked about and have been sort of studied to death, frankly.

It became very exciting to a northern New Englander to look at the innovation and ingenuity that were used.

I will admit, of course, that being frugal in northern New England, we were also a little excited about the potential cost. And I'll comment on that in a minute.

What were the conclusions? We felt that engineered structures were practical for northern New England, particularly considering our climate. We're not quite as bad as Canada, but it starts to approach it.

The economics are always a factor. The dollars per cubic foot were higher. If you looked at Tom's chart, that is certainly so.

But I think you have to raise the question: "Is that the only cost involved in the process?" And I think you've got to answer that with a resounding "no." Like all projects, there are many costs; dollars per cubic foot is just one of them.

What would be included, for example, in the spectrum of cost? At the beginning, I think you've got to recognize that many of the new compacts are going to be planned, constructed, and operated by less-experienced people than those in the past. So, you have a potential for mishaps in several phases of the project which can drive the cost up or cause the mishaps.

You may have some political problems in settling on a site. You may have some economic problems as to where you put a site. And as a result, you're going to get into the one thing I mentioned earlier, of possibly having to exhume waste. Initially it may not be a real, planned cost, but I think you have to consider it. And from the studies we've seen, some of these costs get to be $40 to $100 per cubic foot if you have to exhume the waste and correct errors.

What about other costs? I think there's one that's been mentioned several times here. It's a most exclusive and intangible one, but I think it's vital to the overall success of any program. It's the cost of selling the program to the public. There are dollars involved, but I think, more vitally, there the need to build the public confidence that the efforts and approach you're suggesting provide a safe, long-range solution.

The public concern exists, where it's real or perceived. In many cases perhaps they cannot articulate their concern to our satisfaction, and they may start stressing things that we don't think are so important.

But from my political experience, I think intuitive concern is real and right and something you have to reckon with.

We know the subject of LLRW management is complex. We have spent a fair amount of time at it. I think we have to put ourselves in the public's place, that they don't and can't know the complexities. So you have to be able to convince them what you're doing is right.

So, what do you do as a consequence? I think we've got to take the ideas that were presented today, and I am particularly excited about the Ontario Hydro ideas. I think you've got to expand them and stretch them and match them to northern New England's needs, or to the needs of your area.

Like what, for example? To repeat, roughly 10 percent of the LLRW is a higher radioactivity level; 90 percent is much lower. Some of it you can handle directly. Don't just build one kind of structure for the worst case; build several -- some at lower cost.

Since the material is now retrievable, you can move it from one facility to another, which I believe tney do -- as some of it subsides in activity with time -- they then move it to a less secure, less expensive facility.

The other thing that engineered structures do is allow you a much wider choice of sites where you can put an LLRW location. For example, as big as Texas is, they probably still have some places that are more desirable than others. But I think engineered structures could make more sites possible.

Of course, engineered structures and retrievability answer the question a lot of people have; if the panacea is invented that will make the radioactivity go away, and if it's retrievable, I can reprocess it. I wouldn't hang my hat on that possibility.

I think last, but not least, is the fact that with the use of engineered structures you can assure the public that this is the safest and it's the most secure technical approach available. You can get, hopefully, their support. We certainly know that public groups can locally and nationally oppose poor ideas, but I think you can get them to support good ideas.

Thus, I think the potential for a very powerful and constructive coalition exists to promote this sound idea.

In closing, I'd like to mention a couple of specifics. One, if I can find my notes, is from Tom's report. It was basically the Ontario Hydro philosophy. And I think it's good to read -- I'd like to read it directly. With respect to the storage of LLRW, the report states: "Although the practice of disposing such waste directly in soil at carefully selected shallow subsurface sites appears to be acceptably safe at this time, we have placed such materials in interim storage with multiple confinement envelopes between the waste material and the subsurface environment." I think it's a pretty sound philosophy, and it's one that you promoted 10 to 15 years ago now. In addition, the report also states the principles of their program, which I think are good to read.

The last point I'd like to make is that I think the time for studies certainly hasn't stopped. But I would suggest that NRC and DOE financially sponsor the use of engineered structures in one or more of the potentially new compact areas to learn by doing and to put their money where there is a good solution that's publicly acceptable.

Thank you.

MR. SALTZMAN:

Thank you, Representative Eisengrein and Mr. Carter.

I have good news and bad news, as usual.

The bad news is that we will not be able to get to our next two speakers, the morning wrapup that Rob MacDougall is doing for Robert Browning, who is here now, and Steve Salomon's directions on the workshops.

The good news is that the food is ready, and that's why they would like us to go and eat now.

We will handle those two talks after dinner -- at the luncheon.

So, we will have Mr. Cal Brantley speaking, and then we will have the morning wrapup and then Steve Salomon.

(Whereupon, at 12:15 p.m., the reported session of the meeting was concluded.)

4. QUESTIONS AND ANSWERS ON DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE

(The State Workshop on Shallow Land Burial and Alternative Disposal Concepts reconvened, pursuant to notice, at 8:15 a.m., Thursday, May 3, 1984.)

MR. SALTZMAN:

Would all of the speakers come to the front, please, so we can get started.

If anyone has question cards, could you hold them up and we will pick them up from you.

I would like to welcome you all back this morning. I am sure you appreciated the rest you had from yesterday afternoon's workshops.

We are going to have the half hour of questions and answers at this point. All the speakers I believe are here from yesterday and this is meant to cover not only questions that pertain to the points that they raised in their talks and perhaps were not answered yesterday morning, but also anything that may have come up in the course of the workshops yesterday.

I think you are about evenly spread out now. So I don't know if we can recognize the State participants ahead of the observers. So I will just take them as I see them.

Are there any questions?

By the way, for our transcriber, could you identify your name and State.

MR. KOLPA:

My name is Ron Kolpa and I am with the State of Iowa. I was wondering if there was any last-minute information you can convey to us on the meeting that Mr. Browning had yesterday with EPA sort of finalizing and fleshing out that memorandum of understanding and what is EPA's role going to be in all of these facilities?

MR. SALTZMAN:

Okay. Does anyone from Waste Management have an answer for that?

MR. HIGGINBOTHAM:

Joe Bunting sat in yesterday while Mr. Browning was over here. I understand there were some new developments, but I don't know what they were. They met late yesterday evening, but no, there is nothing new that I can tell you at least.

MR. SALTZMAN:

Did you all hear the answer to that, that there is nothing new to report now. I think Mr. Browning may be in later and if so, you might want to ask that question again.

Yes, name and State, please.

MR. CARTWRIGHT:

Keros Cartwright from Illinois. I would like to ask Mr. Avant from Texas sort of a question on their site selection process and why they felt that without deciding on technology that they could select the best possible site because isn't the site somewhat technology oriented?

MR. AVANT:

Did everybody hear the question?

AUDIENCE:

Repeat the question.

MR. AVANT:

The question was why has Texas elected to go ahead with site selection using basically the criteria from 10 CFR 61 without having a particular specific design in mind? In other words, that you come out and have the engineering design laid out in front of you. There are several reasons for that.

One of them is that we felt like your site design is very specific to the site. If you lay out a requirement that says we know exactly what the soil properties are and we know exactly what the underlying geology is and we know exactly what the hydrology is and all the rest of the design factors, then you could up front design a facility and say we are committing ourselves to these specific design requirements, these properties of the soils and so forth.

Texas has such a wide range of varying suitable geologic regimes and hydrologic regimes that say if we had come forward and come much beyond a conceptual design, which is what we had done, and gotten down to say well the slopes of the trenches will be 33.26 degrees or whatever, and you get into a soil that may have different properties, the design might well have been inappropriate for the site that you ultimately selected.

So our feeling is that you have to go through and use your criteria, and in our case there are 24 site selection criteria, and 16 or so of them come directly out of 10 CFR 61, and then we added about 8 of them, including some things like population density and things like that.

Then you converge to a siting area that you know has the best or at least the suitable operational characteristics, and you come forth then and design a site. I don't necessarily think there is anything magic about that. Another State might well prefer and say we know that this part of the State is where we want the facility to go. We understand the characteristics of that part of the State and consequently we are going to go forth and design the facility up front. You could do it either way.

I don't think there is anything magic about doing it one way or the other, and for a smaller State with maybe a more homogeneous geology and hydrology it might make some sense to do that. We elected to go the other way. Like I say, there is nothing magic about it, I don't think.

One thing that you do get is a lot of public concern about not being able to see the blueprints of your facility, and that is a Catch-22 situation.

MR. CARTWRIGHT:

I didn't mean having specific site designs, but it sounds from your statement that you had pretty well opted that you were going to go to shallow land burial. What I was thinking is if you had some conceptual design and if you had decided that you were going to go to some sort of case one, and I can't remember what we called it yesterday, but the drill holes versus shallow land burial, those would have different site characteristics and you would screen your sites based on slightly different geologic parameters if you were going to put your waste in shafts versus trenches.

MR. AVANT:

Yes, it would be possible that you might get an area where you have an underlying bedrock at say 50 feet or 60 feet that would make it very difficult to come in with say bore holes.

In the area of Texas that we are looking at, first of all, we have some requirements built in like 100 feet to groundwater and some various other requirements. I think that in most cases you could come in and say go with the boreholes or something like that. Now if you want to go with say a mine shaft activity, those site requirements are totally different from the shallow land burials.

In Texas, I don't know of any mine in Texas that does not have water in it. So we don't have the luxury of say looking at something like Lyons, Kansas or bedded salt. So it is a little different situation. We have almost discarded any thought of going to mine cavities.

So what I am saying is that our design is going to be some variation of a shallow land approach. It might be bore holes that are in ground or it might well be some sort of a line trench or it might be an earth mounded concrete bunker or whatever, but it is going to be a variation of shallow land burial, if you will, a hybrid of some sort. So from that standpoint it doesn't really affect our site selection process.

MR. SALTZMAN:

There is a question in the back. Yes.

MS. GOLDSMITH:

My name is Amy Goldsmith. I am with the Massachusetts Nuclear Referendum. I would like to ask a question to Mr. Eisengrein about aboveground storage or disposal, depending on how you want to term it.

My question is in terms of Part 61. The comment that was made was that we could have more of a variety of sites because of the engineering of the facility.

My question is whether a site would have to at least meet the minimum criteria of Part 61 and then engineer beyond that to additional barriers as opposed to not meeting Part 61 and trying to basically engineer a facility potentially to death to try and mitigate problems that are associated with the site?

MR. SALTZMAN:

Does Mr. Eisengrein or Mr. Carter want to try to answer that?

Mr. Eisengrein.

MR. EISENGREIN:

I don't know if Tom is here. He would probably be better qualified.

MR. CARTER:

I am hiding in the front row.

MR. EISENGREIN:

Do you want to speak to it?

(Laughter.)

MR. CARTER:

No, go ahead.

MR. EISENGREIN:

I think the comment from where I sat as far as the choice of sites is concerned, if you are going to engineer it and use some of the structures similar to what they did at Ontario Hydro, I think you automatically will probably exceed 10 CFR requirements or make them a lot easier to meet.

So you could put it in locations you wouldn't consider otherwise. If you look at their pictures, they have the site right on a lake. Normally we try to avoid water like the plague. So that sort of thinking went into my comment that you have a much wider choice of where you can locate this.

MS. GOLDSMITH:

So you are saying in fact that you wouldn't meet Part 61, but you would engineer to meet it. Is that what you are saying?

MR. EISENGREIN:

No, I don't think I am saying that. I am saying you have a wider choice. You are not going to purposely put it in a bad spot and then try to engineer your way out of it.

I think you have additional constraints and barriers which would allow you to pick sites that might be very desirable in other characteristics and by means of these structures meet the requirements.

MR. SALTZMAN:

I think Tom Carter would also like to answer that and then Robert MacDougall.

MR. CARTER:

Well, just a very quick point that indeed when we chose that storage site location recognizing that it was storage and it was in ground facilities, concrete lined and then above ground, even so we still chose a place that has low seismic activity remote from centers of population and not a swamp, these kinds of characteristics, many of which are the same kinds of things you would choose when you are siting a 10 CFR 61 disposal site.

So a lot of the characteristics are the same. As Bob said, you are not going to choose a bad site purposely or put it in the center of Toronto, but the engineered features obviously allow you greater flexibility in meeting the intent of 10 CFR 61 in terms of safety, public dose releases and everything else. So it certainly does give more flexibility though it is above ground or shallow engineered in ground facilities.

MR. SALTZMAN:

Leo Higgenbotham for NRC.

MR. HIGGINBOTHAM:

I am hesitant. I am trying to figure out exactly how I want to answer your question. It is a straightforward answer.

As I understood your question at least, what the answer is the site has to meet the system that we were talking about yesterday that I mentioned briefly and some of the elements of which are described in the written talk.

The system has to meet Part 61 requirements and we wouldn't accept or allow engineered features to compensate for the site. So any extra protection or containment that you get out of engineered features would be over and above the performance requirements in the rule.

Do you understand that?

MS. GOLDSMITH:

Thank you.

MR. SALTZMAN:

Before I take the next question, I might mention that occasionally we get notes from the hotel of messages having arrived, and we have one here for Mr. Daniel Risch, a telephone call.

Any more questions?

(No response.)

MR. SALTZMAN:

Are you sure?

Yes.

MS. PETTI:

My name is Caroline Petti and I am with the Environmental Policy Institute.

I guess this is for Mr. Higginbotham. I am wondering if he could describe how much more flexibility the Agreement States might have for licensing some of these alternative methods versus the non-Agreement States considering the lack of some of the NRC technical criteria for them?

MR. SALTZMAN:

The question was how much more flexibility do Agreement States have versus non-Agreement States or the NRC in licensing some of these other techniques; is that right?

MS. PETTI:

Yes.

MR. HIGGINBOTHAM:

The Agreement State regulations have to be "compatible" with the NRC rules. So your process has to be at least compatible or equivalent or whatever you want to call it to ours.

Over and above that, as long as that is met, I think outside of that the Agreement States have whatever flexibility they can build in or want to have. I don't know exactly. If you have something specific in mind, we can try to answer it, but over and above what I just said, I don't know how to reply to you.

MR. GAYNOR:

Ron Gaynor with U.S. Ecology. In the event of 10 CFR Part 61 you have developed specific regulations to land barriers and you have left flexibility to develop specific regulations and alternatives.

If Agreement States have to be compatible with those, does that mean that an Agreement State would have to wait for NRC to develop those regulations before they could develop compatible regulations?

MR. HIGGINBOTHAM:

I would rather let the Agreement State people answer that, but I would say no. I believe we have always let the States develop regulations that could be more stringent. As long as they were compatible with our requirements, they could be more stringent. I believe they could probably go ahead and work on the alternatives that are missing from ours and I am sure they would do it in consultation with us through the Agreement State program.

I would see nothing to prohibit that, and I don't see anybody from State Programs and there isn't one standing here who is threatening to hit me for saying it, but I would see nothing to preclude that.

MR. SHAFFNER:

Can I try to cloud the issue a little bit? I guess in response to the question that was just asked, there was one thing that disturbed me a little bit and that was the phrase; lack of technical criteria.

As I tried to point out in my presentation yesterday, one of the main conclusions in the Corps of Engineers report is the technical criteria that have been established already in Part 61 to a large degree would apply directly to most of these alternatives.

So what we are talking about is probably a small suite of supplemental criteria that remain yet to be developed, but in fact there is a sound basis of technical criteria for any alternatives that you would use for disposal of low-level waste.

MR. YOUNG:

In terms of comparing the State regulations with NRC's, when it comes to the technical criteria there is a high degree of compatability and similarity. States may be more stringent.

It is the process and in the procedures that the States may vary the most and we have little comment on that. But in the technical criteria there is a high degree of similarity.

I might also point out that in the Agreement States program, States may ask us for technical assistance. They are most often apt to do that for licensing actions which come seldom and require intense effort. So that on licensing actions involving low-level waste facilities, we anticipate that the States would ask NRC for technical assistance and that work would be done by Leo Higginbotham and Jim Shaffner and their people.

I might say that we have had some consultations with Texas although Texas is quite well staffed and able to do much of that work themselves.

MR. SALTZMAN:

Thank you, Frank.

Yes.

MS. CHAPMAN:

Priscilla Chapman, New England Sierra Club. I have a followup question to that. I would like to ask if an Agreement State decided that they would like to make more stringent performance objectives, if they would like to lower, for example, the acceptable dose that a member of the public may receive at the site boundary, would an Agreement State be able to do that or would that be preempted by NRC?

MR. SALTZMAN:

My understanding is that that would be permitted unless it went so far as to make the licensing impossible. We have always said that they can have more stringent requirements than the NRC and still be compatible.

Yes.

MS. ISELIN:

My name is Cornelia Iselin and I am with the New England Coalition on Nuclear Pollution. Could you define that last term, "so far as to make licensing impossible"?

MR. SALTZMAN:

I think if they had requirements that were such that no one could ever meet them as a way to just keep them from being licensed, that they wouldn't be compatible any more with us because they are not carrying out the licensing that we think should be done.

MS. ISELIN:

This would have nothing to do with the economic considerations but only with technical; is that correct?

MR. SALTZMAN:

Yes, technical considerations.

MS. ISELIN:

So it is a technical impossibility and not an economic impossibility.

MR. SALTZMAN:

That is right.

MS. ISELIN:

All right. Thank you.

MR. SALTZMAN:

Yes, Mr. Carter.

MR. CARTER:

I just wonder on that last point though if it is not technically impossible, and nothing is technically impossible, whether in your licensing process, and recognize I am an outsider, whether ALARA (as low as reasonably achievable) which takes into account social and political and economic factors into decisionmaking, whether that has some bearing on what is impossible to license?

MR. SALTZMAN:

Well, I wish Don Nussbaumer from the Agreement States Program was here. I am not sure, and maybe someone from the Agreement States can help me, whether ALARA is a matter of compatibility.

AUDIENCE:

It is.

MR. SALTZMAN:

It is.

Aubrey, would you have a comment on this at all?

MR. GODWIN:

Basically what you all have said has been about right. They generally follow the same requirements as NRC on a technical issue. Procedurally it varies pretty widely. The ALARA concept is one that I believe is a compatibility issue and I think all the States have it in their regulations that you must practice ALARA.

MR. SALTZMAN:

Robert MacDougall.

MR. MACDOUGALL:

Well, it occurred to me that NRC probably would as a practical matter never have to reach that issue of compatibility because under the Low-Level Radioactive Waste Policy Act each State is responsible for developing and providing for the disposal of waste generated within its borders, and if a State were to jack up its regulatory requirements to make it practically impossible to site a facility within its borders, I think it would probably hear first from its neighboring States within a compact region as evidence of its bad faith in the siting process.

I certainly hope that NRC would never have to deal with a question like that.

MR. SALTZMAN:

I understand that Don Nussbaumer who heads up our Agreement States Program will be here around 10. So I think that perhaps either right before or right after we hear from Mr. Cunningham we can ask you to repeat some of these questions about Agreements States for him.

Are there any other questions?

(No response.)

MR. SALTZMAN:

Well, okay. That gives you a little more time, I guess, to go back to the workshops and finish your work.

After the break it will be back here, and while the rapporteurs and chairmen are working on their reports of the various workshops, we will hear from Richard Cunningham.

Yes.

MR. DORNSIFE:

Yesterday DOE mentioned that it was going to be doing a cost-benefit analysis of alternatives. Could you give us more details on that and maybe some idea of other things that might be responsive to the needs that have been addressed.

MR. MEZGA:

Regarding the cost-benefit-risk assessment that I mentioned yesterday, we received the final draft of the report in March. In a very qualitative manner it assesses the dose, both operational and long term, from the alternative facilities that were looked at, basically the alternatives that we have discussed in the past day.

It also looks at relative costs, identifying incremental costs for the alternatives beyond the base cost of shallow land burial in a manner very similar to the way the NRC looked at them in the EIS for 10 CFR 61. That document prepared by Argonne National Laboratory for our program should be available in the next month. I am not sure how our program is planning to issue it at this point, but that document will be available in the near term.

The second part of the question was: What are the other things that we are doing? Argonne National Laboratory is also preparing a report that describes in more technical detail the engineering designs of the alternatives as a followup to this cost-benefit-risk analysis. The report is to be completed by the end of FY 1985.

Those are the two basic planning documents being developed. They are aimed at helping the decisionmakers sort through the alternatives and get to the one which best solves their problems.

MR. SALTZMAN:

Senator Kany.

MS. KANY:

To follow through from his question, are you assuming that all of the waste, including the Class A waste, is handled by the alternative technology, or I would hope that some of the cost-benefit analysis is done just assuming that some of the higher level waste is treated using alternative technology and perhaps the Class A waste just goes into shallow land burial.

MR. MEZGA:

The question is: "In our look at the alternatives, do we consider only that Class C or beyond Class C waste goes into the alternative disposal concept; or are we considering perhaps that Class A and Class B waste can be disposed of using an alternative disposal concept as well?"

Our approach in these studies is to present the engineering information needed to allow you to assess the performance of your site on a site-specific basis and then determine which alternative meets the site performance objectives. We are using this approach for defense sites to allow them to determine which disposal technology allows them to best meet their site performance objective considering the site characteristics, the waste form and disposal technology options.

Without explicitly giving any examples, it may be the case that an alternative disposal option is used at some sites for Class C waste, while at other sites engineered barriers or waste form improvements may allow Class C waste to be disposed of by shallow land burial. The decision must consider the waste, the site, and the disposal technology.

MS. KANY:

Thank you. Will we all automatically receive a copy of this analysis when it is printed?

MR. MEZGA:

I think that we probably can arrange for that to happen if people are interested in having it.

MR. SALTZMAN:

Yes, we can have the registrants' list sent to EG&G Idaho.

MS. JORDAN:

Can I expound on that?

MR. SALTZMAN:

Sure. Betsy Jordan from DOE.

MS. JORDAN:

I would like to expound a little bit on what DOE intends to do or does not intend to do. In the workshop in which I sat in, the participants very vocally voiced a concern that information was not available and that long-term research and development may be needed on some of the alternatives.

The Department's program, as it is currently structured, does not have any intention to do long-term research. We don't have the resources and we are not planning for it.

The only long-term R&D that is currently under way is the greater confinement development test and we began that in 1980, and it will finish somewhere in the '86 to '88 time frame. That is as we are currently structured and with the resources we currently have.

That is not to say if a State or a region came to DOE and had a specific site in mind and wanted technical assistance in the type of operational procedure or technical alternative that they wanted to employ at that site that we wouldn't assist them. That is well within the scope of our program.

If a State or a region comes to DOE, say in 1990, the program may not be there. Currently, the program is set to phase down. So our out-year planning doesn't include big dollars for these kinds of efforts.

MR. SALTZMAN:

Bill Dornsife.

MR. DORNSIFE:

Betsy, it would seem logical that an extension of the studies that are going on now at Argonne, that some of the defense sites would indeed select some of these alternative technologies and in effect build some of these facilities for use at those sites. I mean that certainly would help.

MS. JORDAN:

You are correct. All of the defense work would be well documented and that information would be made publicly available. There are progress reports and other information that is made public quarterly and annually through NTIS and the Technical Information Center at Oak Ridge National Lab.

MR. MEZGA:

The alternatives technology development work done at a defense site is specifically aimed at addressing the needs of the defense site. We are conducting alternatives technology development activities that I mentioned previously, but that work is to address the DOE system's needs specifically. That information is certainly applicable to the commercial sites and will be shared with them, but it is work being done for the defense sites.

MR. SALTZMAN:

Well, I thank you very much and we will be seeing you back here after the break to hear from Mr. Cunningham and the chairmen of the workshops.

Thank you very much.

(Whereupon, a recess was taken from 8:55 a.m. to 10:15 a.m.)

MR. SALTZMAN:

As the first order of business, we intend to take up the questions on the Agreement State matters. We have G. Wayne Kerr, the Director of the Office of State Programs, who can answer your questions on this and we would like to do that before we get to Mr. Cunningham.

Once again two reminders. For those of you who did not hear the announcement at lunch yesterday, checkout time is at 2 o'clock rather than 1 o'clock.

The other is that we again have an overflow room, the Forrest Hills Room just up the hall, and that will be considerably cooler and give you a chance to sit down if it gets a little too crowded in here. You can hear everything very clearly through the speaker.

Now that we have Wayne Kerr from the Office of State Programs, I wonder if we could have the Agreement State questions again that a number of you had asked.

Well, why don't we have Wayne paraphrase some of the questions as we have described them to him and answer them. Then if that leads to more questions on the Agreement State Program, we can go ahead.

MR. KERR:

As I understand the nature of the questions that were passed on to me by the staff, there were a couple.

One was what if an Agreement State wants to go with some alternative, I presume to shallow land burial, what does that mean for compatibility of those programs with NRC's program?

The other question was: Can a State be more strict to the point of effectively banning a particular alternative, and I presume again shallow land burial or one of the others?

I think it would be useful to say that the Section 274 of the Atomic Energy Act which sets up the Agreement States Program says a number of things. It is intended to provide for the transfer, to provide for cooperation between the States and us, but it also says this. It is to promote an orderly regulatory pattern between the Commission and the State, the State governments, and I don't believe that means to frustrate what is a legitimate need within that State.

In terms of an alternative, in a letter to Ms. Kany of Maine on January 5th that John Davis sent to her, there is one sentence that I think I would like to lift out.

It says, "In view of your reference to our letter to Governor Earl of Wisconsin, we believe it is imperative to note that our response to Governor Earl was not a blanket endorsement of engineered aboveground storage, but merely a clarification that it is not a prohibited activity."

Now there are very few things in law or in the regulation that are prohibited. People can make proposals to do all kinds of things and there is no explicit prohibition on that. So if you will pardon the pun, applicants propose and the regulators dispose, meaning they make decisions on whether that should be approved or not.

I think the bigger question though comes down to some action like: Does this meet the test of the Low-Level Radioactive Waste Policy Act, that is to provide for the capability of disposing of waste?

On the question of whether States, can they set more strict standards? And the answer is yes. I have testified to that effect when necessary to meet local conditions.

Now we look for compatability and a high degree of uniformity on the technical parts of the regulations, including Part 61, Part 20 and the others and hope to maintain that, but we recognize that there are times when it may be desirable for a State to put on some more stringent standard.

Now if this result is that you effectively ban disposal of waste, the State still must provide for disposal under the Low-Level Radioactive Waste Policy Act. So what is the alternative?

The ultimate alternative I suppose is that you tell your generators they can't produce any more waste, and that is all types of generators, reactors, hospitals, industry, universities and so on.

So if you come up with a solution that has a ban on disposal by administrative or regulatory action, I think you have created yourselves a problem because the Low-Level Radioactive Waste Policy Act says you shall find a solution without specifying exactly how.

Now I think I will stop there and see if somebody has questions.

Yes.

MS. ISELIN:

I am Cornelia Iselin, New England Coalition on Nuclear Pollution. When you said you tell the generators, do you tell the generators in your State or the generators who presumably might be in compact States with you? I mean supposing that you lived in a State where the conditions were so unsuitable that shallow land burial was absolutely out of the question from the point of your agencies and you decided therefore that the siting arrangement you are going to arrange for would preclude bringing in quantities of waste except at excessive prices because it would be so expensive to bring in all sorts of waste unsorted and put them through this engineered process. What would be your standing there? You can tell your own State to stop generating.

MR. KERR:

Well, presumably if you are a member of a compact, that is one of the advantages of being in a compact, that if technical conditions were such as to rule out siting in one State of the compact, you have the advantage that you have some arrangements with other States where the site is located.

MS. ISELIN:

That is if your compact allows you this privilege.

MR. KERR:

Yes, your compact and if you are alone.

MS. ISELIN:

So you do have to be terribly careful, do you not, when you are going into a compact to make sure that you are not going to get yourself in a box of that sort?

MR. KERR:

Yes, I would think so. I don't think anybody knows ahead of time whether there is any State that has no place that they can put aside or not, but when you go through a site screening process, you would find that out and it certainly is a very important factor.

Way in the back.

MS. PETTI:

Caroline Petti with the Environmental Policy Institute. I am wondering would there be any difference in the time it takes for the NRC to process an application from an Agreement State versus a non-Agreement State?

MR. KERR:

In other words, a difference in time whether NRC is the regulator or whether the Agreement State is?

MS. PETTI:

Right.

MR. KERR:

Yes, I think there can be some and let me say where it can come from.

I think NRC anticipates it may take anywhere from 3 to 5 years from the time a site is selected and you seriously think something is going to come in.

Now we of course operate under the National Environmental Policy Act, and it requires an environmental impact statement and so forth.

Now in the Agreement States the NEPA process does not flow to the Agreement States from the Atomic Energy Act. They are not required to follow NEPA through that. Notwithstanding that, many States, Agreement or non-Agreement do have some type of NEPA law. It may not be as complex or of the same nature as the one for the Federal government, but many of them do have, and even those who don't, I can't conceive of a low-level waste burial site being licensed and approved by an Agreement State that did not have a NEPA law without a pretty extensive discussion.

It might not be quite as formalized as NEPA, but public meetings, hearings or whatever name you want to put on them, and there is a difference of course. It is possible I suppose that some time savings could result from that by not having quite as complex an administrative framework to deal with.

MR. SALTZMAN:

Thank you very much, Wayne.

5. LICENSING FOR STORAGE, INCLUDING INTERIM PERIOD POST-1986

MR. SALTZMAN

Our final speaker as such, other than the workshop chairmen, is Richard Cunningham who is the Director of the Division of Fuel Cycle and Materials Safety, and he will be speaking on licensing for storage, a subject that is near and dear to many of our hearts.

MR. CUNNINGHAM:

Thank you, Jerry.

I understand that there are a number of questions evolving about storage. I am sorry I missed being here yesterday. I was down in Texas on this rebar incident as was Wayne. Wayne has a little more dedication than I do. He traveled at night and arrived at 4 o'clock in the morning yesterday, and I traveled yesterday during the day.

I have a few notes about the licensing considerations for storage of waste of radioactive material, and I will go through these notes rather hurriedly. I don't want to bore you with a lot of technical detail, much of which might have been covered yesterday. Then we can get to some of the questions that you may have and to more germane issues or problems with which you are faced.

So very briefly, I will try to cover the licensing considerations.

I think the first point that is necessary to understand is that storage implies that the waste will eventually be removed for disposal. When we license storage, it has to be based on the assumption that you will eventually remove it for disposal.

Most waste generators have some storage capacity which is evaluated at the time a license application is received. The size of that capacity will depend on the generation rate and the rate at which they remove the waste for disposal, and this varies from approximately 1 month to a year of storage capacity, depending on how they get rid of their waste.

Usually the radiation safety considerations for short-term storage are minor compared to the safety considerations involved with the radioisotope inventory that they normally use. Also, with rather short-term storage you don't have the package deterioration that you would have to account for in longer term storage.

If our waste generators need to have their licenses amended to cover storage for several years, perhaps up to a decade or so, then storage could dominate the safety considerations in some instances. In other words, because so far storage has been of relatively short term and for relatively small inventories, the safety considerations in storage of waste have not been great in most instances, but it could quickly begin to dominate the safety considerations if longer term storage were involved.

One of the technical considerations that would need to be reexamined for extended storage would, of course, obviously be the siting. Some operations are sited in urban areas, densely populated, and they can operate quite safely. But with increased inventories of radionuclides that would be involved with extensive storage, we would have to take a more thorough approach.

Monitoring and surveillance would be another consideration to be sure that the waste is being contained and not leaking and is not susceptible to getting out into the environment.

Another kind of problem to be considered is repackaging of the wastes. Obviously, packages deteriorate with time. A great number of licensees, particularly the small ones, have specialized uses of radioisotopes, and their workers may not be trained to repackage the wastes and deal with the kinds of problems where they have a potential for spread of radioactive contamination. This would have to be seriously considered.

Fire protection would be an obvious and extremely important consideration in licensing extended storage. The single greatest risk probably would be from a fire which could result in release of the materials to the environment. Of course, we would have to review operating procedures and personnel training experience to assure they do the job safely.

Now with these technical considerations I would have to say that it is unlikely that all waste generators which we have licensed would qualify for extended storage of radioactive materials. In other words, we have small research laboratories, hospitals, universities and just a great variety of licensees that generate some kind of waste and which would not necessarily qualify for storage over extended periods.

I think there are two or three things that would limit the ability to issue a license for extended storage. I suspect that siting might be predominant, and a lot of licensees do not have a site suitable for storage of large quantities of radioactive waste.

In some instances simple physical dimensions of the licensee's facility may be inadequate to handle the inventory of waste that they would generate. Then, some licensees are very small operations, and they have a limited financial capability to provide adequate facilities for the storage of a large volume of waste, the necessary equipment and the training associated with safe storage for several years.

In addition to these technical considerations, there would be institutional issues that would arise with extended storage. Certainly if we consider licenses of a few years up to perhaps a decade, we would have to have some reasonable assurance that when the time comes the waste generator would be able to send the waste to disposal.

We would have to have some end point where we could say that if he generates this waste, ultimately he is going to be able to dispose of it or it appears that there is reasonable assurance that he can dispose of it. Somebody told me that one of the questions asked yesterday was: What constitutes reasonable assurance? I can't answer that with precision because we haven't been faced with that problem yet, and there are a number of policy considerations.

In my own opinion, I would say that certainly there would have to be legislation in place for the various States within a compact or within a single State to have waste disposal. Probably the State would have gone far enough to have plans for selecting sites or in the process of site selection gotten past the legislative problem and the political problems associated with it and be honing in on some method of disposal.

While they may not know exactly where the site may be, they would have to be far down the road in working toward that, and I think that we would need some sort of definite date by which the State has reasonable assurance that they would have a disposal capability in operation. That is my own opinion -- what reasonable assurance means -- and I can't really define it any better at this time.

In addition to that, it must be also considered that some of these licensees, particularly the small licensees, do go out of business and have their licenses terminated. Thus, there should be some sort of standby disposal capacity available for situations such as this.

Finally, there are the financial considerations. If the licensee is going to store large volumes of waste, there would be requirements to assure that some financial arrangements are made so that we know that when the time comes for disposal they will have the money to do it.

We have had licensees go bankrupt and monies just weren't available to dispose of the material to decontaminate facilities. As this problem increases and many of the small licensees go out of business for one reason or another, we would have to have some financial protection to assure that the waste can be disposed of and the licensee is prepared to pay for it.

I would like to note that, in general, if waste generators extend the storage of waste at their site, there is some increased risk: the risk of accidents and the risk of incidents. Exactly what that risk is, I can't tell you, but obviously when you have an inventory of radionuclides, particularly in the form of trash, there is some increased risk of an accident or incident.

That isn't to say that extended storage can't be handled safely, but I think we have to face up to the fact that there is some increased risk.

The other alternative for extended storage is, of course, to have some sort of central storage facility. In other words, a facility to which waste generators can ship their waste to be stored until some disposal method is established. This could be operated by the State or as a commercial enterprise. I don't see that either mode of operation would make much difference at least from the point of view of the technical considerations involved.

The technical considerations would be approximately the same for a centralized storage facility as they would for the individual waste generators. There would be some advantages, however. Certainly storage at a centralized facility would probably be less risk than having the individual generators store the waste at a number of sites.

The reason is that if you are starting with a central storage facility, you are starting with a new facility. You can optimize siting. It is a single-purpose operation, and you can design your facilities, your procedures and your fire protection for that single purpose, whereas the waste generator is not in the business to store waste. What is of central interest to him is either doing research or getting the product out the door.

A central facility might also more easily combine some volume reduction techniques that could be incorporated in the licensing procedure. This could be something like incineration or compaction.

There are, however, a couple of disadvantages to the centralized storage facility. The first and most obvious is that it will involve additional transportation and additional materials handling. These risks would probably be small, but they would not be zero.

Probably more important than that in the centralized storage facility is that it will receive packages of radioactive waste with little precise knowledge about the chemical, physical or radionuclide content of the material, and this could constitute some risk to the environment and to the operators of the central facility.

I will grant you that you can pass regulations that would have a paper trail specifying what is in the waste packages, but those records are only as good as people want to make them.

You may recall an incident down in Texas where they were processing scintillation biowaste that has very minor amounts of tritium and found that one of these packages contained significant amounts of strontium-90. That package wasn't supposed to be there and its processing resulted in substantial contamination of the facility and some significant radiation exposure for the working personnel.

In other words, if you are a waste generator, you know pretty well what is in your packages and you can take that into account. If you operate a central repository, no matter how good you make the documentation, there is always going to be some uncertainty involved with either the radionuclides or the toxic or pyrophoric materials that may be included with the waste.

From the licensing standpoint we are ready to receive applications for central storage. The technical issues are not all that much different from other licensing activities. We do have to address those institutional issues that I have outlined.

If we were to receive an application for central storage, we would undoubtedly require an environmental report, issue an environmental impact assessment and notice all these activities that go on with our licenses.

Having said this, I think probably I have just covered a very broad outline of the licensing considerations for storage. I understand you do have a number of questions. So I suppose we can get to the questions now.

Yes, sir.

MR. WILLIAMS:

Dan Williams from Illinois. What we are faced with is if the State can't ship after '86 to the other sites if they don't cooperate and DOE doesn't open their sites, it seems to us that there are two options, either store it where it is at or you come up with a central facility. So I have a couple of quick questions for you then.

One, I am not real certain on the NRC regulations. How long can licensees store presently? I don't have a license.

MR. CUNNINGHAM:

Okay. The licenses are issued for a period of 5 years.

AUDIENCE:

Could you repeat the question, please.

MR. CUNNINGHAM:

The question is: How long can licensees now store their waste under their licenses?

Licenses are issued, materials licenses such as those to hospitals, all except utilities, are issued for a period of 5 years. When we look at an application for a license, we ask how the wastes are to be stored and how they are going to dispose of the wastes, that is, where they are going to send it and how frequently.

So we expect licensees to follow what they said they are going to do in the application so that even if a license is issued for 5 years, if they say they are going to dispose of their waste by sending it out to a disposal company every 3 months, that would be the basis for our technical evaluation.

I am not aware of any licensee that has said that he is going to store his waste for 5 years, although it could be the case and we may have evaluated it on that basis, but it certainly isn't a large-scale practice at this time.

MR. WILLIAMS:

Would they have to amend their license if they plan to store it for a couple of years or would they be safe for the remainder of the license period?

MR. CUNNINGHAM:

The question is: Would they have to amend their license if they now decided to store for 5 years under their existing license?

It hasn't been a problem up till now. I would say that if conditions changed significantly, for example, if they had to expand storage facilities, or if the radionuclide content of their storage exceeded that which the license provides for, yes, they would definitely have to have their license amended.

MR. WILLIAMS:

It is not a problem now because sites are still open.

MR. CUNNINGHAM:

That is correct, and we haven't had to address this up until now because it hasn't been a problem, but we will have to look at it.

MR. WILLIAMS:

We need to do something right now instead of waiting.

MR. CUNNINGHAM:

That is correct.

Yes, ma'am.

MS. LYNCH:

Linda Lynch from Texas. What kind of storage facility are you speaking of? What is the exact structure, and will they include any type of compaction or volume reduction methods during this interim time? Are you talking about this big concrete bunker, or what form will it take?

MR. CUNNINGHAM:

The question is: What constitutes a storage facility? if I can paraphrase it. Again, there is no precise answer to the question because of the variety of radionuclides that our various waste generators use.

In a hospital, for example, it can usually be just a roped-off area with materials properly labeled stored in shields and allowed to decay there.

For production plants it may well be a special room dedicated for this purpose with special fire-protection procedures built into it and maybe even some monitoring procedures, like continual air samples and so forth.

The best answer to the questions is that you have to look at each type of operation on a case-by-case basis, and the sophistication of the storage facility will depend on a number of things, certainly the radioisotope inventory, the toxicity of the materials involved, the nature of the waste itself. In other words, is it trash that is subject to fires or is it material that is pretty stable, is it combined with unstable materials, toxic chemicals and so forth? You have to look at each one on a case-by-case basis.

That means that a lot of resources, both for NRC and the Agreement States, are going to have to be devoted to this if there is large-scale extended storage at each waste generator site.

MS. LYNCH:

Equally if any compaction or volume reduction would be considered, it would also be individual, if at all?

MR. CUNNINGHAM:

Yes. You would have to consider volume reduction as an individual operation at each site. Again, there are safety considerations depending on the type of material, where you are reducing the volume and the process.

We consider compaction as an obvious volume reduction procedure and, depending on the type of compactor, you might or might not have problems.

Another volume reduction procedure, or at least we consider it as such, is incineration. Siting for incineration is important, as are the radionuclides involved, and some assessment of what happens to those materials that go out the stack.

Yes, sir.

MR. DORNSIFE:

If NRC were to receive an application for a facility, an aboveground facility like the above ground vault that was conceptually designed by the Corps of Engineers, how would the agency review that facility? Would it be reviewed as a storage facility? I am talking now that it is designed for a hundred years let's say. Would they review that under criteria for storage or disposal or both?

MR. CUNNINGHAM:

The question is: If the NRC received an application for an aboveground facility, probably a substantial structure that is designed to have a life of a hundred years or so, how would we consider it, as a storage facility or a disposal facility?

Well, of course, the first part of that is easy to address. How does the applicant propose it in his license? Does it propose it for storage or disposal? I think that is up to the applicant to say what he intends to do with it. We can't tell the applicant what his intentions are.

Now obviously if he intended it to be a disposal facility, there would have to be some evaluation of the likelihood of the facility lasting over the period in question for the decay of these materials until they reach innocuous levels. Again, if you are operating an extensive central facility, you will get radionuclides in there that have fairly long half-lives measured in decades or centuries.

Just by rule of thumb, if you think they have to go through about 10 half-lives of decay, you are talking about a facility that would have to last a very long time, and I think there would be substantial questions about the ability to project that such a structure last over centuries.

MR. DORNSIFE:

Would you use some of the criteria for storage though like fire considerations?

MR. CUNNINGHAM:

Yes. I think those protection procedures that are associated with minimizing risk of accident or incident would apply either to storage or disposal by decay in an aboveground facility. I don't think that would look much different.

Yes, sir.

MR. DUNKLEBERGER:

I am Jay Dunkleberger from New York. What NRC or potentially Agreement State licensing requirements would apply to storage at a nuclear power plant of low-level waste from another plant, another nuclear power plant that did not have its own capability, and similarly waste like Class B or Class C waste from a facility such as Union Carbide's medical projects division that might need storage? If they were stored at a nuclear power plant, what licensing requirements might apply there?

MR. CUNNINGHAM:

The question is: What licensing requirements might apply if waste were transferred from a number of waste generators to a reactor facility for storage? I have paraphrased it a little bit, but I think that is essentially what you have in mind.

The licensing would be under Parts 30, 40 or 70, depending on what radionuclides are involved. In the first place, it would have to be clear that that license or the storage operation would have to be separate from the plant operation and the safety associated with the plant operation. In other words, the storage facility could not be a contiguous part of the plant operation, although safety personnel may be the same.

The licensing considerations would be the same as a central storage facility. It is just a question of where you are locating it. Of course, if it were on the reactor site, you would have to have the utility agreement to do it, but you would look at it exactly as you would look at a centralized storage facility that is located somewhere other than a reactor site.

You would have some advantage, some technical advantage in that you will have examined all of the methodologies associated with siting and may save some cost, but that is about all.

MR. DUNKLEBERGER:

I guess my question relates to: If a utility had a large storage facility on site, could that facility be used by another sister plant of that utility at a different site, and, if it was, would it be licensed by the NRC or would it be licensed by an Agreement State, or would we have to build an extra facility outside of the fence?

MR. CUNNINGHAM:

The first part of that question is: If you have a utility with storage capability, then can another, let's say one utility and two reactors to make it simple, reactors located at different sites, could the one reactor ship to the second storage location?

If that facility were operated under 10 CFR 50.59 of the reactor license, I am not sure of the answer; I would have to talk to reactor people. I suspect that the answer is no, unless there was a license amendment because all of the environmental assessments associated with that reactor license were probably limited to the operation of that reactor at that location. So as a minimum, there would have to be another environmental assessment.

Let's see, the second part of your question.

MR. DUNKLEBERGER:

Would it be licensed by the NRC or by an Agreement State or would it have to be a separate facility outside the fence?

MR. CUNNINGHAM:

If it were issued under our materials regulations or those of an Agreement State, and if it were separated from the reactor operations and separated from the reactor license, as I am sure it would be if you were taking wastes from other waste generators, then it would be licensed by the NRC if it is in a non-Agreement State, and as far as I know, it would be licensed by the Agreement State if it were in an Agreement State.

Yes, sir.

MR. EISENGREIN:

Bob Eisengrein, a Representative from New Hampshire. To get back to the disposal versus storage question, your definition of disposal is relating, as I understand it, to when the material becomes innocuous, to use your words. Is that how you consider disposal?

MR. CUNNINGHAM:

No, that is not correct. I did not define disposal. I defined storage.

MR. EISENGREIN:

Would you define disposal then for me?

MR. CUNNINGHAM:

My definition of disposal would be putting it at some location in some form, whether it be shallow land burial or bunkered storage, as you have discussed here, with the intention of leaving it there and not subsequently transferring it to another location for disposal. In other words, you are going to put it there and you are going to leave it there.

The material will not be innocuous at the time you dispose of it, but the presumption is that it will stay there until it indeed becomes innocuous. You are not going to retransfer it at any subsequent time for purposes of radiation protection.

MR. EISENGREIN:

A quick followup. It sound to me then that one could have 50 to 100 years' storage and your intent is to leave it there until it becomes innocuous if it is 150 to 200 or 300 years.

MR. CUNNINGHAM:

The question was that you could store material for decades or a few centuries until it becomes innocuous and that could be disposal. The answer to that is yes, it could be.

Certainly we license and we have for many, many years licensed hospitals to hold their radioisotopes that are used in the treatment of patients until it decays to innocuous levels.

Now the types of radioisotopes mainly involved in medical diagnosis therapy are those that have a relatively short half-life, usually less than 35 days. That is just because of the way things go.

The problem you will run into is that there are probably, aside from the relatively short-lived radionuclides like technicium and some of the iodines that are used in medical work, that there is a big gap between short-lived radioisotopes and many of the radioisotopes otherwise used in industry and in research.

For example, you may find wastes with carbon-14 and tritium, and tritium has a 12-year half-life approximately and carbon-14 goes up to 5000 years half-life, although these are not very radiotoxic materials. But when you start running into the actinides, transuranic materials that have half-lives of centuries, then you cannot say that they are going to decay to innocuous levels in a few hundred years.

If you operate a centralized storage facility, it would have limited utility unless it can accommodate a large range of radionuclides.

MR. CARTER:

Just a comment perhaps on Ontario Hydro's experience operating central long-term storage. It is very important that your operating organization has that as their primary delivery function. That is their business to operate the waste processing and waste storage facilities. That is their No. 1 job.

It is different if you are talking 2-year storage at a plant, but most of us like to get the garbage out the door, and no matter how hard you work, out of sight out of mind. So, therefore, if you want it done properly on the long term, say 50 years, which ours is licensed for, you have to have an operating organization that feels that is an important job. That is their job and they do it with a high degree of care and attention.

MR. CUNNINGHAM:

I certainly agree with that because if you talk about centralized storage, there is an element of risk involved and the job has to be done properly by people who are dedicated to making sure that the job is done properly.

When you have people that are storing waste which they generate, they are interested in the product they are getting out the door or the research they are doing. Waste is something that they have to take care of if forced to, and it is not their primary mission.

Yes, sir.

MR. WILLIAMS:

Dan Williams of Illinois. A two-part question.

No. 1, if an application comes in 6 months from now, how long do you think it will take to approve a license request for a State interim facility?

MR. CUNNINGHAM:

The question is: If an application comes in 6 months from now, how long do we think it will take to approve an interim storage facility? Of course, I can't give you a precise answer on that. It will depend on a number of things.

First, the time over which you plan to use this central storage facility. The structure and the siting is not very complex in itself, except if we get into storage for centuries, then you run into some real engineering questions.

Obviously, in a central storage facility we would do an environmental assessment, and that will require a report from the applicant, and we would notice these reports. If we got into a hearing where substantive issues were raised, it is open ended as to when we could resolve it.

The other part of it is that the length of time it would come out in the environmental assessment and possibly in litigation was what kind of statement the State could make about ultimate disposal of the material, financial protection and that sort of thing.

I think that the technical part of it if we are talking about storage over a relatively short term, a few decades maybe, the technical part is not that difficult. The issues that will come out will center on institutional and possibly on the environmental issues and litigation associated with that.

MR. WILLIAMS:

So can you say from 3 to 5 years?

MR. CUNNINGHAM:

If we have a storage facility that is to be used for say 10 years and evaluated over that time, the technical part of the evaluation would be relatively simple, and I think if the application was a good application, we could do it in less than a year.

The environmental report though and its publications would take at least a year when you go through all the administrative processes. Then if there is litigation, that becomes open ended.

The other part of it is that I do not know if there would be policy questions raised, and it depends on how the State proposes to address these institutional issues that I just don't have a good feel for at the moment.

MR. SALTZMAN:

I think we will take one more question because one of our chairmen has to make a close plane connection.

MR. KUCERA:

I have got a quick question. I want to try and get back to this above ground disposal. You are probably familiar with the suite of isotopes you would get and ion exchange resins and filter sludges from nuclear power facilities. If you were going to design an aboveground facility just for those wastes, how long would the NRC want it to demonstrate containment integrity in order to be able to call that disposal, how many years given that suite of isotopes?

MR. CUNNINGHAM:

What isotopes are in there, carbon-14?

MR. KUCERA:

Well, you have got cesium and strontium.

MR. CUNNINGHAM:

If you have got cesium and strontium and if you have a leaker where you have some transuranics, like plutonium, then I would say it would become very difficult to say that the bunker will last over the period of decay of the plutonium, but it depends on a lot of things. It depends on a lot of things. It depends on how you control what goes into that.

MR. KUCERA:

Well, the reason I ask is because all of us States are grappling with this issue on whether or not it is disposal or storage, and it would be good to have some clear guidance from the NRC on this. If there is no way that you can improve something that has those reactor wastes as disposal, if you would tell us that, that might at least help us to move off the dime in looking at these alternative technologies.

MR. CUNNINGHAM:

Well, I am really not prepared to say that you can't build a bunkered storage facility and entomb waste eventually and that it won't be safe. I don't know. We haven't done it, and we haven't looked at it. I am sorry, but I just can't answer that question.

MR. SALTZMAN:

Thank you very much, Dick.

6. INDIVIDUAL WORKSHOPS

The procedures for conducting the four individual workshops were developed by NRC in consultation with the State workshop chairmen and rapporteurs. The resulting final workshop instructions for chairmen and participants are described in Appendix E. The wall charts used in deliberations were transcribed and then edited by the rapporteurs for the benefit of all. These represent a group memory and can be used for reference. The wall charts, which are in Appendix E, include:

- modified technical, economic, institutional and sociopolitical factors;
- advantages and disadvantages for shallow land burial and alternative disposal technologies;
- data and information needs identification; and
- methods for selecting a disposal technology.

Also presented in Appendix E for the four workshops is the factor rating in terms of importance (Figure 3) and the factor rating in terms of impact for each of the three technologies (Figure 4). All data for these figures were independently verified by NRC staff to assure accuracy and changes. A few minor changes were made.

The discussion surrounding the wall charts and the factor rating formed the basis for the final State reports that are presented in the next chapter.

7. STATE ANALYSES

7.1 Purple Workshop - Lee Jager, Chairman

MR. SALTZMAN

We are now going to get to the chairmen of the various workshops. Lee Jager has a plane connection to make and he has asked to go first. So if we could hear from Lee, please.

MR. JAGER:

I have appreciated all of the speakers that came with prepared text and had 150 copies waiting. I have one text available as opposed to the previous speakers and the first person or a waste basket will get it.

The purple group was assigned, in addition to shallow land burial, which all groups were assigned, the technology dealing with aboveground vaults and earth mounded concrete bunkers.

The group began, as I assume all the groups did, in discussing the advantages and disadvantages of the proposed factors.

In the technical group we added a factor that was identified as development or demonstration of experience to build public confidence.

In the second grouping, economic, we added no factors.

In the group, institutional, we added three factors, risk assessment, education capability, building management capability, and building confidence in the postlicensure period (surveillance and enforcement activities).

In the social/political grouping, we added three factors, public understanding of risk benefit, public acceptance of the risk benefit and the public acceptance of the technology.

Once we had that behind us, we went on with the agenda and applied the factors. In looking at the results and rating the factors in terms of their relative importance, protecting people from radiological and other environmental hazards clearly were considered most important by the group. In fact, if you would just go down and summarize the votes, so to speak, the protecting of the public from radiological hazards was the No. 1 factor. It was listed as "critical" on all the sheets except one on which it was "important." So out of our 12 voters it received almost a unanimous "critical" vote, the very highest vote of any of the factors.

Protection of the workers was the next highest concern and protection of the environment was the third highest concern.

It was interesting that our group found a slight but noticeable difference in terms of the importance of these factors if they are related to radiological concerns as opposed to nonradiological concerns.

The first concern would be protection of the public from radiological hazards and the second concern would be to protect the public from non-radiological hazards associated with the technology.

Social, political and institutional factors were also important and received generally "important" votes, but there was a noticeable step down in the level of importance from those relating to protection of the public and workers and environment.

And least important, I guess predictably were the economic factors. Interestingly, not only were they the least important (based on total score), but also the most inconsistent in terms of scoring. Scores on these factors ranged from "critical" to "not important." Perhaps it indicates the mix of backgrounds represented in our group.

I think it is fair to say that the opinions were heavily weighted towards State representatives, a mix of State legislators and State agency people.

In our group the observers also participated in the survey, but they were definitely in the minority.

In the exercise of applying the factors, although we have not had enough time to do justice to evaluating the results, it seems fair to draw some conclusions from the data.

Specifically, the health and safety issues for the general public definitely leaned towards technologies that did not incorporate shallow land burial (again, our alternative technologies were aboveground vaults and earth mounded concrete bunkers).

Although we had some confusion on the meaning of specific terms, it seems fair to conclude that most of our participants feel public health would be better protected by a disposal facility constructed aboveground than one buried in the ground. This is especially true of the earth mounded concrete bunkers.

Our group felt a greater concern for workers with alternative technologies than the technology of shallow land burial. That was previously mentioned by a couple of speakers at this conference, which may have influenced the ratings.

Our group felt that public perception of risk is greater for shallow land burial than for either of the other two alternatives. Again, rightly or wrongly, the public thinks there is greater risk.

Our group also felt that there would be greater problems with licensing the alternative technologies as opposed to shallow land burial.

That completes the result of our survey.

The other exercise that we went through was to identify the process by which we as State representatives would select a technology. That discussion eventually included a discussion as to what types of information we might need that would lead to technology selection. Our group spent approximately one-half hour on this issue and identified the following factors relating to selection of technology or to information needs prior to selection of technology.

(1) Establish a development group and identify the regulatory agency as information resource very early in the process.

(2) Process selection should focus on development groups for consensus building and cross-representation of all interested parties, including citizen involvement, legislative involvement, agency involvement and so forth.

(3) Characterize the waste stream based on the total hazard, not only the radiological hazard.

(4) Access to generic cost-benefit and risk analyses to identify costs, benefits and risks for all of the available alternatives.

(5) Design an open, publicly accessible process such as the NEPA process, but not necessarily the NEPA process.

(6) Establish site-screening criteria which include regulatory criteria and a site-screening process.

(7) Develop good communication tools to present conceptual designs to non-technical people. If there are no operating facilities to use as examples, models should be constructed so the public knows what they are going to buy.

(8) Field visits for people who have decisionmaking responsibilities and are in positions of recommending technologies. Effectively communicate to non-technical people what it is that the technology will mean to them.

(9) Explore and identify community improvements as incentives.

(10) Address safety issues on a technology basis as community incentives. In other words, which of the technologies are greater or less safe to the community.

(11) The last factor that we had time to identify had to do with establishing regulatory needs on a technology-specific basis. In other words, are the regulatory agencies capable of implementing the type of monitoring, surveillance and enforcement necessary for the particular technology that might be selected?

That was our work group.

MR. SALTZMAN:

Are there any questions for the group Mr. Jager headed?

(No response.)

7.2 Red Workshop - Dante Ionata, Chairman

MR. SALTZMAN:

Let's see, I think Dante Ionata is in the room.

MR. IONATA:

I am.

MR. SALTZMAN:

You are. Where are you? There you are. Perhaps you could give the report for the red workshop.

MR. IONATA:

The red workshop spent a few minutes on discussing the adequacy of the basic important factors that are essential to developing and licensing an alternative technology.

We agreed, I think, that the list developed by NRC and which was the basis for a lot of discussions was an excellent one, but we suggested some new ones.

Under technical we suggested the addition of a factor that would be called risk management, and by that we mean a factor that would ensure that the overall system, whatever the system is, whatever the technology is, is easily understood by the operators, is easily and reliably controlled by the operators so it can be operated effectively and so that the risk of accident is reduced.

Also under technical we suggested a factor called types and forms of waste, a factor which would go toward ensuring that the appropriate type and form of waste is disposed of in the appropriate disposal system, in other words, a matching of waste type and form to the system to be used.

Under economics we suggested a requirement that the operator of a new alternative disposal system must be able to obtain insurance.

Under institutional we suggested two new factors, quality of management and quality of regulatory oversight. They are interrelated and probably cannot be separated. What we meant was the manager of a disposal system, of whatever type, must have the capability to operate it properly, competently, and that the method of obtaining that objective would be good, tough, regulatory oversight.

Now in our discussion on advantages and disadvantages of each of our alternatives, and we talked about augered holes and earth mounded concrete bunkers, we skipped around a bit. We made no attempt to discuss both of our alternatives with respect to all of the factors. We tried to confine our discussions to those that we thought were more important.

We decided fundamentally that in the Northeast/Midwest environments it makes more sense to talk about augered holes with a liner. With respect to augered holes, we generally found I believe under technical that augered holes are superior to shallow land burial (SLB) with respect to protecting the public, with respect to protecting workers, with respect to risk management and with respect to inadvertent intrusion.

Concerning the economic factors we found that augered holes were a disadvantage in relation to shallow land burial because of more extensive land needs, because of higher operating costs, slower rates of disposal and higher costs. But in terms of financial risks we found them to be a wash.

With respect to consumer costs, again we found that augered holes are probably a disadvantage because of higher costs.

With respect to institutional, I think we kind of decided that augered holes were at a disadvantage with respect to SLB because of longer licensing times at least for the first one, since a licensing program would have to be developed either by NRC or by the Agreement State.

Under land use control, for instance, nonradiological State regulation, a negative because of greater land needs.

With respect to earth mounded concrete bunkers, as they relate to the technical factors, the workshop concluded that they were more effective than SLB in protecting the public from releases and in protecting individuals from inadvertent intrusion, but we found that they probably were a disadvantage with respect to protecting individuals because of the requirement for more handling or extensive handling of wastes in the earth mounded concrete bunkers (EMCBs).

There was a feeling that, with respect to stability of a disposal site after closure, there was a potential for instability in the middle levels that formed the tumuli.

With respect to status of technology we found that there is a substantial library of data, so that they wash out with SLB, but probably are at a disadvantage in terms of site availability.

With respect to waste types and forms, one of our new categories, we felt that EMCBs were at an advantage because they can handle a greater variety of waste types and forms.

Under the economic categories, more expensive to operate and therefore at a negative, or a disadvantage, but probably easier to close.

At a negative with respect to the consumer elements because they are more costly.

Institutionally, probably at least for the first one, longer to license. I guess that is probably true of all technologies and therefore a disadvantage.

With respect to the sociopolitical factors concerning public acceptance of transportation risk, there was some discussion that since earth mounded concrete bunkers would force a volume reduction, there might be a plus or and advantage as far as transportation was concerned because there would be less stuff moving toward the facility.

I think our discussions on sociopolitical factors and public acceptance of risk were inconclusive as they related to SLB and augered holes.

In our decisionmaking segment I think we came to the conclusion that the best way or the optimum way to obtain approval for a new technology would be to first fully develop design and engineering concepts that would adhere to minimum performance standards and then move to the public forum carefully integrating other public concerns.

We discussed a number of other things, and we had a fairly extensive discussion on whether or not there should be volume reduction, and everyone without surprise agreed that they should, that we should in some way move toward volume reduction.

There was a fairly widespread feeling in our workshop that retrievability ought to be a part of disposal systems in the Northeast/Midwest. We didn't quite get to the point of saying that NRC ought to license long-term storage, but we had a feeling that the concept of retrievability would be more publicly acceptable.

We on our ratings, our rating sheet showed that the workshop overwhelmingly believed that the performance objectives were critical. Most agreed that they were critical or at least important factors.

When evaluating shallow land burial against the technical factors, we split on whether SLB is favored or inhibited, but when we evaluated augered holes and EMCB, we felt that the alternative technologies were favored concerning the performance objectives.

In looking at the status of technology, the license time frames were important. As far as the augered holes and the EMCB were concerned, these would be inhibiting factors because we simply needed more R&D there.

Under economic considerations we felt that the economic considerations were important, but not critical factors, except in the area of closure and stabilization and institutional control costs.

None of the technologies, whether SLB or whether EMCB, would be disqualified by any of the economic considerations, although for the new technologies the workshop was undecided, was unsure as to whether economics favored or inhibited. We were split and the votes were all over the place there as to whether alternative technologies were favored or inhibited by economic considerations.

There was an extensive discussion in our workshop, and this may have been due to the fact that we did not have sufficient cost information. Most felt that institutional factors were important and that they would inhibit the new technologies and favor shallow land burial.

Under sociopolitical factors most felt that these were important, if not critical, that these factors would inhibit SLB, but favor augered holes and shallow land burial.

Under data needs we felt that more data needs to be collected concerning the type and performance characteristics of backfill materials for augered holes, that we need more data on performance characteristics for liners for augered holes, for engineered materials that would be used in EMCBs, and we also recommend that the available cost data be pulled together to provide guidance to us concerning these since there is apparently very substantial costing data available concerning both of these particular technologies.

MR. SALTZMAN:

Thank you, Dante.

Are there any questions for this group?

(No response.)

MR. SALTZMAN:

Thank you very much.

7.3 Blue Workshop - Kevin McCarthy, Chairman

MR. SALTZMAN

Here is Kevin McCarthy and I see Don Schott. We will take Kevin first and then Don.

MR. McCARTHY:

The Blue Group analyzed shallow land burial, as everyone did, aboveground vaults and belowground vaults.

I would like to start out by thanking the participants that were in our group and our NRC resource person, Dean Kunihiro, and Rich Smith the rapporteur. Both did a fine job.

We also started, as everyone did, by reviewing the factors that the NRC provided for us. We didn't delete any. We did, however, add a few.

One was the ease of establishing and maintaining an environmental monitoring program at each of the sites. We wanted to determine if there was a difference in the monitoring program requirements.

Then we added the ability to model. We wanted to know more about the other two sites and we felt that the modeling capability would provide that to us.

We also wanted to add the ease of retrieving or retrievability as a factor, and these are all technical factors; the ability to survive disasters was also an added factor.

For the economic factors we wanted insurance availability. Is one technology easier to insure than the other technologies?

Institutional, we wanted additional information or an additional factor on RCRA since some of the disposal technologies provide for easy RCRA compliance. We felt that both the aboveground and belowground vaults will allow easy RCRA compliance.

In sociopolitical, the differences involved property values; in other words, will the aboveground vault change adjacent property value more or less than the shallow land burial.

Also, we got into host community compensation, depending on whether it was an aboveground or belowground facility.

Then we talked about the advantages and disadvantages. We had quite a general discussion on that, and in the discussion two issues were discussed to a greater extent than the others. The cost of remedial action was one of these. We felt that in the aboveground vault, remedial action would be easier to take than in either of the belowground situations.

Also, retrievability as it applies to both the aboveground and belowground vaults. We started off assuming it would be easier to retrieve from the aboveground vault and then someone else pointed out well, that applies to the belowground vault also. So we still have a difference of opinion on how retrievability applies to each option.

Another aboveground disadvantage would be the loss of geological protection, the soil. An advantage, however, would be the RCRA requirements would be easier to adhere to.

Two disadvantages, that is disadv[illegible]es for both the aboveground vaults and the belowground vaults were [illegible] ditional time required for licensing. We also felt that the increa[illegible] associated with each of the alternate technologies was a disadvant[illegible].

For data needs we need more information on the alternate technologies, including the technical benefits of alternatives such as the lower migration rates, construction of roofs for all weather operations, the feasibility of roofs, and that would also apply to shallow land burial in certain climates, the feasibility, the need, the cost, et cetera.

We need a "comprehensive systems approach" which will result in the optimal use of various alternative technologies, and we all agreed that that says it all.

We need worker protection modeling for each type of technology. We need a study of the nonradiological hazards and a comparison for each of the technologies involved, a cost-benefit analysis, and that would go along with the comprehensive systems approach which would result in an optimal use. That would include cost.

We agreed that we need public opinion polls, and that is a hot one.

We need criteria for the aboveground sites. Right now we feel we don't have that criteria, and that was pointed out earlier, and the availability of insurance information. Those were additional data needs.

After extensive discussions, we went on to Figure 4, the comparison of the three technologies. In the realm of technical factors we did not disqualify any of the three technologies.

In terms of 10 CFR 61 belowground vaults is favored, except for worker protection.

Site availability: Shallow land is clearly inhibited. We felt that it would be easier to site either of the other two alternate technologies in terms of site availability.

Economics: Generally, economics favored shallow land burial over both the aboveground vaults and the belowground vaults. Conversely, economics clearly seemed to inhibit the aboveground and belowground vaults. And we had almost identical results between aboveground and belowground in terms of economics -- inhibits.

The economics of both closure stabilization and institutional control slightly favor belowground vaults. They were both inhibited, but we did have a slight difference.

Institutional: The institutional factors of both the Federal and Agreement State regulations clearly favor shallow land burial over both the aboveground vaults and the belowground vaults. However, when it came to the nonradiological State regulations, the belowground vaults are slightly favored over both shallow land burial and aboveground vaults.

Sociopolitical: The sociopolitical factors clearly favor both the aboveground and belowground over the shallow land burial. Conversely, sociopolitical inhibits the shallow land burial over both the other alternatives.

Between the aboveground and belowground vaults, generally, except for the public acceptance of transportation risk, the belowground is slightly favored.

That is all I have.

MR. SALTZMAN:

Questions anyone?

(No response.)

7.4 Black Workshop - Don Schott, Chairman

MR. SALTZMAN:

Okay. Finally we have Don Schott from the black workshop.

Don.

MR. SCHOTT:

Well, we were the workshop of people that drew black spots on our name badges. So I don't know whether that was a good sign or bad sign, but we seemed to make it through all right.

First, I should start out by saying that we had as our technologies shallow land burial, belowground vaults and mined cavities.

Like the other people, we started out going over the factor sheet and trying to do some additions and deletions, and we had several additions to the sheet.

First of all, on the technical side, as a technical factor that we added to the list, ease of remedial action. Another technical factor that we added was waste form restrictions, and a final technical factor that we added was the technical factors under 40 CFR and other Federal requirements that may or may not apply to any waste facility or disposal facility.

Under economic or cost considerations we added several factors. Waste treatment factors, how much it would cost to treat waste before it could go into a certain disposal technology.

Regulatory costs, we thought there might be some difference in regulatory cost between the different types of technology being discussed.

The cost of potential remedial action again may differ depending on the technology.

In addition, we made a change to the list that was here regarding the cost to electrical utility customers and other customers, and we thought we should break that down. There was a general feeling that the effect of the cost on utility customers would probably be less than the effect of the cost on other customers in medical and industrial uses.

Finally, we added in here as a cost the cost of an incentive package that might have to go along with any type of disposal facility and perhaps that might vary with the type of facility. By incentive package we meant the incentive package that would be offered to the State or the locality that would be siting or hosting the institution which is allowed under some of the compacts.

Under institutional factors we decided under the Federal regulation to add time and willingness of the NRC to develop any appropriate regulatory structures or changes that might have to be made to accommodate some alternative technologies.

We also added the number of Federal agencies that might be involved. There is a lot of discussion now about what role, if any, EPA will have, but we thought we should just put that down as a factor. Depending on what type of technology was chosen, there might be a different number of Federal agencies involved.

Finally, we thought we would add a new category -- compact regulation. Since we dealt here with Federal and State regulations, we thought since many of the States will be dealing with this through compacts, that should be added also.

Finally, in the sociopolitical we again changed the list here somewhat. We didn't quite understand what was meant by perceived versus real risk. So we just broke that down and made perceived risk one category and real risk another category. The same with State versus local consideration of risk, we treated that as two separate categories, State consideration of risk and local consideration of risk.

We deleted the transportation risk categories under the thought that that wasn't probably very technology dependent. As far as we could see, regardless of the technologies we were looking at, the transportation issue probably wouldn't change very much.

Finally, under the socioeconomic impacts we added property values, as the effect on property values is another consideration.

To quickly run through some of the pros and cons that we identified under the three technologies we looked at.

Under shallow land burial we thought it was a pro that the Federal regulatory structure was already in place, that shallow land burial would have less expensive up-front costs and that by up-front costs we meant the construction costs, capital costs and so forth.

We excluded in that, and we had some discussion about legal costs, and we excluded legal costs in that. There was a group in our workshop that felt that shallow land burial would promote more litigation and, therefore, that it would be more costly because you would end up spending more time in court and spending more time and money on litigation.

There was another element in our workshop that felt litigation was going to come along with any technology that was decided upon and that you should just figure litigation costs across the board for all the different technologies. So we really didn't reach a conclusion on that, but there were two competing points of view.

We also thought it was a pro for shallow land burial that there would be lower worker exposure, protection from natural disasters, the plane crashes, tornados, et cetera, and also the fact that time for getting a shallow land burial site on line would probably be less because of the regulatory structure already being in place.

Finally, we thought it was a pro that since it is underground you are not going to have a visual impact for a shallow land burial site.

Some of the disadvantages, however, of shallow land burial are that it is very land intensive, and the past technical problems and the past bad history with shallow land burial, I think, were felt by everybody to be a very major disadvantage of that technology.

The ease and cost of remedial action were felt to be disadvantages because it would be very costly and not very easy to take remedial action when you don't have the material contained very well.

The fact that site suitability might be very difficult. There might be regions and areas that just are not appropriate at all for shallow land burial facilities.

Some of the nonradiological hazards might be a problem with the toxic nature of some of the waste and so forth.

Waste treatment and pretreatment might be a disadvantage and that it might be more appropriate to do a greater amount of waste pretreatment in a shallow land burial facility than in a more engineered facility.

A shallow land burial facility may very well not be appropriate for all types of waste. So we thought that was a disadvantage.

Probably again the biggest disadvantage had to do with public acceptability and extensive litigation that some people thought would be associated with any attempt to go with the shallow land burial alternative.

For the belowground vaults we thought an advantage of belowground vaults would also be lower worker exposure. We recognize that that was in contradiction to some of the technical information we had been given yesterday, but I think it was the sense of most people in the workshop that there probably are ways that the waste could be handled and different operating procedures and technologies that could be developed that could reduce the amount of worker exposure with belowground vaults to make it comparable to that of shallow land burial.

We also thought there was an advantage that because you had an engineered barrier in addition to the soil barrier, that you would have greater groundwater protection. Another factor that was brought up when we discussed this is that these advantages or these pros for a belowground vault are only if you assume that you are putting the belowground vault in the same place that you were going to be putting a shallow land burial site.

There was some concern that there would be a temptation among people to say that since we are going to have these concrete, or whatever kind of liners, we can put this facility on a site where we wouldn't put a shallow land burial and the net result of that is you don't end up with any better site.

So these are advantages that only apply if you actually put that belowground vault in a place that has the same qualities as a shallow lard burial site might have, and so then it is a pro in comparison to shallow land burial.

We thought remedial action would be a little bit easier and cheaper because some of the waste would be compartmentalized. Protection again from tornados and plane crashes again would be an advantage of belowground storage and also greater intruder protection and public acceptability.

On public acceptability we thought it would be greater from a Statewide perspective, but not necessarily from a local perspective, and that local people would probably be in opposition to whatever technology was developed, but there might be greater public acceptability on a Statewide level for a belowground vault.

Disadvantages or cons for the belowground vault were the cost of developing and operating the procedure because it is a newer technology and we don't have some of the background that exists with shallow land burial, the lack of operating experience.

Also seismic susceptiblity we thought to be a potential disadvantage. The fact that the technical regulations and guidelines are not in place, and there might be some waste packaging requirements that would go along with belowground vaults that would be somewhat expensive, and, finally, it again is land intensive like shallow land burial.

For mined cavities we thought one of the biggest pluses for mined cavities is that it seems to meet all the performance objectives for public protection as well or better than the other technologies. Also, it is good protection from intruders, and of course protection from plane crashes, tornados and that kind of thing, and also seems to have a higher amount of public acceptability.

The cons that we saw are that cost seemed to be more expensive, remedial action might be much more difficult, site suitability is obviously a drawback because there are only so many abandoned mine shafts that would be appropriate for this kind of technology. Worker exposure would probably be higher. Again the lack of technical regulations, and, finally, the time for developing the appropriate regulations and licensing procedure would probably be longer.

Then we discussed some information needs, and I guess I got the sense from our workshop that this was probably the area that people in our workshop felt was most important and that there are a lot of information gaps and a lot of places where we just wished we knew more both in technical and in other kinds of information.

For all of the technologies we thought one big outstanding gap that we have is the long-term isolation capabilities of the technologies. Even with shallow land burial we only have 30 or so odd years of experience and not all of that experience has been positive and we have no experience under a shallow land burial facility that has actually been licensed under the Federal regulations that now exist. So there just is not very much information there on long-term isolation capabilities.

In addition, some other technology-specific things were lacking for shallow land burial, waste packing options and some engineering barrier options that could be used under shallow land burial before you actually get to one of the other alternate technologies.

On belowground vaults and mined cavities we also thought we just don't have very much cost information that exists and we don't have a very good clarification of the Federal role, both in regulation and also in research and development.

Probably more importantly though is we made a category of just general information that we don't have. Particularly in the area of alternative disposal technologies, we need some assistance in compiling, summarizing and distributing the information that does exist.

We hear a lot about experiences in Canada and in Europe and so forth, but I think our workshop felt there was not a good grasp that we had yet on what those experiences have been and what kind of technical knowledge, cost information and so forth can be gained from the experience that already exists in other countries.

In addition, there is not very much information on alternatives to disposal. That was talked about a little bit in some of the meetings that we had yesterday, the lectures that we had yesterday, but there is still not very much information on what alternatives do we have besides disposal.

Someone suggested that more meetings like this would be helpful. That was fairly early on in the workshop and maybe they changed their mind by the end. I don't know.

(Laughter.)

Again, some talk about the need to clarify the Federal role, maybe a regulatory roadmap somebody suggested, so that States or compacts going through the licensing process would have a better idea of what is going to be expected of them in going through these steps.

We got into the factor rating system, and I think what I would like to do is not spend a lot of time giving you our results on each one of the factors because they are not all that different than some of the results that have been reached in some of the other places. Also, particularly in the Figure 4 where we had some problems, people didn't really feel that for a lot of the categories they had enough information to fill out some of the information, particularly with mined cavities. A lot of the people in the workshop felt they didn't have enough information to really know whether a certain factor was a plus or a negative with a mined cavity.

But there are a couple of things that we did pull out from the results of the sheets that I thought would be important to share with you.

First of all, there was great general agreement on the critical factors being the performance standards, those four technical standards, protection of the public, protection of workers and so forth, that were listed at the beginning of the technical factors. There was wide agreement on those as being very important critical factors.

Also the public acceptance factors, the local and state risk factors and the acceptability factors were considered to be very critical factors.

When we looked then at the Figure 4, those were the factors that belowground vaults did very well in and that shallow land burial did very poorly in. In other words, the people in our workshop felt belowground vaults would do very well in meeting the performance objectives and in satisfying some of the public acceptance concerns and that shallow land burial did very poorly in both of those.

We also noticed that of the 45 different rating factors we had, 23 or half of those rating factors, there was a direct dichotomy between people's responses regarding shallow land burial and belowground vaults. In other words, if they felt a particular factor favored belowground vaults, more often than not they would say for that same factor that it was something that either inhibited or disqualified shallow land burial.

In addition, for shallow land burial, the public acceptance factors were considered by many people as absolutely disqualifying shallow land burial.

Finally, for the cost and economic factors we found, as I think the other workshops found, that people considered these somewhat important, but certainly not falling into the critical or important category.

Finally, I would just like to share with you some of the thoughts that came out in our discussion of the decisionmaking process.

For the States that were involved in compact negotiations, I think the feeling was pretty strong in the workshop that the decision on what kind of technology should be chosen would really be a decision that the host State ought to have the major role in deciding and not something that the Compact Commission should be able to decide on its own.

Another thing that we discussed was really two different ways that a host State or compact could go about selecting a technology.

One would be to have the government unit actually make that selection looking at all the different technologies and saying we are going to dispose of waste in this kind of facility or that kind of facility.

Another method would be to have the State or the compact region put together a very detailed set of objective performance objectives, and it was suggested that something somewhat more detailed than 61 CFR would be needed, but then allow developers to come in with suggestions as to different types of technology that they felt would meet these very detailed and strict performance objectives.

We didn't reach any conclusion on that. It was just two different ways that the question could be approached.

Finally, we discussed the importance of having public involvement in whatever kind of decisionmaking process has been determined. We talked about the different experiences good and bad where some people have handled the public involvement well and some people have handled it poorly. I guess the sense that we got was that the best way to handle the public involvement is to have as much public involvement as possible and to be as open and honest with members of the public in dealing with them.

Sometimes that can take a lot of time and lead to a lot of frustrations and mean a lot of hours for people that listen to repetitive testimony time after time after time, but in the end it probably means that you are going to be more successful in doing what you want to do because you have not led people to believing they have been bushwhacked somehow and they don't know what is happening to them and lead to additional concerns just because they don't know what is being done.

Again, like the others, I would like to thank all the people in our workshop. It was a trying experience sometimes to get through everything because we had a heavy agenda, but everybody was very cooperative and it was very enjoyable for me.

MR. SALTZMAN:

Thank you, Don.

7.5 Concluding Remarks

MR. SALTZMAN

I would like to thank Don and all the chairmen of the workshops, all the rapporteurs and assistants to the rapporteurs. I think they did a tremendous job. And of course all of you participants and observers also really put the effort into it, and I think it shows in the reports that we received.

I wonder is there any in the NRC who would like to make any sort of response.

Rob, are you standing up to do that or just putting on your jacket?

MR. MACDOUGALL:

I am just putting on my jacket.

(Laughter.)

MR. SALTZMAN:

Is there any response at all?

(No response.)

MR. MACDOUGALL:

I guess on Bob Browning's behalf I would only reiterate that we would like to see you make a decision -- you still can't hear me?

I guess I am going to have to take Lee Jager's remedial mike-holding course.

(Laughter.)

I just wanted to reiterate what we had said earlier yesterday, which was that in order for us to begin developing guidance that you will feel useful, we are going to need some sort of reasonably authoritative determination on your part that you do in fact intend to pursue one of these alternative technologies.

The message is that we certainly are not adverse to helping you, but we do have to have a firmer basis on which to proceed in helping you.

Unfortunately, Bob Browning couldn't be here to answer your questions on RCRA because the Chairman again wants to see him this afternoon and his boss wanted to see him in preparation for that.

I don't have a whole lot more to tell you, except that the approach that NRC is taking with EPA is that we want to try to eliminate any possibility for dual regulation and see if we can through our own regulatory framework try to deal with the hazardous constituents of comingled low-level waste in such a way as to permit EPA to let those hazardous constituents be regulated through our process.

MR. SALTZMAN:

Are there any other comments or questions at this point?

(No response.)

MR. SALTZMAN:

Well, as you can imagine, a lot of people contributed to putting a workshop like this together. I would like to recognize a couple of them though who really put in a lot of time in recent months, Rob MacDougall, Steve Romano and Jim Shaffner of the Division of Waste Management, Frank Young and Steve Salomon of State Programs who did all the substantive preparation of these workshop materials, Sue Weissberg who handled the arrangements, including the contacts with the hotel and Catherine Berney, Carolyn Duggans and James McQuade who did a lot of our logistical work and staff support.

Of course, again I have to thank all of the chairmen and rapporteurs, all of you who gave so willingly of your time and effort. I know it wasn't easy, but I think we got a good product out of it.

Once again, we will try to get a set of proceedings out in a couple of months. There was a question about whether there will be a compilation of compilations. I would think that is a good idea. The only negative I can see is that if it would hold up getting a report out on the proceedings initially. We might not want to do it then, but supplement it later. It all depends on the timing.

It is something you all want to see, how the four different workshops who had a number of different technologies dealt with them, one against the other, and we will try to do that for you.

If there is nothing else then, I wish you all a safe journey home and thank you very much.

(Whereupon, at 12:05 p.m., the State Workshop on Shallow Land Burial and Alternative Disposal Concepts concluded.)

8. INTEGRATION OF INDIVIDUAL WORKSHOP RESULTS

To gain an overall perspective on the workshop, NRC staff compiled and integrated the results which summarize the views expressed in each of the four workshops.

8.1 Consolidation of Additional Factors

The participants in the four workshops were asked to modify the list of 32 technical, economic, institutional and sociopolitical factors developed by NRC for selecting a disposal technology shown in Table 8.1. Additional factors were added and modifications were made during the workshops and are reported in Chapter 7 and Appendix E. These factors are shown in a consolidated form in Table 8.2. If factors were similarly worded in two or more workshops, they were combined and reworded so that they resulted in a total of 35 factors. The order in which the factors were tabulated (from the blue workshop through the black workshop) represents no ranking by weights. The factors in Tables 8.1 and 8.2, when combined, might represent all the necessary 67 factors that might be considered in the selection of a disposal technology. How these factors rank in terms of importance is the next subject of discussion.

Table 8.1 Technical, Economic, Institutional and Sociopolitical Factors

Technical	Economic	Institutional	Sociopolitical
10 CFR 61 Subpart C - Performance Objectives o protection of the general population from releases of radioactivity o protection of individuals from inadvertent intrusion o protection of individuals during operations o stability of the disposal site after closure	Present Value Cost o licensing cost o capital cost o operating cost o transportation to site o closure and stabilization o institutional control	Federal Regulations - NRC o time to process applications	Public Acceptance of Risk o perceived vs. real risk o State vs. local consideration of risk
Status of Technology Development o conceptual, demonstration or existing practice o licensing time frames	Financial Risk o risk and expected rate of return o public vs. private initiative	Agreement State Regulation o time to develop program o time to process applications	Public Acceptance of Transportation Risk o perceived vs. real risk o State vs. local consideration of risk
Siting Constraints o site availability	Consumer Cost/Pricing o impact of waste generator o impact on institutional, medical, industrial and electric utility customers	Non-Radiological State Regulation o land use control o environmental o site ownership	Socioeconomic Impacts o land use o local economy o public service (roads, schools, fire protection, etc.)
	Cost of Delay o extended storage pending disposal o research and development needs		

Table 8.2 Consolidation of the Additional Technical, Economic and Sociopolitical Factors

Technical	Economic	Institutional	Scociopolitical
Monitoring during operational and institutional phases	Insurance availability	Resource Conservation and Recovery Act of 1976 (RCRA)	Host community compensation
Avoidance of environmental contamination, such as meeting 40 CFR 264 and other Federal requirements	Fees for host community onsite inspections	Quality of management	Property values
Ability of technology to deal with all and special waste forms	Cost distribution	Quality of regulatory oversight including postlicensing	Public understanding of risk
Volume reduction requirement	Waste treatment	Risk assessment education capability	Public acceptance of risk/benefit
Transportation availability	Regulatory	Building management credibility	Public acceptance of technology
Modeling capability	Potential remedial action	Surveillance and enforcement	Public acceptance of perceived risk and real risk
Retrievability	Consumer cost for utility customers separately from others	Time and willingness to develop alternatives	Public acceptance of State consideration of risk and local consideration of risk
Ability to survive disaster	Cost of incentive package	Number of agencies involved	
Ease of construction, monitoring, repair and remedial action		Flexibility	
Development or demonstration of experience to build public confidence		Compact regulation	

8.2 Ranking of Factors in Terms of Importance

The participants in the four workshops ranked the factors, including the additional ones, in terms of importance. This ranking is shown by individual workshops in Appendix E and interpreted in Chapter 7. In some of the workshops only the results from State participants were compiled by workshop chairmen and rapporteurs working with the NRC assistants. In others, the results from the participants from industry, NRC, and other Federal agencies and observers were also included in the compilation. The comprehensiveness of the tabulation depended primarily on time constraints. To acknowledge all the contributions, the results from all 58 participants were compiled by NRC. The additional factors and other modifications shown in Table 8.2 are not reported here because they were not considered by all participants. The factors that were marked "critical" by at least a mean of the participants, i.e., 29 or more, are shown by rank in Table 8.3. The factors that were marked "critical" and "important" combined by at least a mean, and not already included, are also shown by rank in Table 8.3. The number in parentheses indicates the number of participants who checked "critical" and "critical" and "important." (Supporting tabulation by workshop is found in Appendix F.) All the other factors were checked by at least a mean as "critical," "important," and "somewhat important" combined. The importance ratings, "not important" and "don't know," were checked by only a small number of participants.

The ranking indicates that the mean or more of the participants believe that the factors that are critical are the four performance objectives of Subpart C of 10 CFR 61 (i.e., protection of the general population from releases of radioactivity, protection of individuals from inadvertent intrusion, protection of individuals during operations, and stability of the disposal site after closure) and perceived versus real risk. (Note that perceived versus real risk is at the border of the two categories with 29 critical checks. There are 12 participants who marked this factor important and 4 that marked it somewhat important for a total of 45. All 58 participants did not complete the entire form.) The 16 factors that were ranked by at least the mean of all participants as critical and important include a wide variety of issues related to siting, cost, nonradiological State regulation, aspects of public acceptance of risk, the status of the technology, Agreement State regulation, and socioeconomic impacts.

The application of these factors to the ranking of the disposal technologies is discussed in the following section.

Table 8.3 Ranking of Factors in Terms of Importance

Critical	Critical and Important	
10 CFR 61 Subpart C - Performance Objectives	Siting Constraints	Cost of Delay
	o site availability (51)	o research and development needs (33)
o protection of the general population from releases of radioactivity (57)	Non-Radiological State Regulation	o extended storage pending disposal (32)
	o environmental (48)	
o stability of the disposal site after closure (51)	Present Value Cost	o Present Value Cost
	o closure and stabilization (47)	o operating cost (32)
o protection of individuals during operations (40)	o institutional control (43)	o capital cost (31)
	Status of Technology Development	Non-Radiological State Regulation
o protection of individuals from inadvertent intrusion (33)	o conceptual, demonstration or existing practice (40)	o land use control (32)
	Public Acceptance of Risk	o site ownership (32)
Public acceptance of Risk	o State vs. local consideration of risk (37)	Public Acceptance of Transportation Risk
o perceived vs. real risk (29)	Socioeconomic Impacts	o perceived vs. real risk (30)
	o land use (36)	Socioeconomic Impacts
	Agreement State Regulation	o local economy (29)
	o time to develop program (34)	

NOTES: Number in parentheses indicates number of participants
Total participants:58; mean: 29

8.3 Shallow Land Burial

In each of the four workshops the factors were ranked in terms of importance for shallow land burial. The results are shown by individual workshops in Appendix E and interpreted in Chapter 7. The ranking by 57 participants is shown in Table 8.4. See supporting data in Appendix F. One was invalid because it was improperly filled out. The factors that were checked off in the "favor" and "inhibit" columns by at least a mean (29 or more) are shown. There are 13 favorable factors and 5 inhibiting ones. The number in parentheses indicates the number of participants checking that factor. Also, the letter "C" indicates those factors that at least the mean indicated as critical, and the letters "CI" indicate those factors that at least the mean indicated as critical and important combined.

Of the critical factors, protection of individuals during operations and protection of the general population from releases of radioactivity, are considered by 44 and 30 participants, respectively, as favoring shallow land burial. Perceived versus real risk, related to public acceptance of risk, and stability of the disposal site after closure are considered as inhibiting it by 32 and 30 participants, respectively. Of the factors not classified as critical, but critical and important combined, cost, time, and status of technology favor shallow land burial, whereas perceived versus real risk related to transportation, site availability, and State versus local consideration of risk inhibit it.

The major factors that remained unresolved (i.e., there was not at least a mean among the participants) are indicated by the letter "U" in Table 8.5. This table reproduces the critical and critical and important factors of Table 8.3. The tabulation shows that at least a mean was not reached among the participants for the nine factors. They include Subpart C performance objective, protection of individuals from inadvertent intrusion, cost factors (closure and stabilization, institutional control, and extended storage pending disposal), nonradiological State regulation, and socioeconomic impacts.

Table 8.4 Ranking of Factors in Terms of Impact for Shallow Land Burial

Favor		Inhibit
Present Value Cost	Consumer Cost-Pricing	Public Acceptance of Risk
o capital cost (46)-CI	o impact on institutional, medical, industrial and electric utility customers (38)	o perceived vs. real risk (32)-C
o licensing cost (45)		
10 CFR 61 Subpart C - Performance Objectives	o impact on waste generator (37)	Public Acceptance of Transportation Risk
	Agreement State Regulation	o perceived vs. real risk (32)-CI
o protection of individuals during operations (44)-C	o time to develop program (36)-CI	
Present Value Cost	Status of Technology Development	10 CFR 61 Subpart C - Performance Objectives
o operating cost (41)-CI	o conceptual, demonstration, or existing practice (34)-CI	o stability of the disposal site after closure (30)-C
Status of Technology Development	Agreement State Regulation	
o licensing time frames (41)		Siting Constraints
	o time to process applications (33)	
Federal Regulation - NRC		o site availability (30)-CI
o time to process applications (41)	10 CFR 61 Subpart C - Performance Objectives	
		Public Acceptance of Risk
	o protection of the general population from releases of radioactivity (30)-C	o State vs. local consideration of risk (29)-CI
	Cost of Delay	
	o research and development needs (30)-CI	

NOTES: Number in parentheses indicates number of participants.
Total participants: 57; Mean = 29
C = critical; CI = critical and important

Table 8.5 Nine Major Unresolved Factors for Shallow Land Burial (Indicated by U)

Critical	Critical and Important	
10 CFR 61 Subpart C - Performance Objectives	Siting Constraints	Cost of Delay
	o site availability (51)	o research and development needs (35)
o protection of the general population from releases of radioactivity (57)	Non-Radiological State Regulation	U o extended storage pending disposal (32)
	U o environmental (48)	
o stability of the disposal site after closure (51)	Present Value Cost	Present Value Cost
	U o closure and stabilization (47)	o operating cost (32)
o protection of individuals during operations (40)	U o institutional control (43)	o capital cost (31)
	Status of Technology Development	Non-Radiological State Regulation
U o protection of individuals from inadvertent intrusion (33)	o conceptual, demonstration or existing practice (40)	U o land use control (32)
	Public Acceptance of Risk	U o site ownership (32)
Public Acceptance of Risk	o State vs. local consideration of risk (37)	Public Acceptance of Transportation Risk
o perceived vs. real risk (29)	Socioeconomic Impacts	o perceived vs. real risk (30)
	U o land use (36)	Socioeconomic Impacts
	Agreement State Regulation	U o local economy (29)
	o time to develop program (34)	

NOTE: Number in parentheses indicates number of participants who considered that factor as critical or critical and important combined. See Table 8.3. Those factors not marked by U were resolved to be either favoring or inhibiting shallow land burial.

8.4 Aboveground Vaults

A similar ranking in terms of importance for aboveground vaults is shown in Table 8.6. This technology was considered in two workshops (blue and purple) consisting of 27 participants. (See Appendix F.) More than a mean of participants believe that two of the four critical Subpart C performance objectives are favorable, i.e., protection of individuals from inadvertent intrusion (19 participants) and protection of the general population from releases of radioactivity (15 participants). One performance objective is inhibiting -- protection of individuals during operations (16 participants). One, stability of the disposal site after closure, is considered unresolved as shown in Table 8.7. The other critical factor, perceived versus real risk, is ranked favorable (20 participants).

In summary, 11 factors favor aboveground vaults. Of these, three are critical and eight are critical and important combined. There are 13 factors that inhibit aboveground vaults. Of these, one is critical and six are critical and important combined. There are three unresolved major factors as shown in Table 8.7, only one of which is critical, stability of the disposal site after closure. The overall impression is that factors that pertain to safety and environment and the public's perception of risk favor aboveground vaults, but factors that pertain to costs and time to license inhibit this technology.

Table 8.6 Ranking of Factors in Terms of Impact for Aboveground Vaults

Favor		Inhibit	
Siting Constraints o site availability (23)-CI Public Acceptance of Risk o State vs. local consideration of risk (22)-CI o perceived vs. real risk (20)-C 10 CFR 61 Subpart C - Performance Objectives o protection of individuals from inadvertent intrusion (19)-C Present Value Cost o closure and stabilization (16)-CI Non-Radiological State Regulation o land use control (16)-CI o environmental (16)-CI	10 CFR 61 Subpart C - Performance Objectives o protection of the general population from releases of radioactivity (15)-C Non-Regiological State Regulation o site ownership (15)-CI Public Acceptance of Transportation Risk o perceived vs. real risk (15)-CI Socioeconomic Impacts o land use (15)-CI	Federal Regulation - NRC o time to process applications (21) Agreement State Regulation o time to develop program (19)-CI o time to process applications (19) Present Value Cost o licensing cost (19) o capital cost (19)-CI Status of Technology Development o licensing time frames (19) o conceptual, demonstration or existing practice (18)-CI	Consumer Cost/Pricing o impact on institutional, medical, industrial and electric utility costomers (18) o impact on waste generators (17) Cost of Delay o research and development needs (17)-CI 10 CFR 61 Subpart C - Performance Objectives o protection of individuals during operations (16)-C Present Value Cost o operating cost (16)-CI Cost of Delay o extended storage pending disposal (14)-CI

NOTES: Numbers in parentheses indicate number of participants.
Total participants: 27; Mean: 14
C = critical; CI = critical and important.

Table 8.7 Three Major Unresolved Factors for Aboveground Vaults (Indicated by U)

Critical	Critical and Important	
10 CFR 61 Subpart C - Performance Objectives	Siting Constraints	Cost of Delay
o protection of the general population from releases of radioactivity (57)	o site availability (51)	o research and development needs (33)
U o stability of the disposal site after closure (51)	Non-Radiological State Regulation	o extended storage pending disposal (32)
o protection of individuals during operations (40)	o environmental (48)	Present Value Cost
o protection of individuals from inadvertent intrusion (33)	Present Value Cost	o operating cost (32)
Public Acceptance of Risk	o closure and stabilization (47)	o capital cost (31)
o perceived vs. real risk (29)	U o institutional control (43)	Non-Radiological State Regulation
	Status of Technology Development	o land use control (32)
	o conceptual, demonstration or existing practice (40)	o site ownership (32)
	Public Acceptance of Risk	Public Acceptance of Transportation Risk
	o State vs. local consideration of risk (37)	o perceived vs. real risk (30)
	Socioeconomic Impacts	Socioeconomic Impacts
	o land use (36)	U o local economy (29)
	Agreement State Regulation	
	o time to develop program (34)	

NOTE: Number in parentheses indicates number of participants who considered that factor as critical or critical and important combined. See Table 8.3. Those factors not marked by U were resolved to be either favoring or inhibiting aboveground vaults.

8.5 Belowground Vaults

Belowground vaults were ranked in two workshops (blue and black) consisting of 27 participants. (See Appendix F.) More than a mean of the participants believe that all four critical factors of Subpart C performance objectives as shown in Table 8.8 favor the technology. Also, the critical factor, perceived versus real risk, is considered favorable.

In summary, nine factors favor belowground vaults. Of these, five are critical and four are critical and important combined. There are 12 factors that were believed to inhibit belowground vaults. Of these, seven are critical and important combined. There are six major unresolved factors that are critical and important combined listed in Table 8.9. None are listed as critical.

The overall impression is that factors pertaining to safety, environment and the public's perception of risk favor belowground vaults. Inhibiting factors relate to time to process applications and a variety of cost factors.

Table 8.8 Ranking of Factors in Terms of Impact for Belowground Vaults

Favor		Inhibit	
10 CFR 61 Subpart C - Performance Objectives o stability of the disposal site after closure (21)-C o protection of the general population from releases of radioactivity (20)-C o protection of individuals from inadvertent intrusion (20)-C Siting Constraints o site availability (18)-CI Public Acceptance of Risk o perceived vs. real risk (18)-C Present Value Cost o closure and stabilization (15)-CI	Non-Radiological State Regulation o environmental (15)-CI 10 CFR 61 Subpart C - Performance Objectives o protection of individuals during operations (14)-C Public Acceptance of Risk o State vs. local consideration of risk (14)-CI	Agreement State Regulation o time to develop program (20)-CI o time to process applications (20) Federal Regulations - NRC o time to process applications (19)-CI Present Value Cost o capital cost (19)-CI Cost of Delay o research and development needs (18)-CI Present Value Cost o licensing cost (16)	Status of Technology Development o licensing time frames (16) o conceptual, demonstration or existing practice (15)-CI Present Value Cost o operating cost (15)-CI Consumer Cost/Pricing o impact on waste generator (14) o impact on institutional, medical, industrial and electric utility customers (14) Cost of Delay o extended storage pending disposal (14)-CI

NOTES: Number in parentheses indicates number of participants.
Total participants: 27; mean: 14
C = Critical; CI = critical and important.

Table 8.9 Six Major Unresolved Factors for Belowground Vaults (Indicated by U)

Critical	Critical and Important	
10 CFR 61 Subpart C - Performance Objectives	Siting Constraints	Cost of Delay
	o site availability (51)	o research and development needs (33)
o protection of the general population from releases of radioactivity (57)	Non-Radiological State Regulation	o extended storage pending disposal (32)
	o environmental (48)	Present Value Cost
o stability of the disposal site after closure (51)	Present Value Cost	o operating cost (32)
o protection of individuals during operations (40)	o closure and stabilization (47)	o capital cost (31)
	U o institutional control (43)	Non-Radiological State Regulation
o protection of individuals from inadvertent intrusion (33)	Status of Technology Development	U o land use control (32)
Public Acceptance of Risk	o conceptual, demonstration or existing practice (40)	U o site ownership (32)
o perceived vs. real risk (29)	Public Acceptance of Risk	Public Acceptance of Transportation Risk
	o State vs. local consideration of risk (37)	U o perceived vs. real risk (30)
	Socioeconomic Impacts	Socioeconomic Impacts
	U o land use (36)	U o local economy (29)
	Agreement State Regulation	
	o time to develop program (34)	

NOTE: Number in parentheses indicates number of participants who considered that factor as critical or critical and important combined. See Table 8.3. Those factors not marked by U were resolved to be either favoring or inhibiting belowground vaults.

8.6 Earth Mounded Concrete Bunkers

Earth mounded concrete bunkers were ranked in two workshops (red and purple) consisting of 28 participants. (See Appendix F.) At least the mean of the participants believe that three of the four critical Subpart C performance objectives favor the technology as shown in Table 8.10. The inhibiting critical performance objective was considered to be protection of individuals during operations. Also, the critical factor, perceived versus real risk, was considered to be favorable.

In summary, nine factors favor earth mounded concrete bunkers. Of these, four are critical and five are critical and important combined. There are 10 factors that inhibit this technology. Of these, one is critical and four are critical and important combined. Seven major factors are unresolved, all of which are critical and important combined. (See Table 8.11.)

The overall impression is that factors pertaining to most aspects of safety and perceived risk and some aspects of costs and site availability favor earth mounded concrete bunkers. The technology is considered inhibited by the status of the technology, time factors, cost considerations, and concern about protection of individuals during operations. Factors related to environmental concerns and the cost of delay are considered unresolved.

Table 8.10 Ranking of the Factors in Terms of Impact for Earth Mounded Concrete Bunkers

Favor	Inhibit	
10 CFR 61 Subpart C - Performance Objectives	Federal Regulations - NRC	10 CFR 61 Subpart C - Performance Objectives
o protection of individuals from inadvertent intrusion (22)-C	o time to process applications (23)	o protection of individuals during operations (16)-C
o protection of the general population from releases of radioactivity (20)-C	Status of Technology Development	Present Value Cost
o stability of the disposal site after closure (19)-C	o licensing time frames (22)	o operating cost (14)-CI
Public Acceptance of Risk	o conceptual, demonstration or existing practices (19)-CI	Consumer Cost/Pricing
o perceived vs. real risk (18)-C	Agreement State Regulation	o impact on institutional, medical, industrial and electric utility customers (14)
o State vs. local considerations of risk (17)-CI	o time to develop program (19)-CI	
Present Value Cost	o time to process applications (18)	
o closure and stabilization (17)-CI	Present Value Cost	
o institutional control (17)-CI	o capital cost (18)-CI	
Siting Constraints	o licensing cost (16)	
o site availability (16)-CI		
Socioeconomic Impacts		
o local economy (16)-CI		

NOTES: Number in parentheses indicates number of participants.
Total participants: 28; mean: 14
C = critical; CI - critical and important.

Table 8.11 Seven Major Unresolved Factors for Earth Mounded Concrete Bunkers (Indicated by U)

Critical	Critical and Important	
10 CFR 61 Subpart C - Performance Objectives	Siting Constraints	Cost of Delay
	o site availability (51)	U o research and development needs (33)
o protection of the general population from releases of radioactivity (57)	Non-Radiological State Regulation	
	U o environmental (48)	U o extended storage pending disposal (32)
o stability of the disposal site after closure (51)	Present Value Cost	Present Value Cost
o protection of individuals during operations (40)	o closure and stabilization (47)	o operating cost (32)
	o institutional control (43)	o capital cost (31)
o protection of individuals from inadvertent intrusion (33)	Status of Technology Development	Non-Radiological State Regulation
Public Acceptance of Risk	o conceptual, demonstration or existing practice (40)	U o land use control (32)
o perceived vs. real risk (29)	Public Acceptance of Risk	U o site ownership (32)
	o State vs. local consideration of risk (37)	Public Acceptance of Transportation Risk
	Socioeconomic Impacts	U o perceived vs. real risk (30)
	U o land use (36)	Socioeconomic Impacts
	Agreement State Regulation	o local economy (29)
	o time to develop program (34)	

NOTE: Number in parentheses indicates number of participants who considered that factor as critical or critical and important combined. See Table 8.3. Those factors not marked by U were resolved to be either favoring or inhibiting earth mounded concrete bunkers.

8.7 Mined Cavities

Mined cavities were ranked in one workshop (black) consisting of 11 participants. Of these only five are valid because the others were not completed properly. (The reasons stated include: "The form is a non-sequitur"; "All don't know, New Hampshire does not have any sites"; "Unsuitable for Pennsylvania"; "All are disqualified"; and "Not in my State.") (See Appendix F.) More than the mean of participants believe that three of the four critical Subpart C performance objectives favor the technology, as shown in Table 8.12. The inhibiting critical performance objective is protection of individuals during operations. Inhibiting factors relate mainly to time to process applications and site availability. There are 14 unresolved major factors, one of which is critical -- perceived versus real risk, as shown in Table 8.13. The classification, "don't know," was used most frequently for this technology.

Table 8.12 Ranking of Factors in Terms of Impact for Mined Cavities

Favor	Inhibit	Don't Know
10 CFR 61 Subpart C - Perofrmance Objectives o protection of the general population from releases of radioactivity (4)-C o protection of individuals from inadvertent intrusion (4)-C o stability of the disposal site after closure (4)-C	Federal Regulation - NRC o time to process applications (4) Agreement State Regulation o time to develop program (3)-CI o time to process applications (3) 10 CFR 61 Subpart C - Performance Objectives o protection of individuals during operations (3)-C Status of Technology Development o licensing time frames (3) Siting Constraints o site availability (3)-CI Present Value Cost o licensing cost (3) Cost of Delay o extended storage pending disposal (3)-CI	Present Value Cost o capital cost (3)-CI Financial Risk o risk and expected rate of return (3) o public vs. private initiative (3) Non-Radiological State Regulation o site ownership (3)-CI Socioeconomic Impacts o public service (roads, schools, fire protection, etc.) (3)

NOTES: Number in parentheses indicates number of participants.
Total participants: 11 (only 5 are valid); mean: 3
C = crticial; CI = critical and important.

Table 8.13 Fourteen Major Unresolved Factors for Mined Cavities (Indicated by U)

Critical	Critical and Important	
10 CFR 61 Subpart C - Performance Objectives	Siting Constraints	Cost of Delay
	o site availability (51)	U o research and development needs (33)
o protection of the general population from releases of radioactivity (57)	Non-Radiological State Regulation	o extended storage pending disposal (32)
	U o environmental (48)	
o stability of the disposal site after closure (51)	Present Value Cost	Present Value Cost
o protection of individuals during operations (40)	U o closure and stabilization (47)	U o operating cost (32)
	U o institutional control (43)	U o capital cost (31)
o protection of individuals from inadvertent intrusion (33)	Status of Technology Development	Non-Radiological State Regulation
	U o conceptual, demonstration or existing practice (40)	U o land use control (32)
Public Acceptance of Risk		
U o perceived vs. real risk (29)	Public Acceptance of Risk	U o site ownership (32)
	U o State vs. local consideration of risk (37)	Public Acceptance of Transportantion Risk
	Socioeconomic Impacts	U o perceived vs. real risk (30)
	U o land use (36)	Socioeconomic Impacts
	Agreement State Regulation	U o local economy (29)
	o time to develop program (34)	

NOTE: Number in parentheses indicates number of participants who considered that factor as critical or critical and important combined. See Table 8.3. Those factors not marked by U were resolved to be either favoring or inhibiting mined cavities.

8.8 Augered Holes (With Liners)

Augered holes (with liners) were ranked in one workshop (red) consisting of 18 participants. (See Appendix F.) More than the mean of participants believe that all four of the critical Subpart C performance objectives favor this technology as shown in Table 8.14. Also, the critical factor of perceived versus real risk is favorable.

In summary, 18 factors favor augered holes (with liners). Of these, 5 are critical and 11 are critical and important combined. There are six factors that inhibit this technology. Of these, none are critical and three are critical and important combined. There are three major unresolved factors, all of them critical and important combined. (See Table 8.15.)

The overall impression is that factors pertaining to safety, public acceptance of perceived risk versus real risk, and many areas of cost, site availability, and status of the technology favor augered holes (with liners). Time and land use factors inhibit augered holes primarily. Factors pertaining to operating and capital cost, as well as site ownership, are considered unresolved.

Table 8.14 Ranking of Factors in Terms of Impact for Augered Holes (With Liners)

Favor			Inhibit
10 CFR 61 Subpart C - Performance Objectives o protection of the general population from releases of radioactivity (17)-C o protection of individuals from inadvertent intrusion (17)-C Public Acceptance of Risk o perceived vs. real risk (17)-C 10 CFR 61 Subpart C - Performance Objectives o stability of the disposal site after closure (16)-C o protection of individuals during operations (15)-C	Public Acceptance of Risk o State vs. local consideration of risk (15)-CI Present Value Cost o closure and stabilization (13)-CI o institutional control (13)-CI Cost of Delay o extended storage pending disposal (12)-CI Socioeconomic Impacts o local economy (12)-CI Status of Technology Development o conceptual, demonstration or existing practice (11)-CI Siting Constraints o site availability (10)-CI	Cost of Delay o research and development needs (10)-CI Status of Technology Development o licensing time frames (9) Present Value Cost o transportation to site (9) Non-Radiological State Regulation o environmental (9)-CI Public Acceptance of Transportation Risk o perceived vs. real risk (9)-CI o State vs. local consideration of risk (9)-CI	Socioeconomic Impacts o land use (12)-CI Agreement State Regulation o time to develop program (11)-CI o time to process applications (10) Consumer Cost/Pricing o impact on waste generator (9) Federal Regulation - NRC o time to process applications (9) Non-Radiological State Regulation o land use control (9)-CI

NOTES: Number in parentheses indicates number of participants.
Total participants: 18; mean: 9.

Table 8.15 Three Major Unresolved Factors for Augered Holes (With Liners) (Indicated by U)

Critical	Critical and Important		
10 CFR 61 Subpart C - Performance Objectives	Siting Constraints		Cost of Delay
o protection of the general population from releases of radioactivity (57)	o site availability (51)		o research and development needs (33)
o stability of the disposal site after closure (51)	Non-Radiological State Regulation		o extended storage pending disposal (32)
o protection of individuals during operations (40)	o environmental (48)		Present Value Cost
o protection of individuals during inadvertent intrusion (33)	Present Value Cost	U	o operating cost (32)
Public Acceptance of Risk	o closure and stabilization (47)	U	o capital cost (31)
o perceived vs. real risk (29)	o institutional control (43)		Non-Radiological State Regulation
	Status of Technology Development		o land use control (32)
	o conceptual, demonstration or existing practice (40)	U	o site ownership (32)
	Socioeconomic Impacts		Public Acceptance of Transportation Risk
	o land use (36)		o perceived vs. real risk (30)
	Agreement State Regulation		Socioeconomic Impacts
	o time to develop program (34)		o local economy (29)

NOTE: Number in parentheses indicates number of participants who considered that factor as critical or critical and important combined. See Table 8.3. Those factors not marked by U were resolved to be either favoring or inhibiting augered holes (with liners).

8.9 General Impression

In this section, the attitudes of the workshop participants with regard to shallow land burial and alternative disposal technologies are organized in quantitative fashion in order to form an overall impression. The attitudinal data base for critical and important factors and for shallow land burial was represented by four workshops. The data base was limited to two workshops for aboveground and belowground vaults and for earth mounded concrete bunkers. The narrowest data base at one workshop was for augered holes (with liners) and mined cavities, with 18 and 5 valid participants, respectively. The size means that the larger the data base the greater the certainty that can be attributed to the conclusions. The number of valid participants by technology is shown in Table 8.16.

To understand the degree to which one technology may be favored with respect to another, the technologies were arranged according to the number of critical and favorable factors in decreasing order. The order is shown in Table 8.16.

The five critical factors favor both augered holes (with liners) and belowground vaults. Recall that the five critical (C) factors identified by all the workshop participants are the four Subpart C performance objectives plus public acceptance of perceived versus real risk. The table also shows the remaining combined critical and important (CI) factors. There are 11 CI factors for augered holes (with liners) versus 4 for belowground vaults. In the "inhibit" column, there are no C factors and there are seven CI factors for belowground vaults and three for augered holes. The technology, augered holes, has fewer major unresolved factors, three as compared with six CI factors.

In conclusion, the attitude of the participants is that all the critical factors of the 10 CFR 61 Subpart C performance objectives and the public's acceptance of perceived versus real risk, plus a number of other factors, rate favorably with respect to both augered holes (with liners) and belowground vaults. These technologies are considered inhibited by time and cost considerations, although the cost for augered holes is not considered to be resolved.

Another overall impression is that the technologies of mined cavities and shallow land burial involve the most unresolved major factors. These are: for mined cavities, the critical factor of public acceptance of perceived versus real risk; for shallow land burial, the protection of individuals from inadvertent intrusion. In addition, there are 13 and 8 CI factors, respectively. Perceived inhibiting critical factors are: for mined cavities, protection of individuals during operations; for shallow land burial, public acceptance of perceived versus real risk and the stability of the disposal site after closure. There are three additional CI factors that inhibit both technologies and five that favor shallow land burial.

In conclusion, the attitude of the participants is that shallow land burial is favored by protection of individuals during operations and the general population from releases of radioactivity but is inhibited by perceived versus real risk and stability of the disposal site after closure. Participants did not resolve the views on protection of individuals from

Table 8.16 General Impression of Disposal Technologies

Technology	Valid Partici- pants	Favor			Inhibit			Unresolved	
		C	CI	O	C	CI	O	C	CI
Augered holes (with liners)	18	5	11	2	0	3	3	0	3
Belowground vaults	27	5	4	0	0	7	5	0	6
Earth mounded concrete bunkers	28	4	5	0	1*	4	5	0	7
Aboveground vaults	27	3	8	0	1*	6	6	1**	2
Mined cavities	5	3	0	0	1*	3	3	1	13
Shallow land burial	57	2	5	6	2**†	3	0	1#	8

* Protection of individuals during operations.
** Stability of the disposal site after closure.
† Perceived vs. real risk.
# Protection of individuals from inadvertent intrusion.

NOTES: C = critical factors;
CI = critical and important factors;
O = other factors

The critical factors are:

(1) Protection of the general population from releases of radioactivity
(2) Stability of the disposal site after closure
(3) Protection of individuals during operations
(4) Protection of individuals from inadvertent intrusion
(5) Perceived versus real risk.

inadvertent intrusion. Some cost and time considerations were believed to favor the technology, but there are a number of cost and environmental issues that are unresolved.

For mined cavities, the critical factor, protection of individuals during operations, was believed to inhibit this technology, in addition to time and licensing considerations and site availability. The critical factor, perceived versus real risk, is unresolved.

The two technologies, earth mounded concrete bunkers and aboveground vaults, fall in between the two other groups. The critical factor, protection of individuals during operations, inhibits both technologies. The critical factor, stability of the disposal site after closure, is unresolved for aboveground vaults. Earth mounded concrete bunkers were perceived to rate favorably by three of the Subpart C performance objectives, whereas aboveground vaults are favored by two. Both technologies are favored by public acceptance of perceived versus real risk and inhibited by cost and time considerations.

8.10 Conclusions

The broad conclusions from the workshops are summarized below. Workshop findings reflect the views of the participants, who were primarily State officials.

(1) Significant data gaps and information needs have to be addressed before timely State decisionmaking can be accomplished in pursuing development of a technology. At a minimum, existing data should be coordinated, especially with regard to engineering economics and operational and long-term performance of the existing alternative technologies that are used in Canada, France and Germany. Ideally, a generic cost/risk/benefit analysis for all the alternatives is required and might best be performed by the Federal government on behalf of the States.

(2) All the alternative land disposal concepts appear capable of satisfying the 10 CFR Part 61 Subpart C performance objectives. Four of the alternatives -- augered holes with liners, belowground vaults, earth mounded concrete bunkers, and mined cavities -- appear to satisfy the 10 CFR 61 Subpart C performance objectives more fully than does shallow land burial. The main perceived weakness of shallow land burial appears to be the stability of the disposal site after closure followed by the fact that one performance objective is unresolved, i.e., protection of individuals from inadvertent intrusion. The main perceived weakness of aboveground vaults is that the participants were not sure about the stability of the disposal site after closure. For those concepts where protection of individuals during operations was believed to be an inhibiting factor, participants also believed this problem could be overcome by innovative technology. These concepts are earth mounded concrete bunkers, aboveground vaults, and mined cavities. Augered holes were generally assumed to include liners because of groundwater and annual precipitation considerations in the Northeast and Midwest regions of the country. These were the only regions focused on in the workshop.

(3) Alternatives to shallow land burial appear to be more costly overall, but the importance of cost was not considered to be as important as protecting the public from both radiological and nonradiological hazards of the waste.

(4) The public was perceived to place greater confidence in disposal alternatives that incorporate man-made engineered barriers because of problems at the shallow land burial facilities operated before 10 CFR Part 61 was adopted to correct past deficiencies. No shallow land burial site has been licensed under the new regulations. Public perceptions of risk are considered to be critical in selecting a disposal technology, and shallow land burial does not appear to be favorably perceived by the public at present. The unfavorable perception might be overcome through public education.

(5) All the alternatives will take longer to develop and license than shallow land burial because Federal and Agreement State regulations and guidance on alternatives have not been developed. Some States

believe that they cannot develop an alternative before NRC completes its regulatory guidance. NRC believes that States should provide a commitment by undertaking development-oriented studies, and that NRC would provide prelicensing guidance based on demonstrated State interest in pursuing a specific alternative disposal technology. NRC indicated that resources are not available to develop detailed regulatory guidance and technical positions on all conceivable disposal concepts.

(6) In addition to the 32 technical, economic, institutional and sociopolitical factors proposed by NRC for selecting a disposal technology, 35 other factors should be considered. A few of those stressed were retrievability of the waste, the type of waste form, and the nonradiological hazards of the waste.

(7) Finally, public involvement in all aspects of technology selection is deemed important. This approach relates to public education with regard to perceived risk versus real risk, and building confidence in the management of the disposal technology and regulatory oversight.

NRC staff performed an analysis of the attitudes of the workshop participants on shallow land burial and alternative disposal technologies. Recognizing the imprecision in summarizing overall attitudes, alternative disposal concepts that appear to be most favorably perceived when rank ordered by critical factors are augered holes with liners, belowground vaults, earth mounded concrete bunkers, aboveground vaults and mined cavities.

The critical factors, as ranked by workshop participants, are:

10 CFR Subpart C - Performance objectives

- o Protection of the general population from releases of radioactivity
- o Stability of the disposal site after closure
- o Protection of individuals during operations
- o Protection of individuals from inadvertent intrusion

Public Acceptance of Risk

- o perceived vs. real risk.

Workshop participants did not reach general agreement on the overall suitability of mined cavities and shallow land burial. Workshop participants noted that a generic cost/risk/benefit analysis that emphasizes the long-term performance of the alternative technologies may help to resolve these uncertainties and put the States on a firmer basis to actively pursue development of a specific disposal technology.

APPENDIX A

U. S. NUCLEAR REGULATORY COMMISSION
FINAL AGENDA

State Workshop on Shallow Land Burial and Alternative Disposal Concepts

Linden Hill Hotel
Bethesda, Maryland

Tuesday, May 1, 1984

4:00 p.m. to 8:00 p.m. Registration, Lobby

Wednesday, May 2, 1984

7:30 a.m. Registration, Wimbledon Room

8:00 a.m.	Welcome	Jerome Saltzman, Assistant Director, Office of State Programs, NRC
	Why the Workshop?	Robert MacDougall for Robert Browning, Director, Division of Waste Management, NRC
	NRC LLW Regulations	Leo Higginbotham, Branch Chief, Division of Waste Management, NRC
	Disposal Concepts Being Studied by NRC	James Shaffner, Division of Waste Management, NRC
	Research and Practices of U.S. Department of Energy (DOE)	Elizabeth Jordan Office of Terminal Waste Disposal and Remedial Action (DOE), and Lance Mezga, Manager Low-Level Waste Program Oak Ridge National Laboratory
10:00 a.m.	BREAK	

10:15 a.m.	<u>State Studies of Shallow Land Burial and Alternative Disposal Concepts</u>	
	Economic and Political Framework for Alternatives	Robert Avant, Jr., Texas Low-Level Radioactive Waste Disposal Authority
	Shallow Land Disposal Options for Pennsylvania	William Dornsife, Bureau of Radiation Protection, Department of Environmental Resources, Pennsylvania
	Alternative Disposal Facilities for New York	Jay Dunkleberger, New York State Energy Office
	The Ontario Hydro Experience and Engineered Structures for Maine, Vermont and New Hampshire	Thomas Carter, Ontario Hydro, Canada, and Robert Eisengrein, Representative New Hampshire
12:15 p.m.	<u>LUNCH</u>	
	Luncheon Speaker:	Dr. J. Calvin Brantley, Former Vice President, New England Nuclear Corporation, and Member, Massachusetts Special Legislative Commission on Low-Level Radioactive Waste
	Morning Wrapup	Robert MacDougall, Division of Waste Management, NRC
	Decisionmaking Framework for Selecting a Disposal Option and General Instructions for Workshops	Stephen Salomon, Office of State Programs, NRC

1:45 p.m.	Four Workshops	Chairpersons
	Toward a Systematic Approach to the Evaluation of Shallow Land Burial and Alternative Disposal Technologies	Dante Ionata, Rhode Island, Credentialed Member, CONEG Low-Level Radioactive Waste Policy Working and Implementation Group Red Workshop (Newport)
		Kevin McCarthy, Connecticut, CONEG Low-Level Radioactive Waste Subcommittee Blue Workshop (Forest Hills)
		Lee Jager, Michigan, Chairman, Midwest Compact Commission Purple Workshop (Wimbledon/Sea Pines)
		Don Schott, Wisconsin, Governor's Office Black Workshop (Grand Prix)

Thursday, May 3, 1984

8:15 a.m.	Questions Posed to Panel of Speakers and Resource Persons	Wimbledon Room
8:30 a.m.	Concluding Session of Workshop	
10:00 a.m.	BREAK	
10:15 a.m.	Licensing for Storage, Including Interim Period Post-1986	Richard Cunningham, Director, Division of Fuel Cycle and Material Safety
11:00 a.m.	Closing Plenary	Jerome Saltzman Chairpersons
12:05 p.m.	ADJOURN	

APPENDIX B

FEDERAL REGISTER NOTICE ANNOUNCING STATE WORKSHOP

14460 Federal Register / Vol. 49, No. 71 / Wednesday, April 11, 1984 / Notices

State Workshop on Shallow Land Burial and Alternative Disposal Concepts; Meeting

On May 2 and 3, 1984, the Nuclear Regulatory Commission (NRC) will sponsor a workshop with State officials to discuss shallow land burial and alternative disposal concepts for low-level radioactive waste. The meeting will be conducted at the Linden Hill Hotel, 5400 Pooks Hill Road, Bethesda, Maryland. The meeting is open to the public for attendance and observation and will take place from 8:00 a.m. until 5:00 p.m. on Wednesday, May 2, and from 8:00 a.m. to 1:00 p.m. on Thursday, May 3, 1984. If you plan to attend or have questions regarding this workshop, please contact Dr. Stephen Salomon at (301) 492-9881.

Dated at Bethesda, Maryland this 5th day of April 1984.

For the Nuclear Regulatory Commission.

Jerome Saltzman,

Office of State Programs.

[FR Doc. 84-9739 Filed 4-10-84; 8:45 am]
BILLING CODE 7590-01-M

APPENDIX C

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APPENDIX D

WORKSHOP PREPRINTS

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Economic and Political Framework for Alternatives

Robert V. Avant, Jr., P.E.
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INTRODUCTION

Shallow land burial is the common practice used in disposing of much of mankind's wastes from garbage to hazardous materials. The record of performance of many land burial facilities is not enviable. It is instead fraught with disasters like Love Canal and Times Beach. Hazardous waste facilities are not alone because low-level radioactive waste disposal sites such as Maxey Flats and West Valley also have received notoriety.

Today just the phrase "high technology" intimidates the average lay person. To compound the problem, scientists and engineers tend to maintain a "holier-than-thou/trust-me" attitude. This attitude, along with recent dramatic technical incidences like Three Mile Island, the Kansas City Hyatt collapse, the loss of the Ranger drilling platform, numerous automobile recalls, etc. give the general public little confidence in technology.

The Texas Low-Level Radioactive Waste Disposal Authority recently conducted a poll to determine how the general public perceived nuclear issues in general, and low-level radioactive waste management in particular. A strong vote of no confidence was given for shallow land burial. This attitude on the part of the general public is also reflected in the growing grass roots support of alternatives. An alternative is defined as anything that allows close and continuous public scrutiny of the waste with a minimum of dependence on high tech monitoring. Alternatives range from sophisticated mausoleums to aboveground vaults. The often stated concern is that once the waste is placed in the ground, it is out of sight and out of mind to all involved, including the site operator. The presence of sophisticated environmental and radiological monitoring systems, and remedial action plans give little reassurance to a suspicious public.

This paper provides an overview of the status of the Authority's activities since it began almost two years ago. To date, the following technical activities have been completed or are nearing completion:

- Waste Volume Characterization
- Conceptual Facility Design
- Economic Analysis
- Transportation Study
- Regional Waste Evaluation
- Surface Storage Facility Design
- Health Impact Study
- Local Socioeconomic Evaluations
- Local Public Official Attitude Survey
- General Public Attitude Survey
- Site Selection (nearing completion)
- Alternative Waste Management Options (in progress)

An overview of these activities will be provided with emphasis on alternative low-level radioactive waste management approaches.

OVERVIEW OF SELECTED TECHNICAL ACTIVITIES

Waste Characterization

Over the past four years, numerous reports have attempted to characterize low-level radioactive waste generation from each state. There is wide disagreement among these reports concerning the volume and source of waste generated in Texas. Discrepancies are due in part to the nature of survey formats and techniques, failure to eliminate out-of-state wastes shipped for disposal by Texas brokers, and failure to follow-up on erroneous and missing data. Estimates of Texas-generated waste volumes range from as little as 14 m^3 (500 ft^3) to amounts approaching 2,549 m^3 (90,000 ft^3) per year (1). The Authority elected to conduct its own evaluation to more accurately predict waste generation rates for support of the conceptual design and economic evaluation of a Texas disposal facility. Table 1 provides the results of the Texas evaluation.

TABLE 1

Texas Low-Level

Radioactive Waste Volume Projections[a]

Generator	Volume m^3	(ft^3)[b]
Institutional	651	(23,000)
Industrial	227	(8,000)
Federal Facilities and NRC Licensees	85	(3,000)
Remedial Action Sites[c,d]	198	(7,000)
Commercial Power Reactors	2,973	(105,000)
TOTAL	3,936	(139,000)

[a]Approximately 850 m^3 (30,000 ft^3) of waste per year is currently generated in Texas.

[b]Numbers are rounded off and do not add exactly.

[c]Assumed.

[d]Not included in total.

Source: Avant, R.V., Alvarado, R.A., and Dehmel, J.C., 1984.

Conceptual Facility Design

The objective of the conceptual design was to plan a facility which is adequately sized to handle the projected waste volumes over a 30-year period; takes advantage of the state's geological and hydrological characteristics, supports efficient site operation and disposal activities; and complies with state and federal regulatory requirements and performance objectives (2). Finally, the design was developed in sufficient detail to support site selection, provide the necessary engineering considerations and proposed specifications to select a final facility design and contractor, and to determine the economic feasibility of the project. This is a conventional shallow land burial facility with engineered approaches considered only from the perspective of satisfying performance objectives.

Based on Texas waste characteristics, approximately 81 ha (200 acres) will be required. Only about 20 ha (50 acres) will be required for disposal units. Because of regulatory requirements, two trench systems were specified -- one for Class A waste and the other for Class B/C waste. Trenches were specified consistent with 10 CFR 61 requirements. Support facilities included an evaporation pond, maintenance building, administrative building, controlled access building, trucker waiting building, truck wash facility, sanitary facility, water system, fencing, roads, and parking areas. The conceptual design also included an equipment list and staffing pattern (21 employees). Figure 1 is a sketch of the conceptual design.

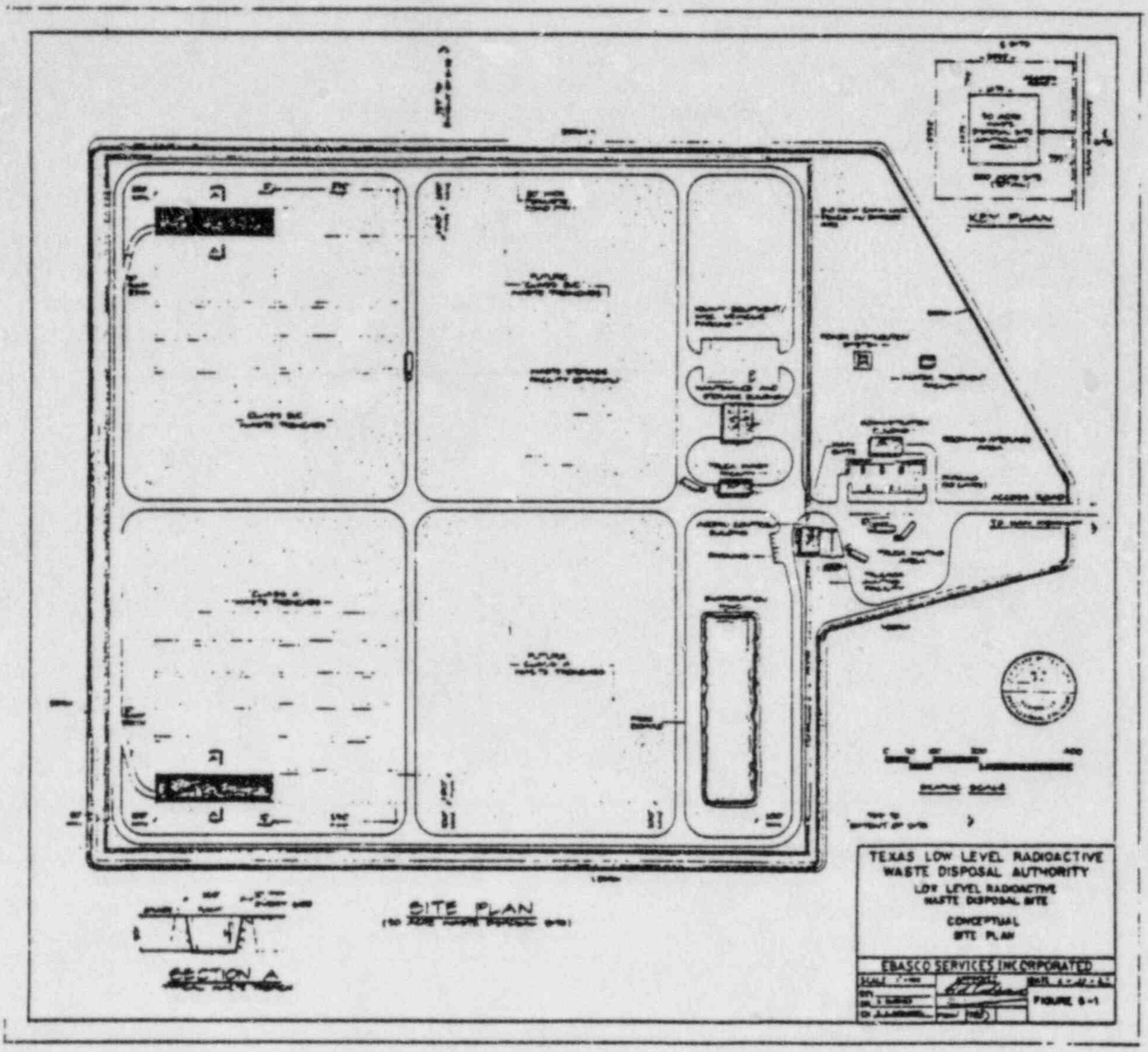
Economic Analysis

The economic analysis examined the feasibility of the low-level waste disposal facility with a custom-designed economic model using the waste characteristics and conceptual design as a basis. The scope included examination of: (1) two modes of operation, an Authority-operated disposal facility and a private contractor-operated facility; (2) two alternate financial analyses with a zero and an 8.5 percent cost of money; and (3) a parametric sensitivity study. The operation was based on an average disposal volume projection of 3,936 m^3 (139,000 ft^3) per year (3).

A 5-year startup period, a 20-year operating period, a 5-year closure period, and a 100-year institutional care period were assumed in the analysis. Although this anticipates a somewhat different operating scenario than the conceptual design, the 30-year operating period specified in the design is viewed as a safety factor and would serve to reduce costs if the time frame were extended.

Table 2 is a summary of the projected cost of operating the Texas facility using conventional shallow land burial. Sensitivity studies indicated that a 10 percent variation in up-front capital cost would cause the per unit disposal cost to vary by about \$12 per m^3 (\$0.35 per ft^3). However, increased operating costs of ten percent over the life of the facility would result in an increase of about \$58 per m^3 (\$1.64 per ft^3). In other words, up-front capital costs influence

Figure 1. Sketch of Conceptual Design



Source: Ebasco Services Incorporated, 1983.

disposal costs much less than annual costs. This is especially important if significant annual capital costs become a factor as in certain types of alternative waste management designs.

Table 2

Summary of Projected Unit Cost of the Texas Low-Level Waste Disposal Facility[a] [\$/m³ (\$/ft³)]

Category	Base Case #1 Contractor-Operated Facility		Base Case #2 Authority-Operated Facility	
Average Base Price	1,035.07	(29.31)	847.91	(24.01)
Post-Operating Fund Surcharge	96.76	(2.74)	87.93	(2.49)
Total Average Disposal Cost[b]	1,131.83	(32.05)	935.84	(26.50)

Category	Variation #1 Contractor-Operated Facility		Variation #2 Authority-Operated Facility	
Average Base Price	1,190.28	(33.70)	996.93	(28.23)
Post-Operating Fund Surcharge	96.76	(2.74)	87.93	(2.49)
Total Average Disposal Cost[c]	1,286.87	(36.44)	1,084.87	(30.72)

[a]Units of $\$/m^3$ ($\$/ft^3$) based on 3,936 m^3 (139,000 ft^3) per year.

[b]Base cases used in zero percent cost of money.

[c]Variations used an 8.5 percent cost of money.

Source: Avant, R.V., Alvarado, R.A., and Dehmel, J.C., 1984.

Site Selection

The Authority's site selection activity is the most intense effort that has been encountered both in terms of manpower and in terms of funding. Over 10,000 manhours have been expended with costs amounting to about one million dollars.

Twenty-four exclusionary and inclusionary criteria were used to screen the 254 counties in Texas for potential siting areas (4). The screening process systematically narrowed the areas of interest into nine preferred regions. Figure 2 shows the shaded preferred siting areas. The Authority does not have eminent domain powers; consequently, a conventional land market survey was conducted in an attempt to identify parcels of land which were in the preferred areas. Also, a further complication was a Texas Attorney General's Office requirement that the Authority must own the property in fee simple title.

These requirements - technical suitability, land availability, and fee simple title - made the task of identifying suitable property very difficult in Texas. Because of these constraints, the Authority has not been able to move forward as expeditiously as desired. However, unless further new complications are inserted into the process, a prime site should be named in the summer of 1984.

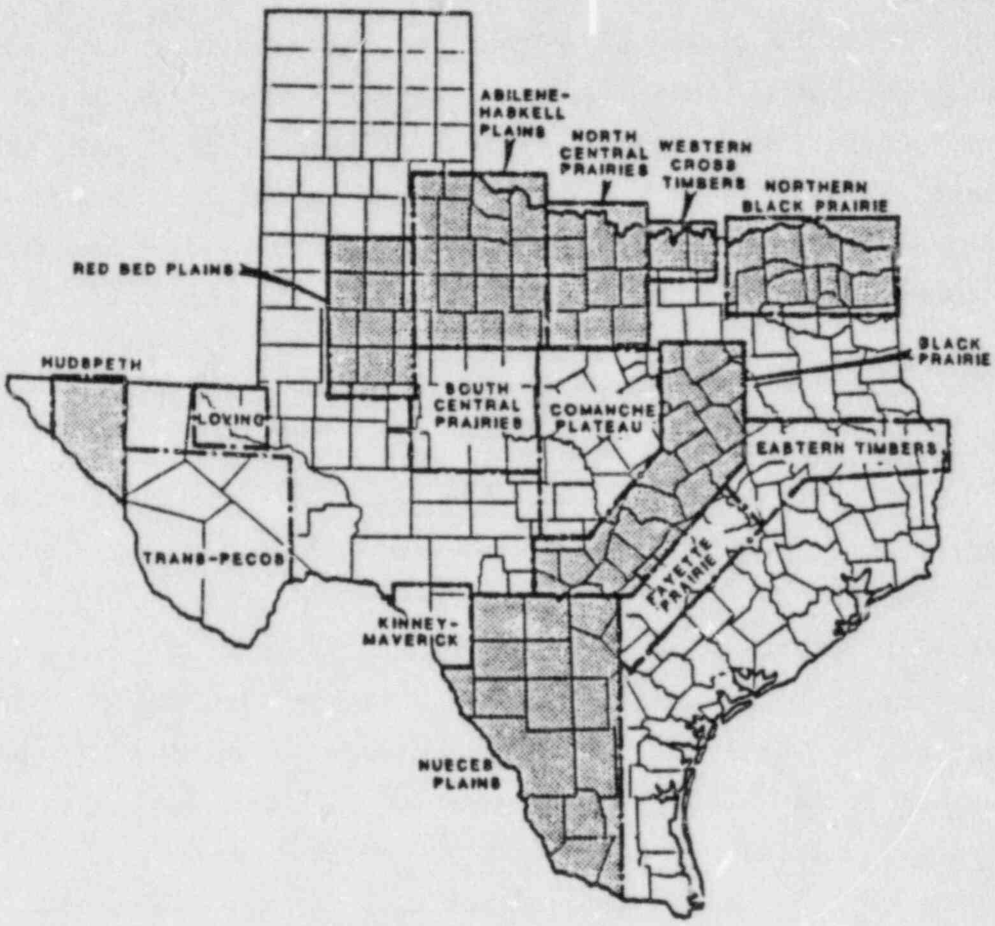
ATTITUDE TOWARD AUTHORITY ACTIVITIES

Public Response to Siting

In early 1983, the Authority began it's siting activity. Earlier activities such as the waste characterization, economic analysis, conceptual design, etc. elicited very little public attention. However, as the siting process began to narrow the areas of interest, predictably, the public began to respond with the classical "NIMBY" mentality. Even at the regional scale, when over 100 counties remained under consideration, local politicians, special interest groups, and individuals began to respond with petitions, letters, phone calls, and newspaper editorials. As the siting process began to converge on specific areas, the public response became more heated and emotional, and in some cases hysterical.

From the beginning of the site selection process, the Authority attempted to keep the public well informed as major thresholds were crossed. For instance, when the gross screening phase of the project identified 109 counties, a press release to the major state news organizations and wire services was prepared. Also, state senators and representatives and regional governmental entities were notified if part of their area was included.

Figure 2. Preferred Siting Areas



Source: Alvarado, R.A., Avant, R.V., and Hussey, J.R., 1984.

When the process identified specific counties, local politicians, county judges, and commissioners were advised. Even with this aggressive public information approach, many local politicians and individuals attempted to discredit the validity of the site selection process claiming that a secretive process had been conducted.

In addition to press releases and personal notifications of officials, key Authority staff held local information meetings to attempt to better explain the need for a low-level radioactive waste disposal facility and why the Authority was interested in the particular area. In most all cases, the Authority staff members experienced loud, orchestrated demonstrations. Common concerns expressed were:

Fear of radiation induced health effects.

Groundwater pollution.

Surface water pollution.

Air pollution.

Transportation accidents.

Choice of their area because of politics.

Local area does not use radioactive materials, so why should they get the site.

Stigma associated with facility.

Negative impact on land values.

Local produce and products would contain radioactive contamination.

Negative impact on industrial development.

Negative impact on flora and fauna.

Aggregation of the waste resulting in an explosion.

Lack of confidence in disposal technology.

Lack of confidence in continuity of good management.

Changes in policy to allow receipt of high level waste.

Long-term integrity of site, etc.

After observing the behavior of the general public, the following general patterns became repetitive from area to area:

1. When the general public first learns that their area is under consideration, individual contacts and letters appear first.

2. The second stage of public opposition is manifested through formal petitions and resolutions opposing the activity.
3. The third stage of public opposition is the formation of special interest groups with catchy acronyms, i.e. STAND (South Texans Against Nuclear Dumping). Also, outside groups who are sympathetic to the local cause may also join in opposition. The Catholic diocese of San Antonio is one example.
4. The fourth stage of public opposition is an attempt to halt siting progress by legal action - injunctions, restraining orders, law suits, etc.
5. The fifth stage of public opposition is an attempt to prohibit site designation by informal political intimidation or through formal political action. For example, political threats could be made against the future of the operating entity or more formal political actions such as political appointees, executive orders, or legislative actions could be taken.
6. The sixth stage in public opposition is to formally intervene in the licensing process.
7. The final stage of public opposition is public disobedience. The laying down in front of trucks, etc.

Formal Evaluation of Public Attitudes

At each of the local meetings, the assembled public attempted to convince the Authority that there was unanimous public opposition to the siting activity. The Authority elected to evaluate the public attitude on an objective basis through three approaches: (1) a socioeconomic profile of the local areas; (2) interviews with local officials; and (3) a mass telephone poll of the public.

Socioeconomic profiles are important because they identify particular local idiosyncrasies which may motivate public opposition and which may have a direct impact on the ability to name a site. For instance, if the demographics show a large minority population, a local response that the site selection process is discriminatory can be expected. Socioeconomic evaluations were conducted in South

Texas, West Texas, and Northwest-Central Texas. These studies showed that there was a large majority of Mexican/Americans in the South Texas region with a large degree to Mexican-American/Anglo conflict over the years. It was also predicted that it would be hardest to work with South Texas residents because of socioeconomics, education, and political structure. In West Texas, there was also a high proportion of minorities, but there was not a history of local conflict. It was predicted that residents in West Texas might be somewhat easier to work with based on the socioeconomic profile. In Northwest-Central Texas, the population is predominantly white, well educated farmers and ranchers. Since society in this area was the most homogeneous, it was predicted that there would be strong unity of action and this could make it very difficult to work with local residents (5).

Interviews with local officials and regional units of government were conducted to attempt to determine overall attitude toward the siting activity and toward the Authority itself (6). Representatives from 150 political subdivisions, including cities, counties, school districts, river authorities, soil and water conservation districts, water districts, hospital authorities, housing authorities, junior college districts, regional councils of government, appraisal districts, as well as affected state senators, representatives, congress members, and chambers of commerce were almost unanimously opposed to the siting activity. Major concerns were:

1. Water contamination.
2. Threat to economic development.
3. Threat to health and safety.
4. Risk of transportation accidents.
5. Lack of emergency response capability.
6. Impact on local public works.
7. Impact on local governmental services.

Also, general concern was expressed regarding a lack of confidence in shallow land disposal because of problems associated with sanitary landfills and hazardous waste facilities. Even with the aggressive public information program, concern was expressed that local officials were not well informed by the Authority and this translated into instant opposition. There was a general feeling that officials had not been provided with enough detailed information on the site selection process and the facility itself. Unfortunately, this was a problem that could not be easily resolved since public officials were notified well before due dates of the siting reports. This situation lead to the widespread generation of misinformation.

These findings led to the conclusion that an effort larger than just public information must be instituted. In order to have any impact on local attitudes, a comprehensive public education program must be conducted. A question still remains as to the effectiveness of a public education effort because experience indicates that in most cases, the public's mind is made up and it is often difficult to redirect perceptions.

The third public attitude evaluation project involved polling individuals in the South Texas, West Texas, and Northwest-Central Texas areas (7). The Public Policy Resources Laboratory at Texas A&M University, working with the Authority, developed a poll to evaluate public attitudes on nuclear issues, risks, confidence in various professions, and low-level radioactive waste characteristics and disposal technology. Nine hundred ninety-eight persons randomly selected in 12 counties were interviewed by telephone. Results of the poll were structured into three areas -- attitudes toward disposal, site planning and management issues, and group difference in attitude. The following is a synopsis of the results:

- Attitudes Toward Waste Disposal

  Eighty percent of those surveyed oppose the location of a low-level radioactive waste disposal site in their county.

  Survey respondents have a great fear of low-level radioactive wastes:

  1. Fifty-three percent said wastes are one of the most serious threats facing the world.

  2. Only fifty percent believe that science can develop safe disposal technologies. Only about twenty-eight percent feel that current technology is adequate.

3. Living near a waste disposal site is perceived as being nearly as dangerous as living near a nuclear power plant.

4. In order to feel safe, respondents need to live 80-100 miles from a disposal site.

5. Respondents fear that a disposal site will contaminate the environment and create health hazards including cancer, radiation sickness, and birth defects.

- Site Planning and Management Issues

Respondents trust physicians and university professors for advice on managing low-level radioactive wastes. They do not trust the news media or businessmen.

State officials are trusted by a majority (fifty-seven percent) of those surveyed to manage Texas' waste disposal site. Private business is not trusted.

The public does think that management of the disposal site is an important issue.

- Group Differences in Attitudes

College educated persons are more likely than other groups to say they are undecided on whether they support or oppose a waste disposal site in their county.

Hispanics are more likely than Anglos to be undecided on the establishment of a site in their county.

Persons who think they know the most about radioactive waste disposal are the most strongly opposed to siting in their county.

Residents of Hudspeth County are slightly more favorable to the location of a site in their county than are residents of the other eleven counties.

These conclusions probably reflect the attitudes of most of the public across the country. They tend to trust professors and physicians, but they also distrust the technologies that these professionals recommend. Today's public tends to draw on a relevant experience base rather than rely faithfully on the expertise of experts. The public finds it much easier to correlate all hazardous waste activities to the failures at Times Beach and Love Canal instead of having confidence in scientists and engineers. Admittedly the track record could have been better.

This track record has caused the general public and even some of the more technically attuned environmentalists to have concerns. This has caused nontechnical individuals to seek to find alternatives in light of the technology "credability gap." The subject of alternatives has been elevated from a viewpoint expressed by a few Ivy League environmentalists to legislation which requires the consideration of alternatives. Shallow land burial is being strongly challenged even in areas where it makes considerable sense. The public is not convinced that even in an area with 25.4 cm (10 in.) of rainfall and a water table at 304.8 m (1,000 ft) that shallow land burial is appropriate. The public is asking for a good faith effort to evaluate and consider alternative approaches to shallow land burial and it is incumbent on the technical and regulatory community to respond to this request. Otherwise, public confidence in the regulatory framework will be further eroded.

Alternatives are definitely not a panacea, and in certain applications, they could be a Pandora's box. Many questions related to regulatory consistency, public health implications, occupational exposure, operational complexities, economics, and long-term integrity remain to be answered from the standpoint of the Low-Level Radioactive Waste Policy Act and of existing federal and state perspectives. Alternatives should not be narrowly viewed by either the general public or by the technical community. Rather, the application of alternatives should be evaluated and considered within the context and constraints of waste characteristics, local site characteristics, public attitude, and the existing regulatory climate. In other words, different alternatives such as mausoleums, bunkers, concrete vaults, etc. may not be the answer in each and every application. In fact, in most of the drier regions of the country shallow land burial may well provide more protection than any alternative. On the other hand, in the humid, densely populated New England region, variations to shallow land burial may be the best approach in terms of protection. Even in cases where shallow land burial could meet performance objectives, the public may request variations in conventional shallow land burial designs to introduce additional protective barriers.

TEXAS CONSIDERATION OF ALTERNATIVE APPROACHES

Types of Alternatives

Although shallow land burial applies readily to Texas characteristics, the Authority has been evaluating a variety of alternative management schemes. Alternatives ranging from variations of in-ground systems to aboveground systems have been studied. The type of disposal method which has the best application to Texas is some variation of shallow land burial although at this time the design has not been specified. The final design will be dependent on site-specific conditions, regulatory requirements, economics, and public input.

The economics of alternative disposal methods must influence the Authority's decision on which alternative or what degree of alternatives are implemented. However, the most important criteria for selecting an alternative was to protect the public's health. Table 3 lists various types of methods of disposal that can be employed with each of the various alternatives. Figure 3 depicts various alternatives.

Table 3

Alternatives for Disposal of Low-Level Radioactive Wastes
(Excluding Shallow-Land Burial)

Alternatives	Method of Disposal
Space Disposal	Space shuttle

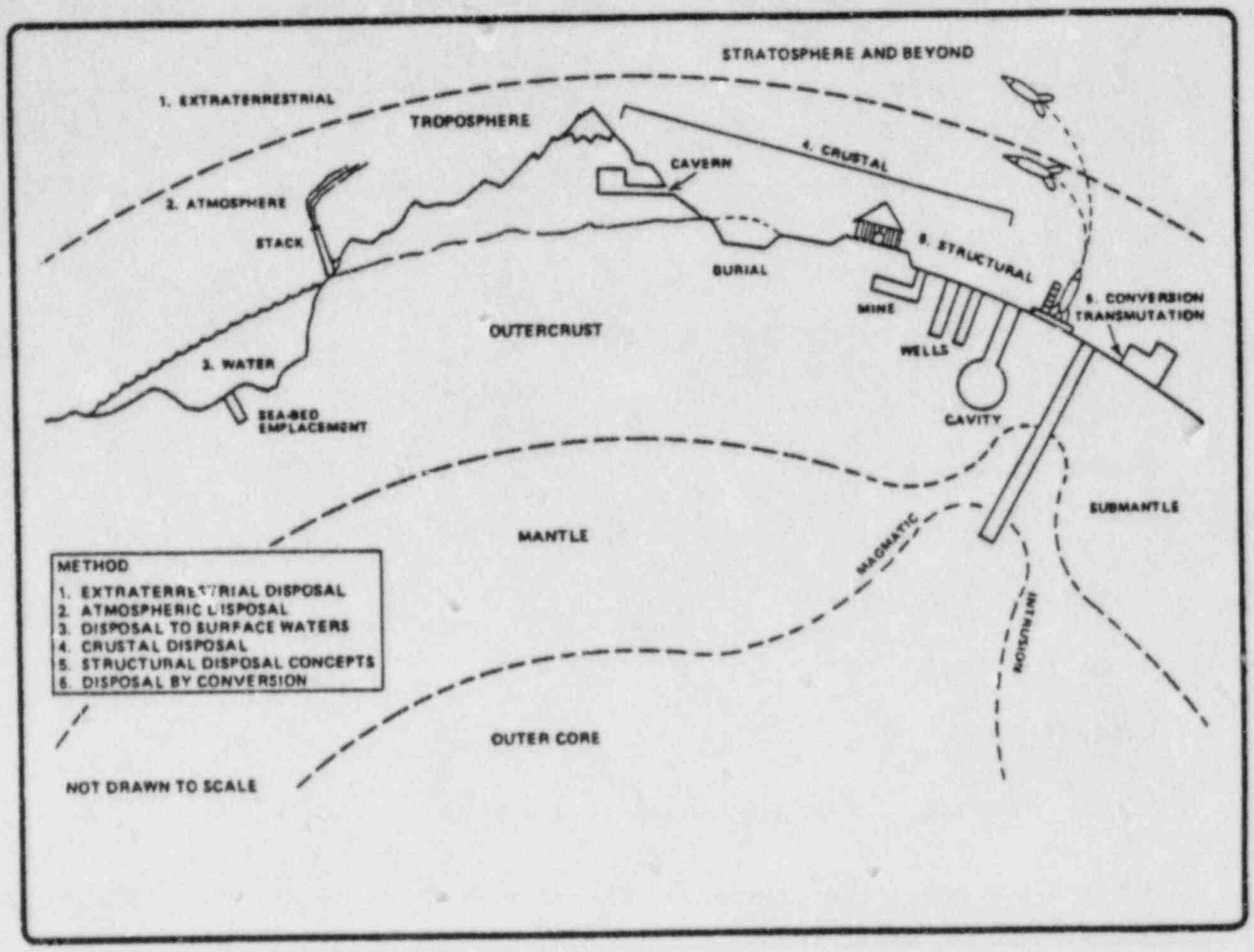
Table 3 (Continued)

Alternatives	Method of Disposal
Atmospheric	Stacks Rockets Balloons
Geologic Formation	Mined, drilled or exploded cavity Hydrofracturing Ice-sheet disposal Dispersal by mixing into soil and leaching ponds Release to aquifers Island disposal Seabed disposal Very deep hole
Hydrosphere	Discharge to rivers, lakes, and seas Ocean dumping
Aboveground Structural Buildings	Warehouse operation
Proposals to Shallow-land Burial	Baffle concept Addition to future barriers Natural impermeable strata

Source: Takamura, E.S., 1979

The Authority's technical and economic feasibility survey consisted of an in-house literature evaluation. A key document used in the assessment was the report prepared for the U.S. Nuclear Regulatory Commission (U.S. NRC) by Ford, Bacon, and Davis (NUREG/CR-0308) (8). Several follow-up reports to NUREG/CR-0308 also were used in assessing the economics of alternative disposal technologies and various methods for near-surface disposal (2, 9, 10). Table 4 shows the range of disposal costs ($\$/ft^3$) associated with each technically suitable alternative technology. The range of cost for each of the alternatives results primarily from the fact the various methods of disposal are available within each alternative. Table 4 also shows that land disposal is still one of the most economical alternativea available. Other advantages associated with near-surface disposal methods are the ease of efficient monitoring, requirement for little handling of the waste, and ease of retrievability.

Figure 3. Schematic Showing The Relation of Various Low-Level Radioactive Waste Disposal Alternatives to the Earth and its Surroundings



Source: NUREG/CR 0308.

Table 4

Cost of Various Low-Level Radioactive Waste Disposal Concepts

Concept	$/ft³ of Wastes[a]
Ocean dumping	3 - 4
Geologic disposal	
(a) Mined or drilled shaft	2 - 3
(b) Hydrofracturing	6
(c) Mined vault	5 - 15
Seabed disposal	3,335 - 7,410
Ice-sheet disposal	1,000 - 10,000
Structural concepts	7.5 - 37
Space disposal	10^5 - 10^6
Land disposal	1 - 10

[a]1979 cost does not include pretreatment, conditioning, handling, transporting, and efficiency of disposal trench utilization.

Source: Takamura, E.S., 1979

The various methods for near-surface disposal are shown in Table 5. Bennett, et al. addressed the status of each method (see Appendix A) and whether the method meets all the requirements of 10 CFR 61 (10). He concluded that the various methods offer some advantages over shallow-land burial; however, the design, construction, and operating cost would probably be higher. Associated with this elevated cost would be the increased complexity in the design and operating procedures for each method.

Table 5

Near-Surface Disposal Alternatives

Belowground Vaults
Aboveground Vaults
Earth Mounded Concrete Bunkers
Mined Cavity
Augered Holes

Several of these near-surface options are worth elaborating on. One method being seriously considered is the use of belowground vaults. This method refers to any enclosed engineered structure constructed below the surface of the earth. Belowground vaults are being studied by the Atomic Energy of Canada, Ltd. (AECL) and are currently in use as storage facilities at Oak Ridge National Laboratories (ORNL). Aboveground vaults are similar to belowground vaults except that these are constructed on or near the surface. Aboveground vaults are currently used for storage facilities at sites located in Ontario and New Brunswick, Canada. Earth-mounded concrete bunkers feature trenches, belowground vaults, and earth mounds, as well as controlled packaging and encapsulation where the finished product resembles a bomb shelter. Earth mounded concrete bunkers are used as storage facilities in Canada as well as a disposal method at the Gentre de la Manche site in France. Mined cavities are being seriously considered and research activities are underway in Canada, Sweden, West Germany. and the United States (U.S. DOE and Tennessee Valley Authority). The mined cavity method is used as a disposal and storage facility by the West Germans for disposing of low-level radioactive waste at the Asse Salt Mine and for hazardous waste disposal at the Herfa-Neurode Potassium Mine. Augered holes consisting of augering boreholes into stable geologic media are also being pursued. Research at the Nevada Test Site, in Corleborn, West Germany, and in Canada is being conducted. Augered holes have also been extensively applied as storage facilities at ORNL, Los Alamos National Laboratory, and in Ontario, Canada. Figures 4 through 6 show some of the previously discussed concepts.

Shallow Land Burial Variations

In addition to a familiarization with the previously discussed alternative approaches, the Authority, through Ebasco, evaluated shallow land burial variations which incorporated different degrees of additional barriers (2).

Figure 7 shows a cross section of a typical excavated trench with no additional barriers other than an intrusion barrier. In most areas of Texas that are under consideration by the Authority, this design would be expected to meet required performance objectives.

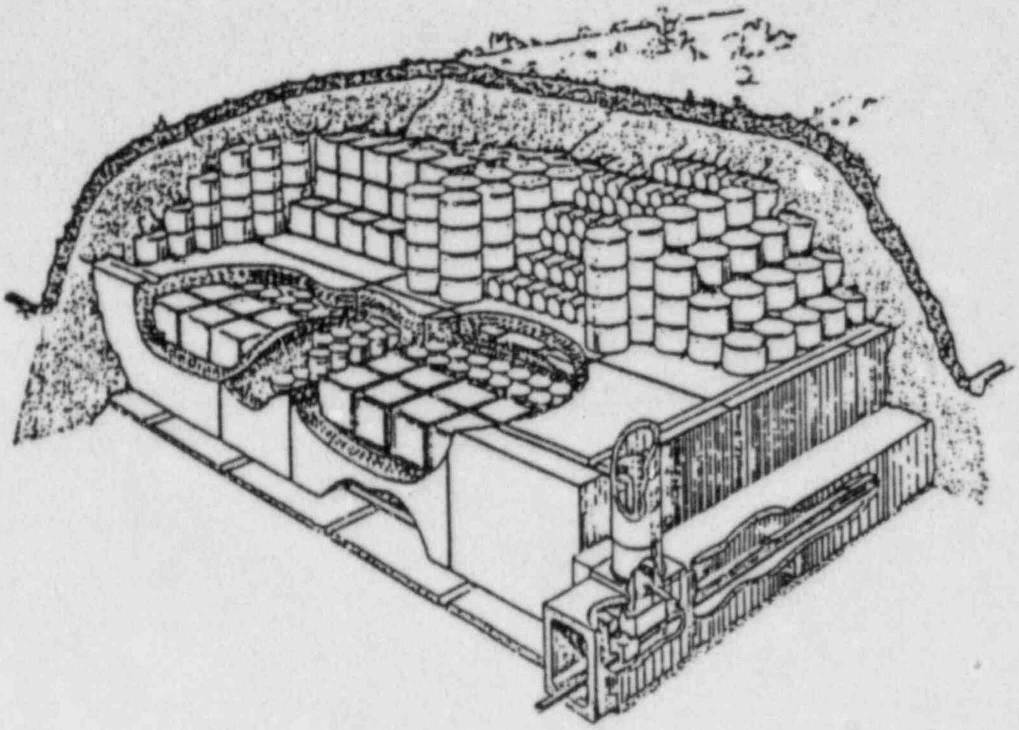
Variations in land burial which were evaluated by the Authority are shown in Figures 8 through 12. The concrete cylindrical tank and pit and borehole designs do not have as much practical appeal as the concrete canal or rectangular concrete trench designs. Additional designs which the Authority is currently evaluating include partially buried and aboveground bunkers. Time and space do not allow for a more complete discussion of these approaches; however, this information is available in report form through the Authority.

Perspective on Alternatives

A number of technical concerns related to alternative designs were discussed earlier. These do not necessarily mean that there is a blanket indictment against these approaches, but it does mean that alternatives must be considered on a case-by-case basis.

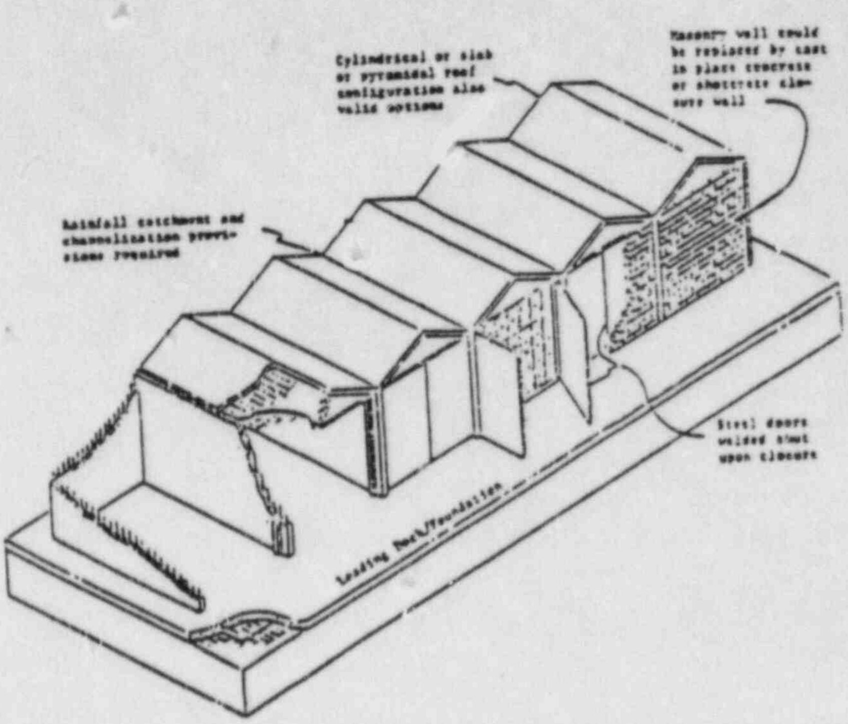
With the exception of economic considerations, the other concerns can be appropriately addressed. However, if additional capital costs force the unit disposal costs to inordinately high levels, generators might resort to other, less environmentally suitable means of disposal. In order for alternatives to be considered on parity with shallow land burial, government subsidies might be required to augment

Figure 4. Permanent Waste Storage/Disposal Facility in France.



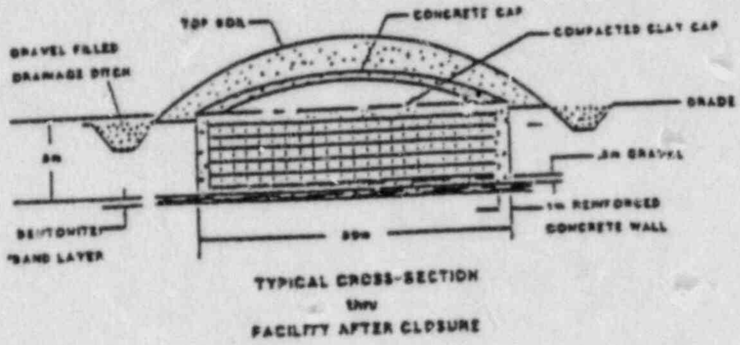
Source: New York State Draft Report, 1984.

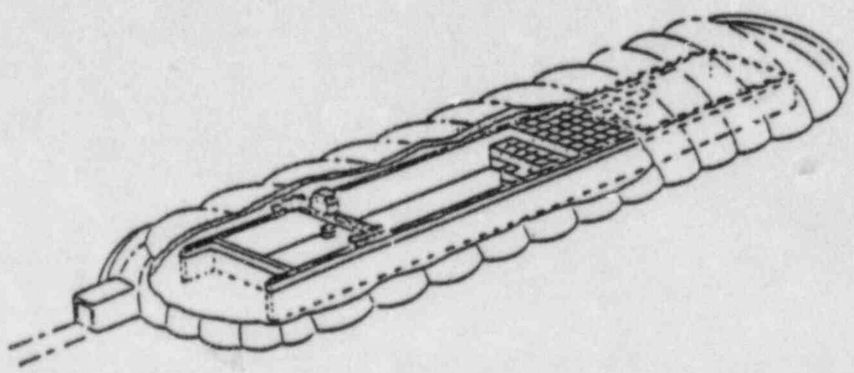
Figure 5. Conceptual Sketch of Cellular Aboveground Vaults for Low-Level Waste Disposal.



Source: Bennet, et al., 1984.

Figure 6. Earth Mounded Concrete Bunker with an Air Supported Weather Shield.

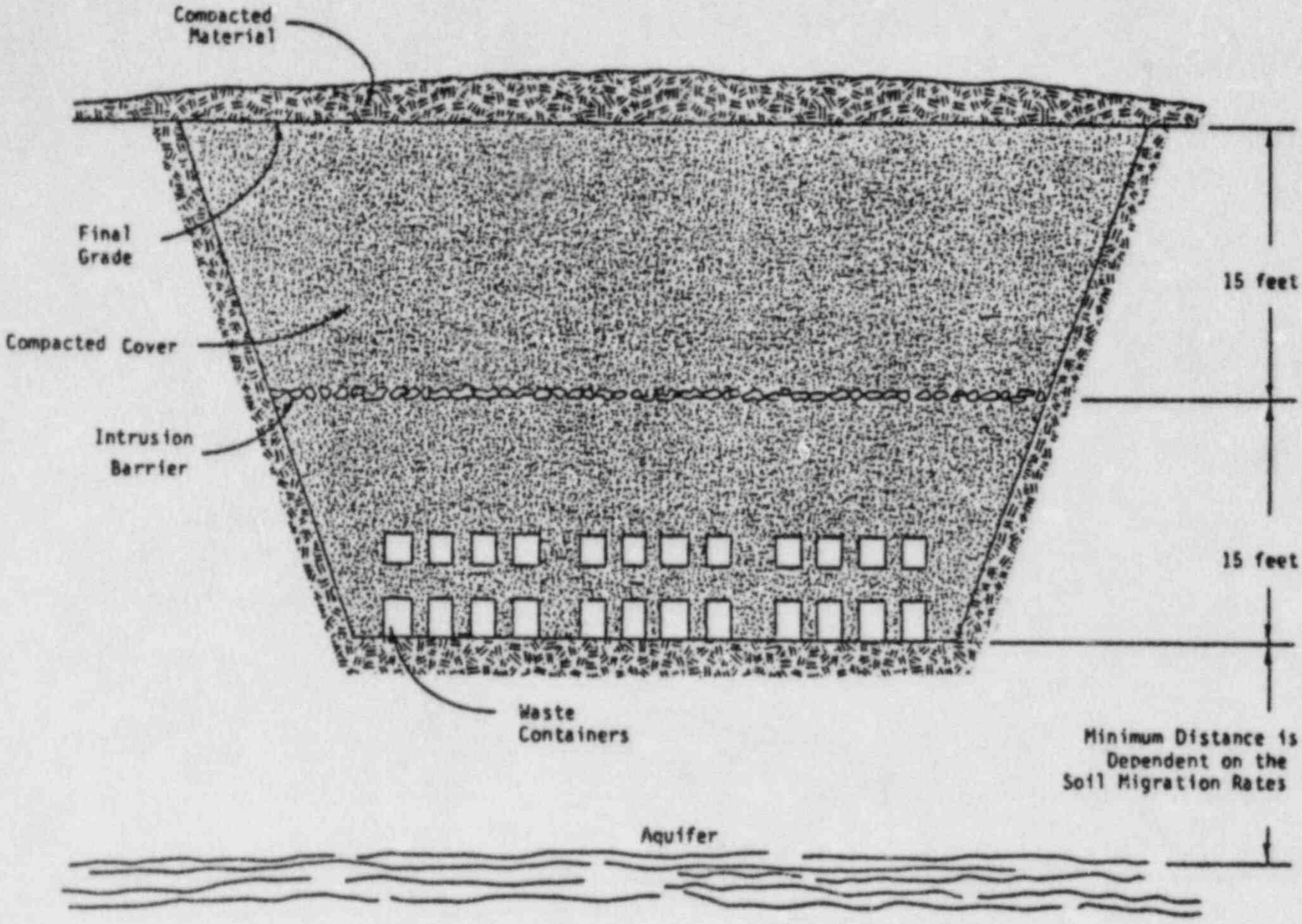




The conceptual drawing of a concrete walled disposal vault depicts an air supported weather shield which is used during the operational stage. The facility represents only one of many possible variations to the Earth Mounded Concrete Bunker concept. The use of an air supported weather shield has potential application to most of the alternative disposal methods considered in this report.

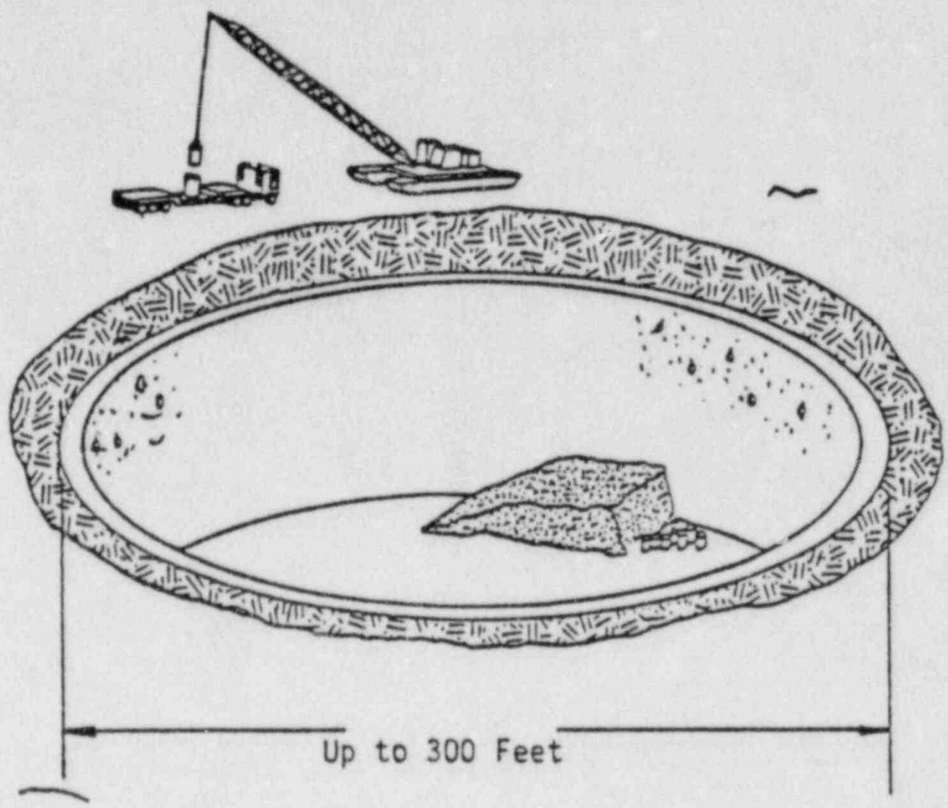
Source: Bennet, et al., 1984.

Figure 7. Cross Section of a Typical Standard Excavated Trench.



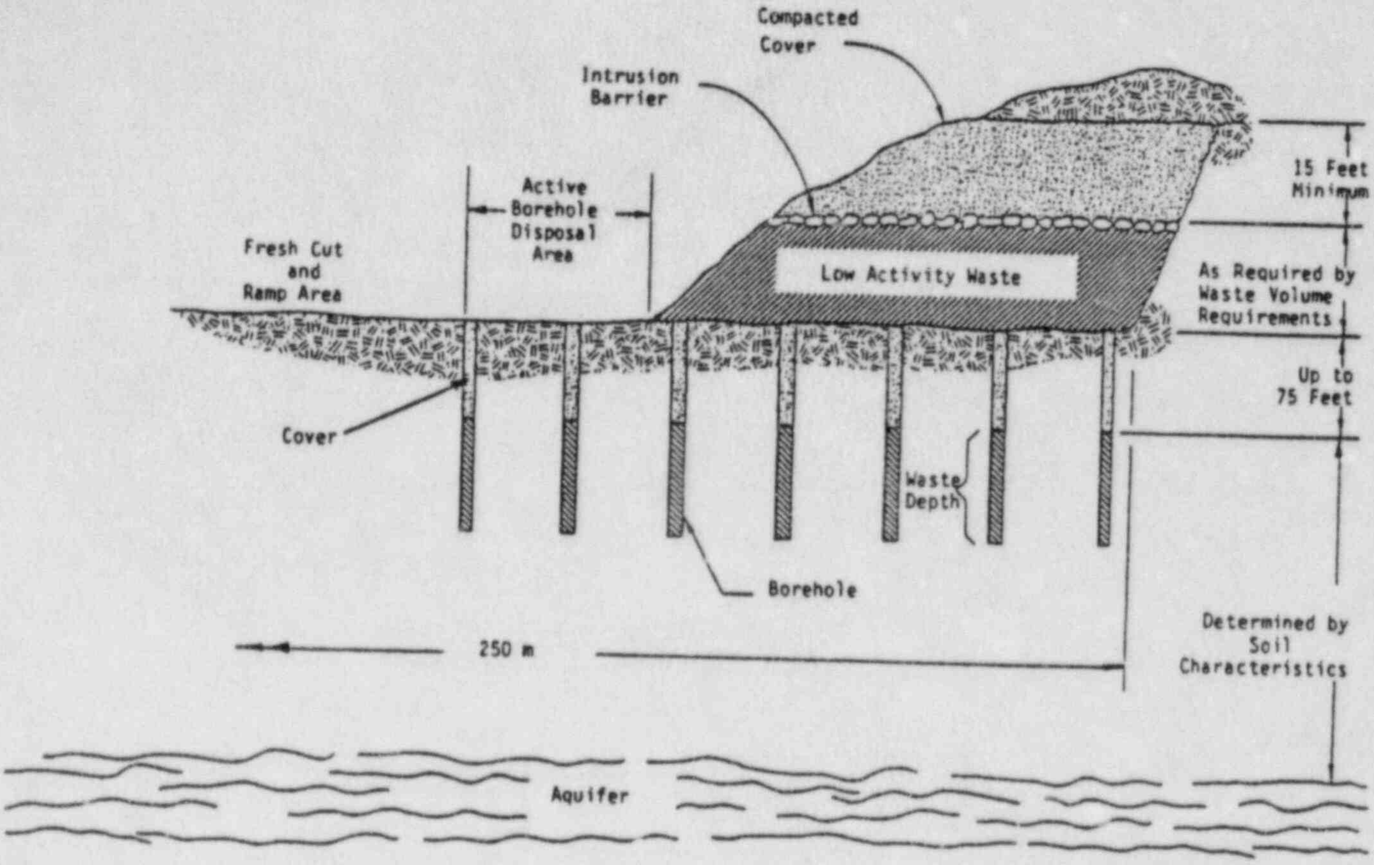
Source: Ebasco, 1983.

Figure 8. Concrete Cylindrical Tank.



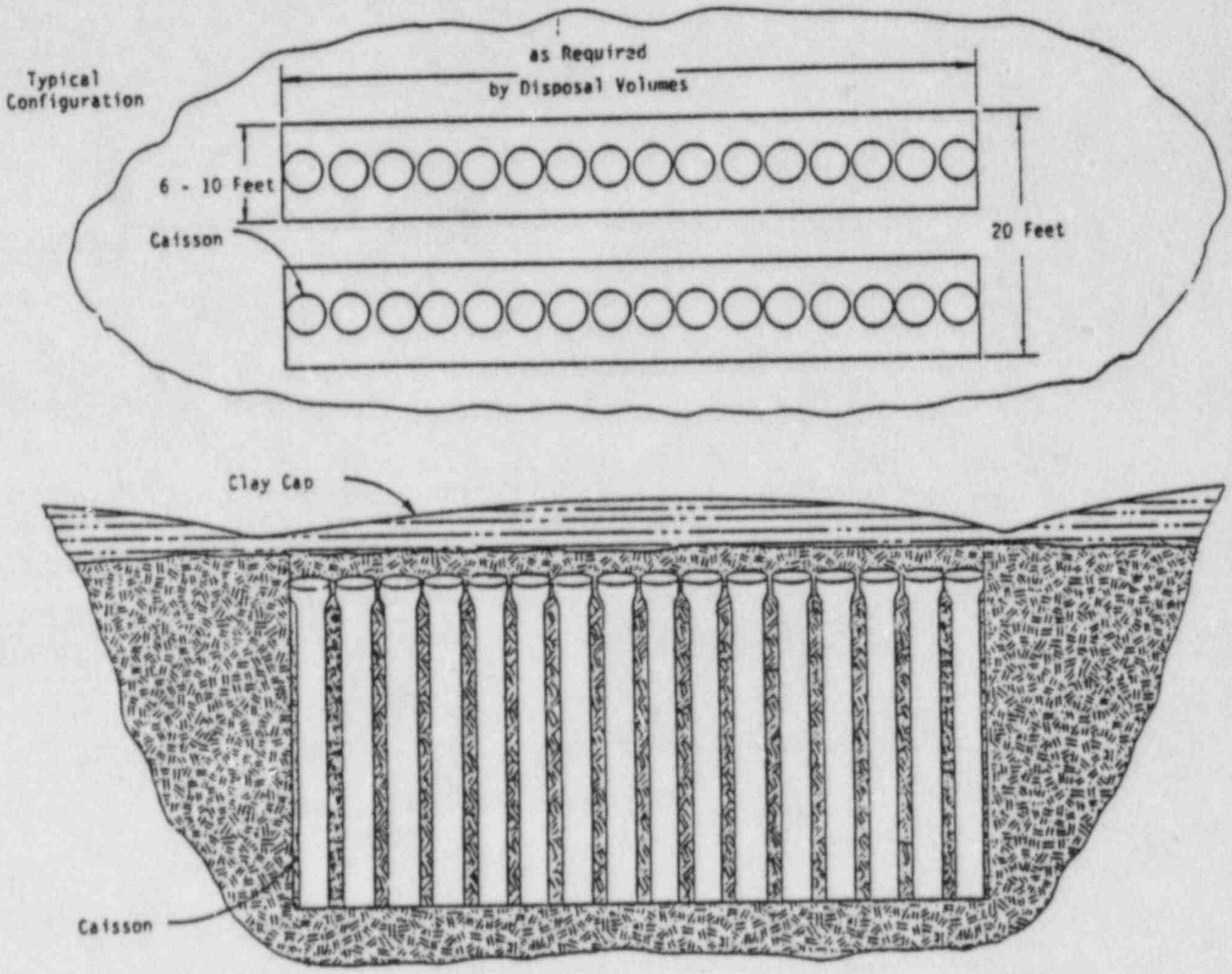
Source: Ebasco, 1983.

Figure 9. Cross Section of a Pit and Borehold Design.



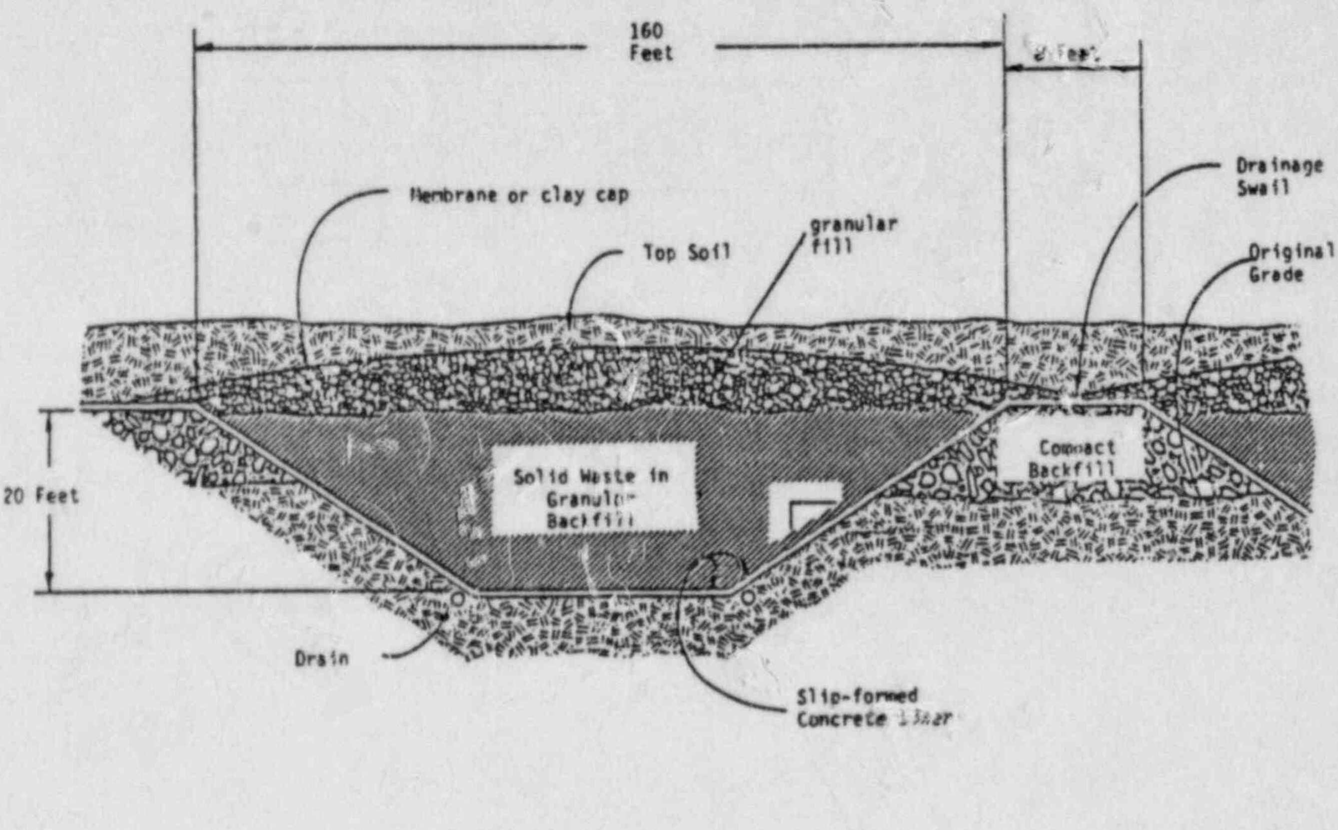
Source: Ebasco, 1983.

Figure 10. Caisson Trench Disposal.



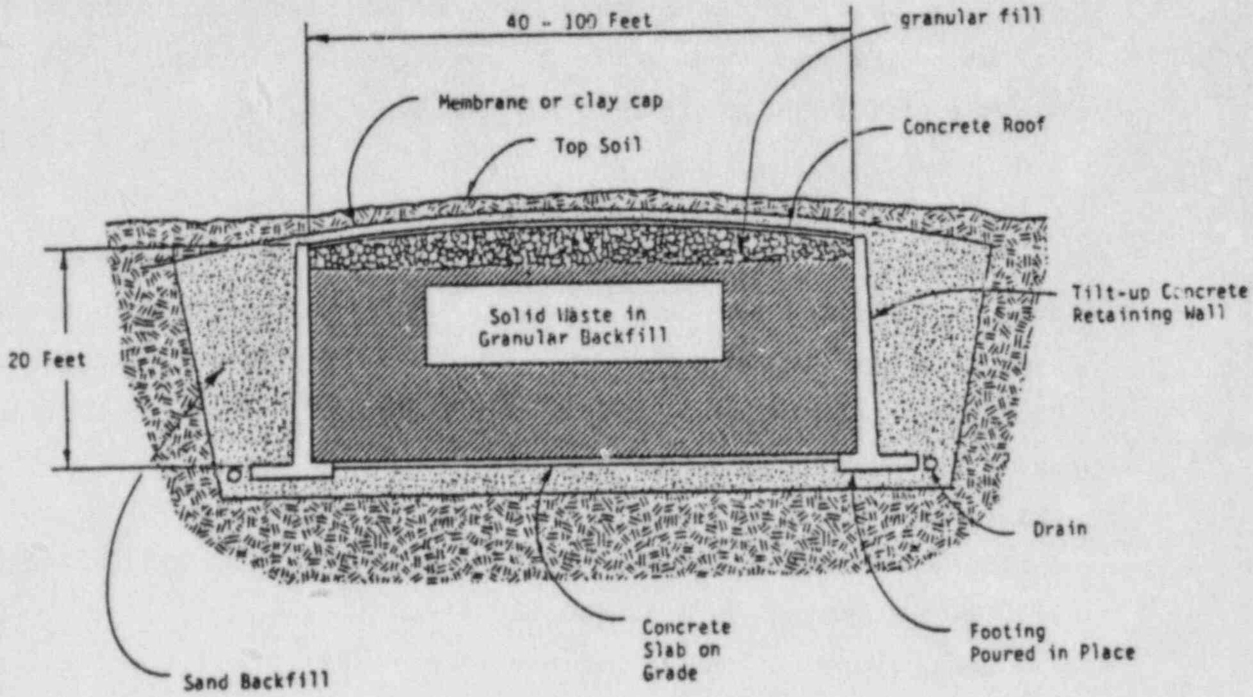
Source: Ebasco, 1983.

Figure 11. Generic Concrete Canal Design.



Source: Ebasco, 1983.

Figure 12. Generic Rec'ıngular Concrete Trench Design.



Source: Ebasco, 1983.

disposal fees. Otherwise, alternative approaches could be priced out of the market even if the market is governmentally controlled by the states and compacts.

The Authority will be evaluating the sensitivity of additional capital costs for particular alternatives during FY 84. Preliminary figures indicate that additional costs for alternatives can range from an almost insignificant increase to a doubling or tripling of the per unit disposal fee. In some extreme cases, the impact could be an order of magnitude larger. For example, if an additional $2 million per year in operational costs were added to the Authority's budget, per unit disposal fees would be expected to increase by at least a minimum of $\$706.40/m^3$ ($\$20/ft^3$).

CONCLUSION

Over the past two years, the Authority has conducted 12 major studies ranging from waste characteristics evaluations to alternative considerations. The Authority anticipates annual waste volume generation of approximately 3,936 m^3 (139,000 ft^3) when the four nuclear reactors under construction in Texas come on line. About 81 ha (200 acres) of land will be required for a conventional shallow land burial facility. Disposal costs for this type facility are projected between $\$935.84/m^3$ ($\$25.50/ft^3$) and $\$1,286.87/m^3$ ($\$36.44/ft^3$).

All 254 counties in the state were subjected to screening using 24 exclusionary and inclusionary criteria. Nine areas in the south, central, and west parts of the state emerged as the most favorable. The Authority anticipates naming a site during the summer of 1984.

Experiences gained from the site selection process led the Authority to conduct socioeconomic studies and attitude analyses of the most preferred areas. It was determined after interviewing representatives from over 150 local entities and polling 998 individuals, that the public does not have confidence in the current technology. The public trusts physicians and professors the most, and the news media and businessmen the least. Health impacts, environmental contamination, and transportation accidents are feared. There is a large public relations problem regarding low-level radioactive waste which might be difficult to resolve.

A number of factors must be considered in evaluating the appropriateness of alternative designs. These include technical factors, regulatory concerns, and economics. Technical factors and regulatory concerns can be solved. Depending on the alternative design, the cost could require a subsidy to ensure an acceptable user response. In Texas, the nominal rate of increase for an additional $2 million per year in operating cost would add about $706.40/$m^3$ ($20/$ft^3$) to the disposal fee.

Texas is proceeding with a complete evaluation of alternative designs in FY 84. The answers to this issue may well be some hybrid between a shallow land burial design and an alternative design.

ACKNOWLEDGEMENTS

The author acknowledges Eric S. Takamura, Ph.D., John Salsman, Ruben A. Alvarado, P.E., and Rhonda Durst for their assistance in preparing this report.

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Appendix A

Status of Alternative Methods

Alternative	Status
Belowground Vaults	Research: Canada, Atomic Energy of Canada, Ltd. (AECL), deep vaults Whiteshell Nuclear Research Establishment (WNRE), Manitoba, Canada
	Storage: Chalk River National Laboratory (CRNL), Ontario, Canada, shallow vaults WNRE, Manitoba, Canada, shallow vaults Oak Ridge National Laboratory (ORNL), Tennessee, US, shallow vaults
Aboveground Vaults	Storage: Ontario Hydro, Bruce Site, Ontario, Canada New Brunswick Electric Power Commission, Pt Leprau Site, New Brunswick, Canada
Earth Mounded Concrete Bunkers	Storage: Hydro Quebec, Gentilly Site, Quebec, Canada CRNL, Ontario, Canada WNRE, Manitoba, Canada

	Disposal: Gentre de la Manche site, France
Mined Cavity	Research: AECL, Canada, deep vaults Sweden, Low-Level Wastes (LLW) and Intermediate Level Wastes (ILW) Gorlebon, W. Germany, boreholes in mine floors in bedded salt U.S. Department of Energy (DOE) Tennessee Valley Authority, U.S.
	Storage and Disposal: W. Germany, Asse Salt Mine (Radioactive Waste Facility) W. Germany, Herfa-Neurode Potassium mine (Hazardous Waste Facility)
Augered Holes	Research: DOE, Nevada, U.S., Greater Confinement Disposal Test (GCDT) Gorlebon, W. Germany, boreholes in mine floor, bedded salt AECL, Canada, boreholes in glacial till
	Storage: ORNL, Tennessee, U.S. Los Alamos National Laboratory (LANL), New Mexico, U.S. Ontario Hydro, Ontario, Canada Bruce site "tileholes" CRNL, Ontario, Canada, "tileholes"

ALTERNATE MANAGEMENT TECHNIQUES FOR LOW-LEVEL RADIOACTIVE WASTE TO BE CONSIDERED BY THE THREE-STATE LLRW STEERING COMMITTEE FROM MAINE, VERMONT AND NEW HAMPSHIRE

Robert Eisengrein,
House of Representatives,
New Hampshire

1. BACKGROUND
2. THE REVIEW EFFORTS
3. WHAT PICTURE EMERGES FROM THIS REVIEW
4. MATERIAL MOST APPLICABLE
   - 4.1 THE ONTARIO HYDRO EXPERIENCE
   - 4.2 REPORT 1 EVALUATION
5. SOME CONCLUSIONS
6. SOME RECOMMENDATIONS

TO: Three-State LLRW Steering Committee--Maine, Vermont, New Hampshire

FROM: Representative R. H. Eisengrein, New Hampshire House

DATE: November 1, 1983

SUBJECT: Alternate Management Techniques for Low-Level Radioactive Waste

1. BACKGROUND

Per the request of the technical subcommittee of the 3-state LLRW steering committee investigating a potential compact to manage LLRW, a variety of applicable material has been reviewed. The following report lists:

--A SUMMARY OF THE REPORTS REVIEWED, APPENDIX 1
--DIGEST OF PERTINENT FACTS FROM APPLICABLE REPORTS, APPENDIX 2
--THE REVIEW EFFORTS
--WHAT OVERALL PICTURE EMERGES FROM THIS REVIEW
--MOST APPLICABLE MATERIAL
--SOME CONCLUSIONS
--SOME RECOMMENDATIONS

2. THE REVIEW EFFORTS

A variety of people and groups have come forth with information that has been reviewed. The material is cited in APPENDIX 1. The material is pragmatic and in use presently--not just theoretical. The reports consider such things as:

--Who designed and built the equipment
--How it was operated
--The land use
--The costs--both capital and operating
--Safety and health hazards
--Why of the approach
--Unique features
--Volume of LLRW handled
--Type of LLRW handled

Individual digests of the most informative reports are revealed in APPENDIX 2. From these, one can decide if reading the entire report in detail is worthwhile. The most important reports will be made available to the steering committee.

The most valuable and pertinent reports are the ones covered by the Ontario Hydro experience and Report #1 of APPENDIX 1. Why is this so?

Ontario Hydro's length of operating experience, variety of alternate storage structures, and excellent documentation provide a base of comparative information. Additionally, Ontario Hydro has been very willing to share their information; telephone conversation was one method.

Likewise, Report #1 provides a broad base for comparing different alternate techniques for managing and storing LLRW.

3. WHAT OVERALL PICTURE EMERGES FROM THIS REVIEW

In the United States, our approach for managing LLRW has focused on Shallow-Land Burial. It has only relaxed in one area--the NRC's willingness to permit interim storage of waste at a nuclear plant site for a maximum of five years. However, a special license is needed for this. The concept behind this idea is to allow plants to gather sufficient material for more economical handling and packaging.

Despite a varying past record of performance, future Shallow-Land Burial installations, covered by Regulation 10CFR61, are encouraged and should be better. However, there are some inherent questions that the public has asked about their long-term safety. The use of engineered alternate management methods in the United States has been very limited. Innovation has been minimal in our country.

Real innovation has existed elsewhere; the Ontario Hydro plant being the prime example. Their experience, and willingness to share it, provides us with a good base for seeing how innovation might be applicable to the unique needs of smaller generators of LLRW.

4. MATERIAL MOST APPLICABLE

This report borrows heavily on Ontario Hydro's experience based on the variety of alternate structures and approaches they have created for managing LLRW. The experience is particularly applicable since it is concerned directly with the LLRW from a nuclear plant--the major generators of LLRW in Maine, Vermont, and New Hampshire.

4.1 COMMENTS ON THE ONTARIO HYDRO EXPERIENCE - REPORT 5

Ontario Hydro Philosophy

In reviewing their material it would appear that their overall philosophy is to handle and manage LLRW in as complete a manner as possible--from its generation to its disposal. Their report outlines methods for handling liquid waste, gaseous waste, and solid waste. The following material covers some detail on each approach. With respect to storage of LLRW, their report states, "Although the practice of disposing such waste directly in soil at carefully selected shallow subsurface sites appears to be acceptably safe, at this time we have placed such materials in interim storage with multiple confinement envelopes between the waste materials and the subsurface environment."

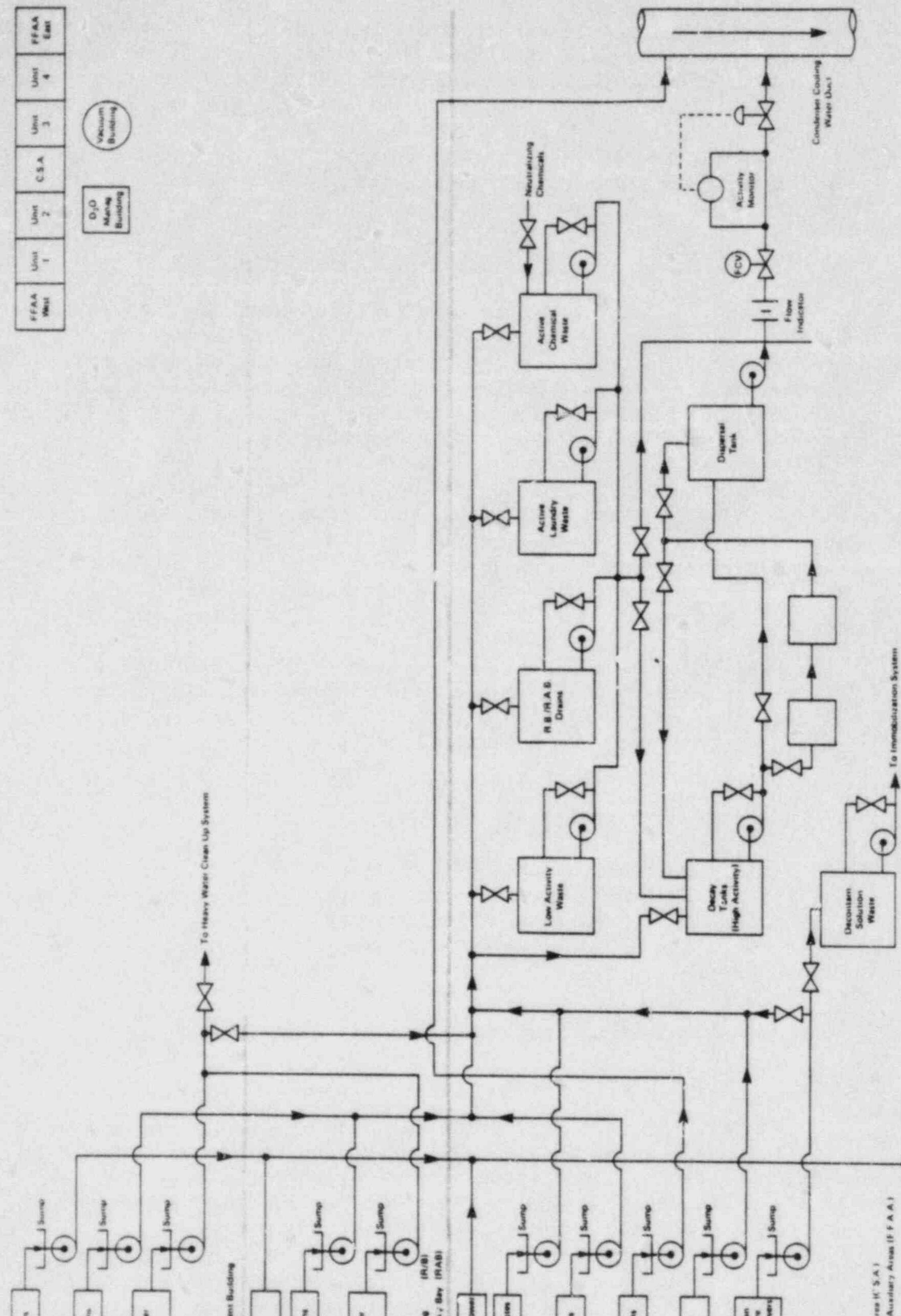


FIGURE 1
Darlington GS A
Active Liquid Waste Management System

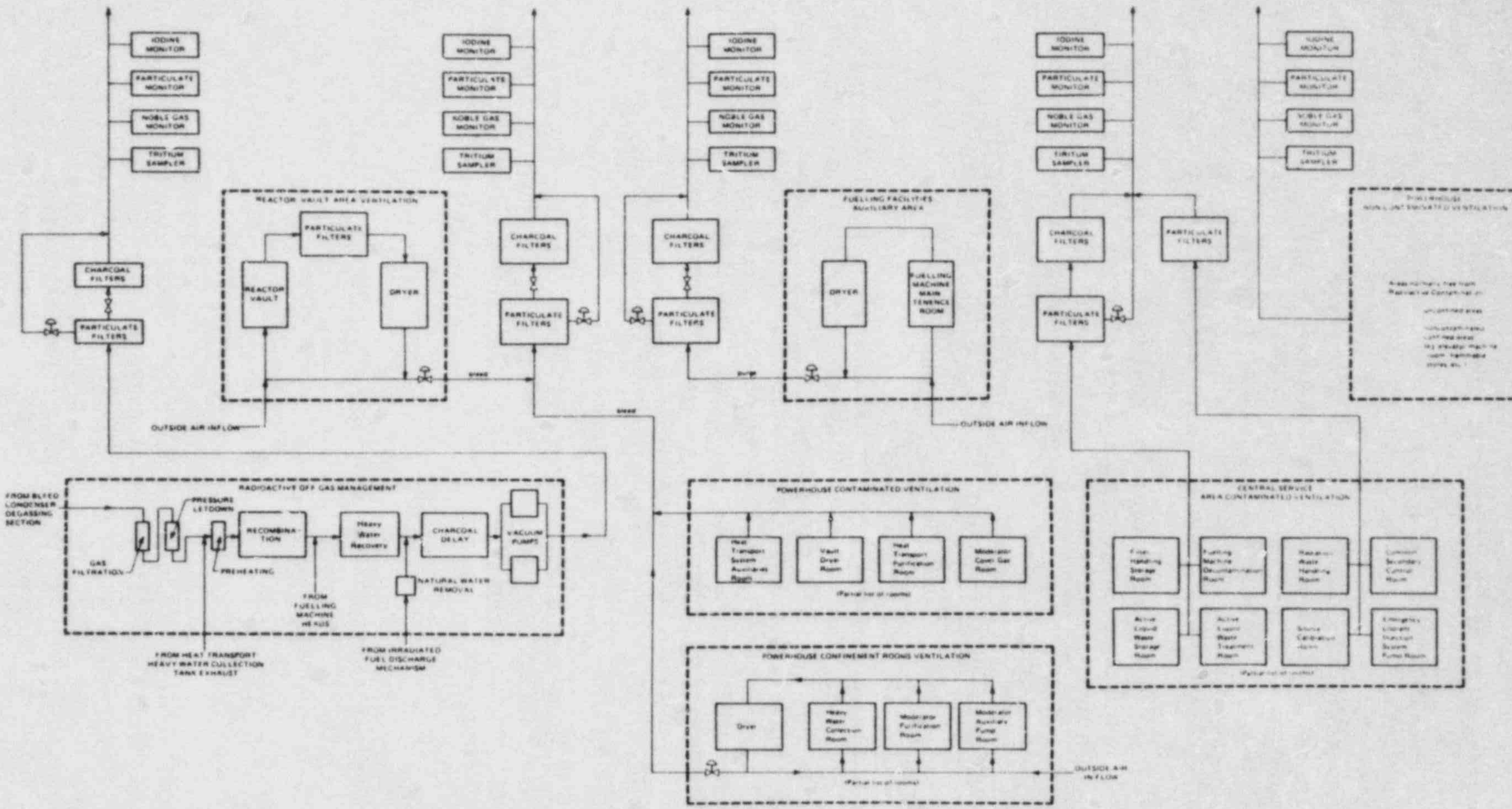


FIGURE 3
Radioactive Gaseous Waste Managment

The principles of their program are as follows:

--All materials are stored in a retrievable manner in facilities having a design lifetime of 50 to 100 years.

--No radioactive materials are placed directly in soil; engineered structures are used.

--Only solids are placed in storage; liquids which are potentially much more mobile and hence more difficult to isolate from the environment are first immobilized.

--All waste placement is treated as interim storage. A certain component of the waste stored may outlive the expected lifetime of the storage structures and hence may be needed to be retrieved and sent to ultimate disposal.

Specific Processing Techniques

Liquids

For liquid waste management there is a centralized system which consists of a centrally located collection system which includes epoxy-lined, concrete tanks of up to 200 cubic meter capacity. The liquid active waste from each nuclear unit flows via segregated sump and pump systems to these centralized tanks. Figure 1 is a block diagram of the active liquid waste management system. The design intent of the liquid radwaste system is to have approximately 60 hours' worth of hold-up capacity in the tanks. The liquids flowing into the active chemical waste tank are sampled and neutralized before transfer to other decay tanks where they can be held up for decay, treated or released.

As a further means of reducing the volume of liquid waste, they have adopted a drycleaning system for laundering all cotton protective clothing. This significantly reduces by about 25,000 cubic meters per year the amount of water being released to the liquid radwaste system.

Gases

The radioactive gaseous management system is typical of those used in light water reactor systems. Figure 3 is a block diagram of this waste management system for gas products.

Solids

The reactor operating waste is composed of a wide variety of materials and shapes. A major volume component is non-radioactive housekeeping wastes from areas of the station in which radioactivity is present. Typical reactor wastes include discarded protective clothing, temporary floor coverings used for contamination control, mop heads, wood, vermiculite, water purification media such as filters and ion exchange resins used in maintaining the quality of reactor process systems, solidified liquid waste, discarded piping, valves, tools, and other hardware arising from the maintenance of reactor systems. Table 1 shows a summary of the solid waste generated. More than 99 percent of the radioactivity is contained in about 5 percent of the total volume.

The combustible, compactible and generally the nonprocessible categories of solid waste are collected in the same manner throughout the station. Various convenient garbage collection locations around the station are established near reactor building airlock entrances and other locations, either permanent or temporary. These locations have two or three garbage cans lined with clear polyethylene bags, and each can is labeled "combustible," "compactible" or "nonprocessible." In this way, segregation of the three waste types, so important for efficient waste processing later at the waste operation site, begins with the station operators and the maintainers. The cans are emptied once every shift by service maintainers and taken to a centralized solid waste handling area in the station in preparation for shipment. After a gamma survey of each bag, it is taped closed with an appropriate colored type indicating its category and is placed in drums or 3-cubic-meter rectilinear packages ready for shipment.

For ion exchange resins, they have moved away from the use of disposable ion exchange vessels, which are very expensive, to systems where the spent resin is slurried to central storage tanks in the station. Figure 5 is a block diagram of the radioactive solid waste management flow sheet.

At the radioactive waste operation site, the combustible and compactible wastes are processed at the waste volume reduction facility, and the nonprocessible waste is sent directly to storage.

Incineration

Since 1977 the combustible waste category has been volume reduced, prior to storage, in a batch pyrolysis-type starved air incinerator. Although the radwaste incinerator system is a working prototype, it has been in operation and relatively productive accumulating over 20,000 operating hours to date. It has processed over 8,000 cubic meters of waste of which 2,800 cubic meters of waste was burned in 1980. One of its major deficiencies is the excessive length of the burn cycle--approximately 40 hours--which limits the maximum incineration capacity to about 3,000 cubic meters of waste per year. It was designed for a 24-hour burn cycle.

Compaction

A mechanical compactor reduces the volume of compactible waste utilizing a drum as the packaging container. Waste in plastic bags is inserted into the drum and the force ram is lowered and compresses the waste. To improve the storage efficiency of compacted waste, a baler was installed in May, 1981. The baler utilizes a rectangular compartment as the waste receptacle. After completion of the compacting process, the package is tied with steel straps before the force ram is withdrawn. They have achieved a gross volume reduction of 7.5 to 9, and a net stored volume reduction factor of 5 to 6 to 1.

Table 2 shows the net overall volume reduction of LLRW via both compaction and incineration.

Storage Techniques

With respect to storage of processed wastes, there are four basic engineered

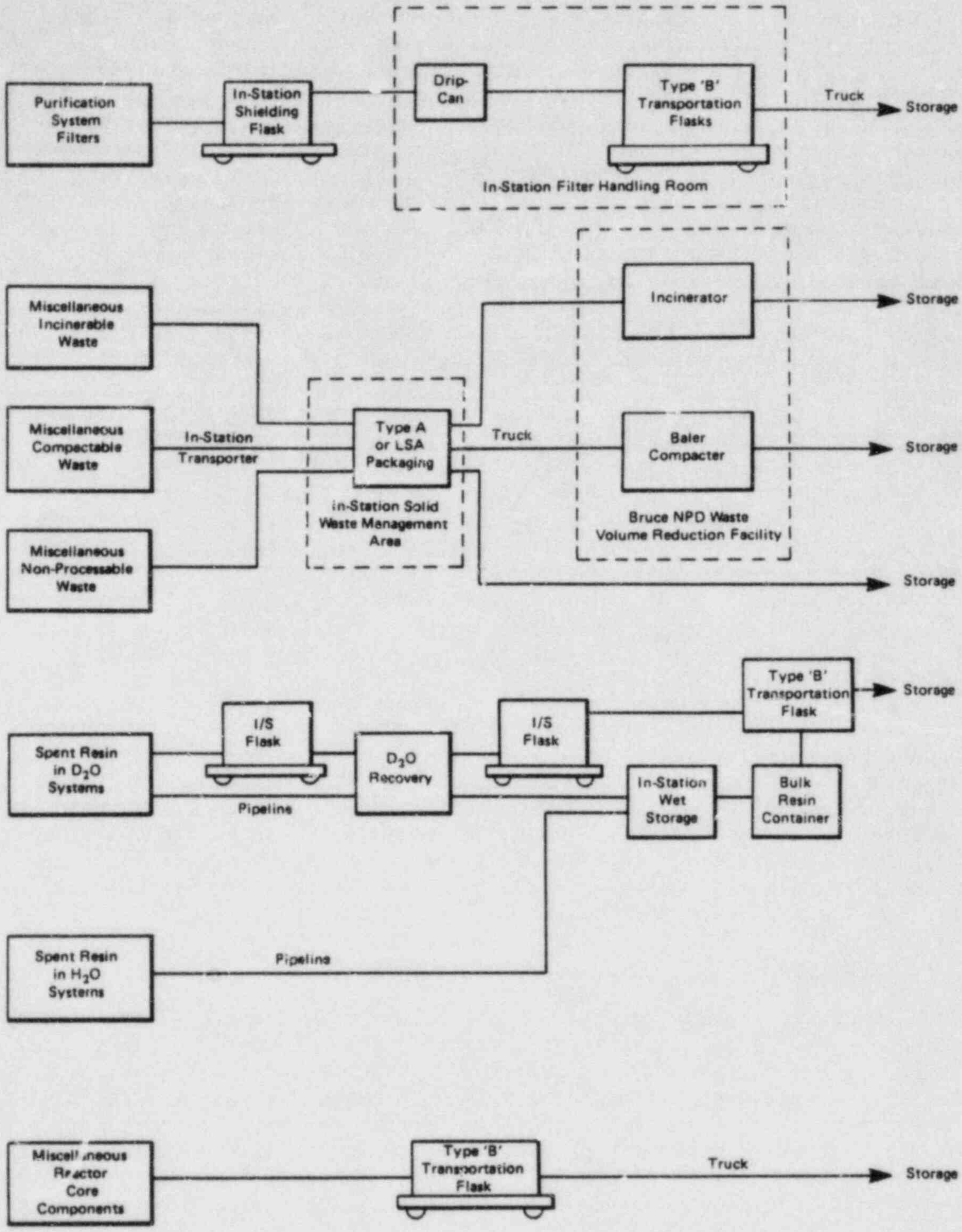


FIGURE 5
Radioactive Solid Waste
Management Flowsheet

structures used. The first of these is the concrete trench shown in Figure 6. It receives processed and nonprocessible lower level reactor wastes. Because of the modest radioactivity levels, much of this waste can be manually loaded.

The second approach for storage uses concrete tile holes, which by virtue of their small cross-sectional area, minimize radiation exposure during loading, and are used for higher levels of radioactivity--such as cartridge filters and packaged ion exchange resins. See Figure 7.

The third type of storage facility, Quadricells, is an above-ground facility; see Figure 8. Quadricells are primarily designed to contain bulk quantities of spent ion exchange resins that are initially collected in large, in-station storage tanks. The bulk resin is transported in 3-cubic-meter disposable steel liners in a Type B shipping flask. The Quadricells are also designed for a secondary role of storing highly radioactive core components. Being totally above grade, the Quadricells have the advantage of being largely site independent; reinforced concrete being used to provide two independent envelopes with a monitored interspace. Minimum design life is 50 years with low maintenance.

The fourth type of storage structure which is now under construction is an above-ground storage building, the low-level storage building (LLSB); see Figure 9.

The LLSB is designed to complement rather than to supplant the other structures. Its dimensions are 50x30x8 meters; it can store about 6,600 cubic meters of packaged LLRW. Only wastes which exhibit radiation fields less than 10 mSv/h (1 rem/h) will be stored.

The LLSB will allow the capacity of the in-ground trenches to be reused once the LLRW in this category, which is presently stored there, is retrieved and placed in the LLSB. This technique, plus the selective placement of some wastes from the tile holes (which have decayed to lower levels since initial placement) into the trenches, will provide adequate storage capacity for all of Ontario Hydro's needs until about 1995.

Costs

Costs, which involve both the capital cost and the operating cost, are cited in the following table for the various types of management.

Type of Process	Cost per Cubic Meter	Cost per Cubic Foot
Incineration	$ 850/cubic meter	$ 24/cubic foot
Nonprocessible material in drums	1,400/cubic meter	40/cubic foot
Filters, etc., for tile holes	7,500/cubic meter	214/cubic foot
Quadricells	10,000/cubic meter	285/cubic foot
Above-ground LLBS	500/cubic meter	14/cubic foot

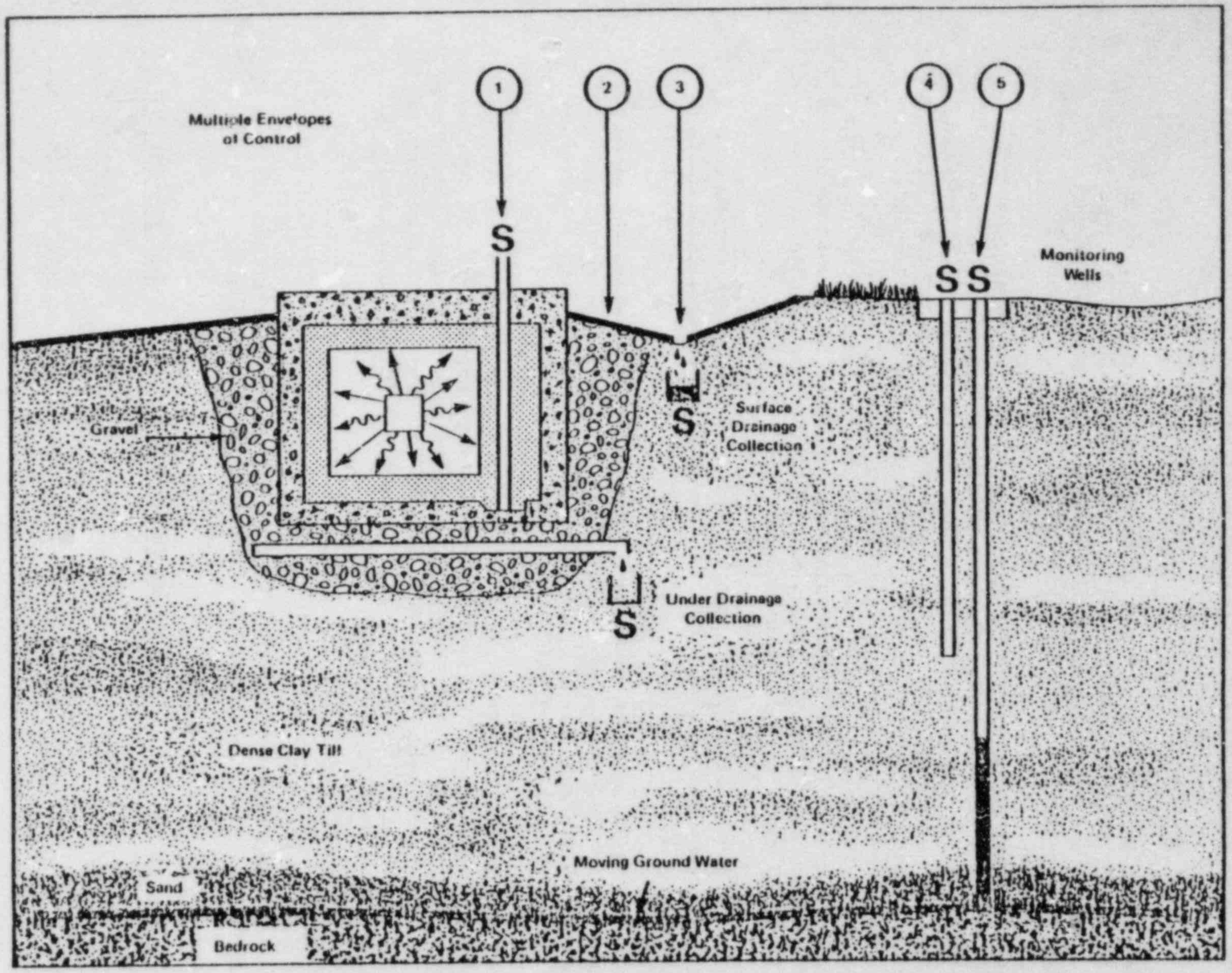


FIGURE 6
Shallow Sub-Surface Storage: Multiple Envelopes of Control

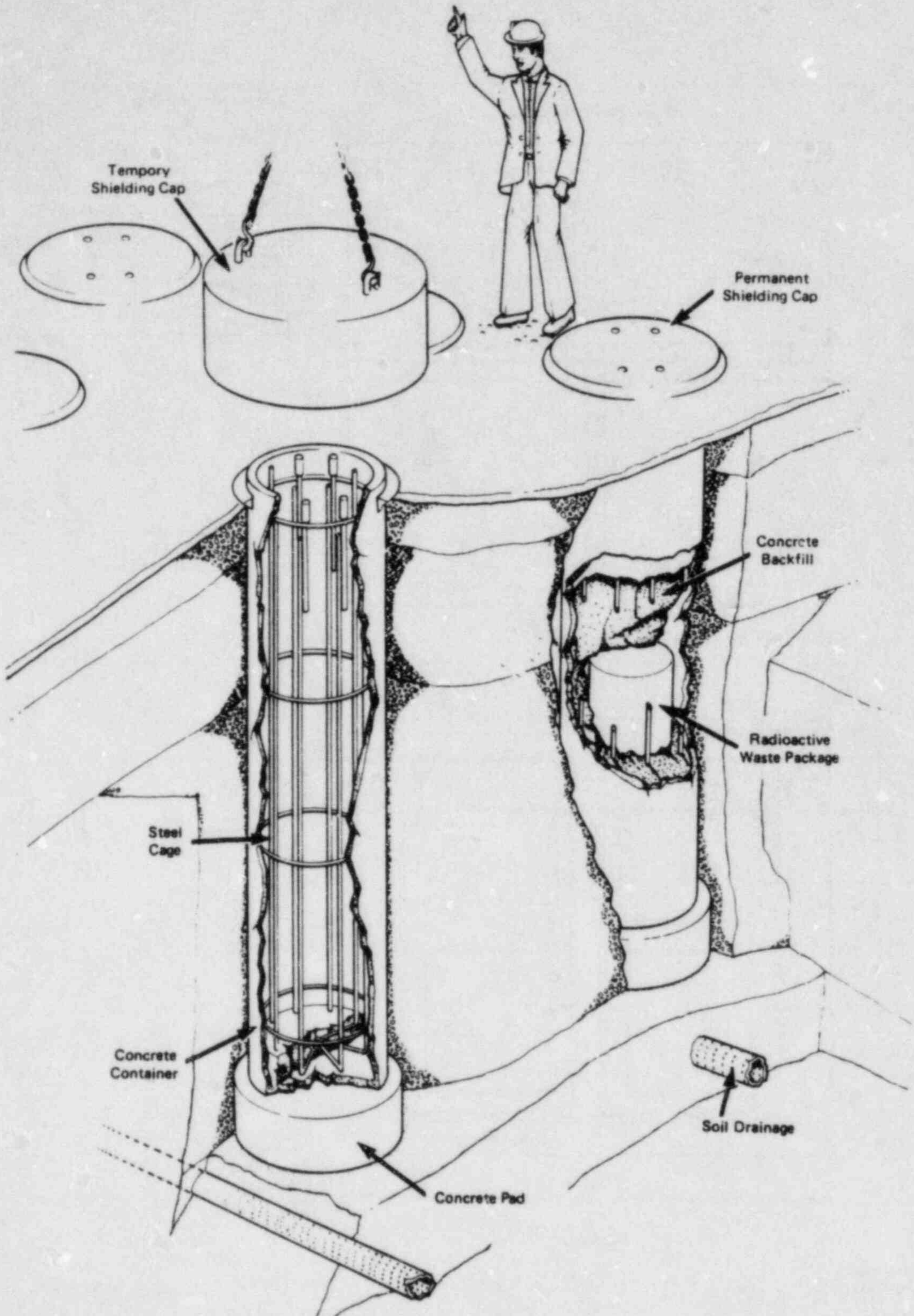
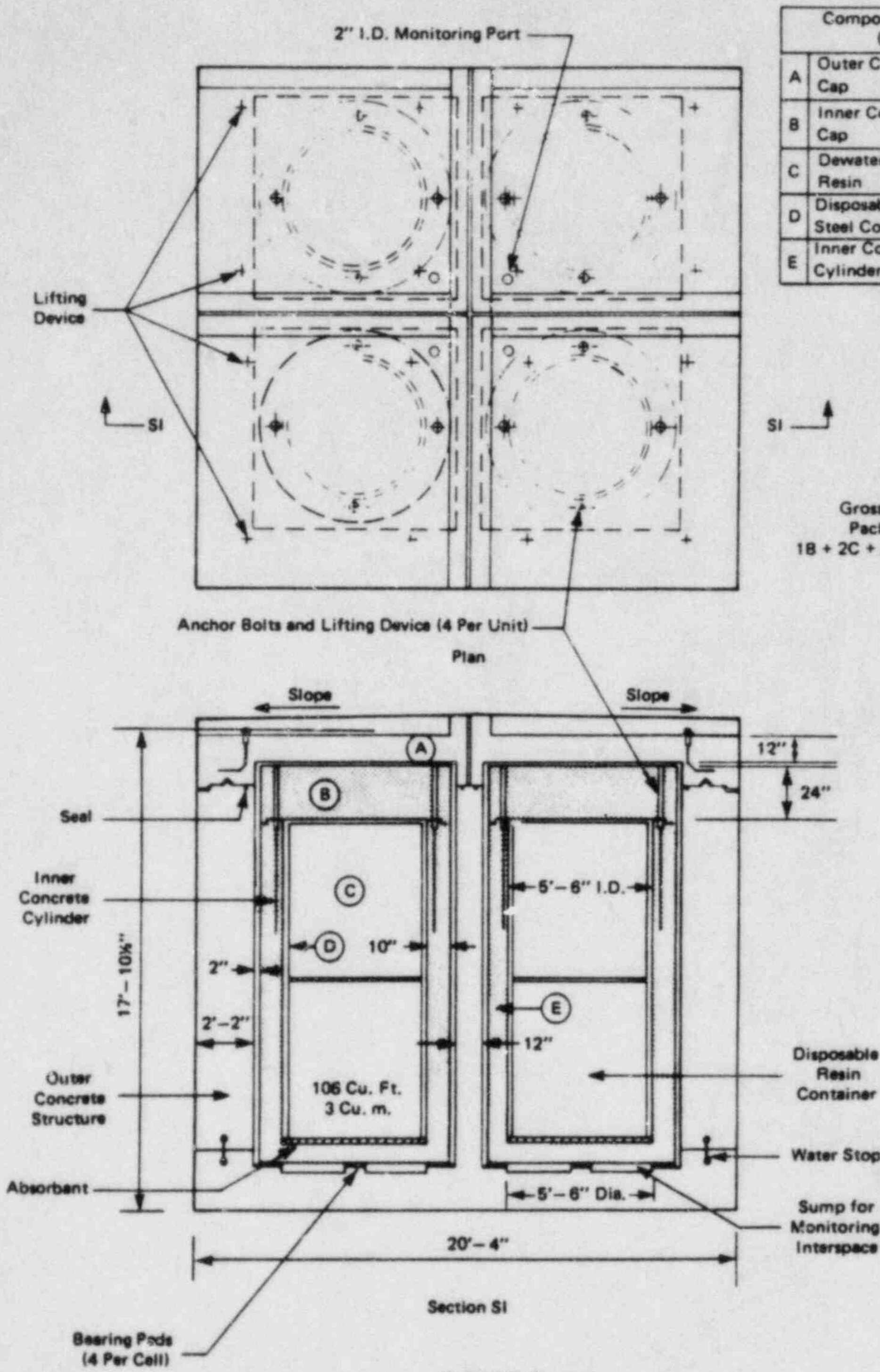


FIGURE 7
Radioactive Waste Tile Hole



Component Weights (Tons)		
A	Outer Concrete Cap	12.0
B	Inner Concrete Cap	6.0
C	Dewatered Resin	3.5
D	Disposable Steel Container	1.0
E	Inner Concrete Cylinder	18.0

Gross Retrievable
Package Weight
1B + 2C + 2D + 1E 33 Tons

FIGURE 8
The Quadricell Storagae Facility

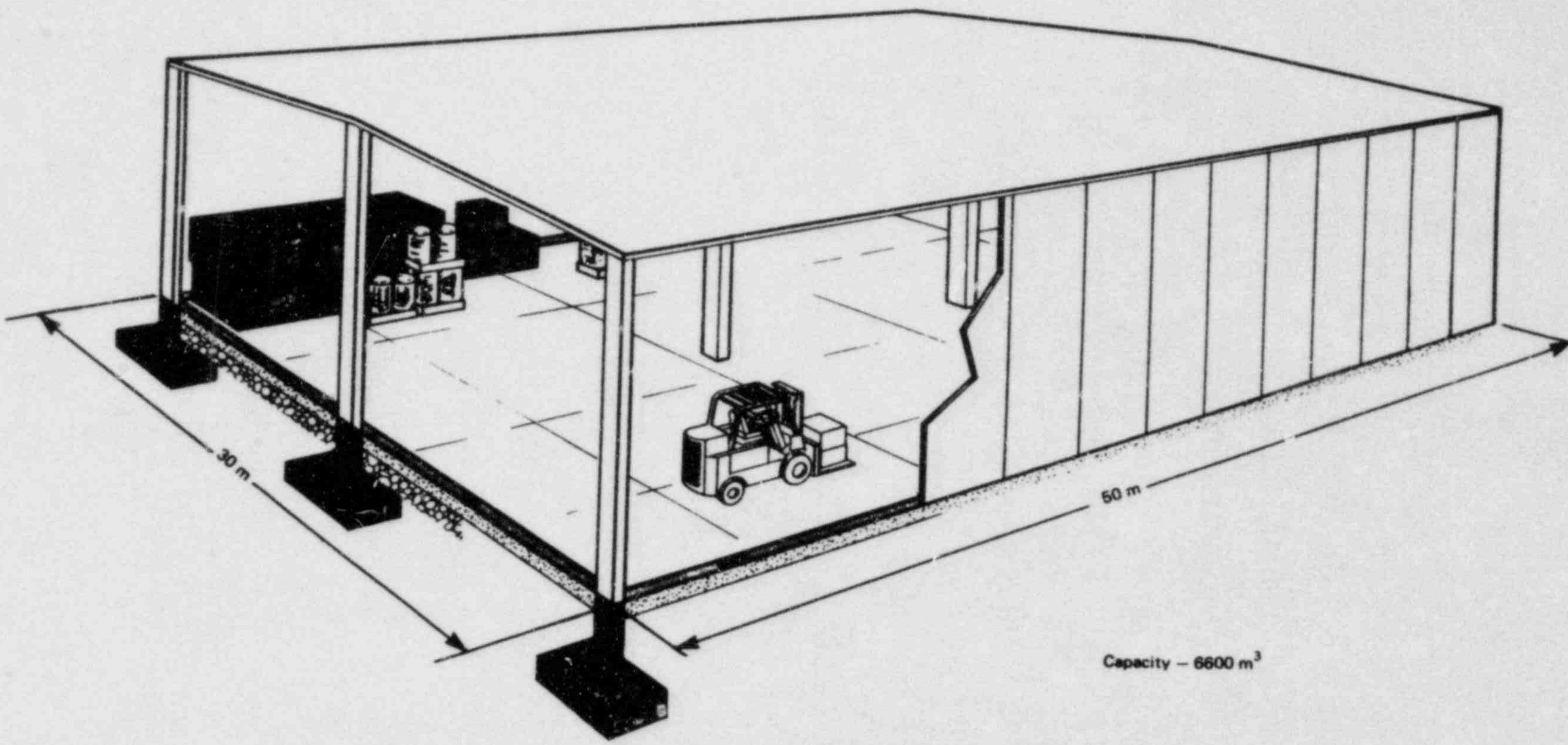


FIGURE 9
Perspective View of Low Level Storage Building

ONTARIO HYDRO

Solid Waste Generated

Type of Waste	Volume/Meters^3	Total Activity C_i
Combustible	500	0.3
Compactible	300	1.0
Non-Processible	200	8.4
lx Resins		
Disposable Can	12	1,000
Bulk	30	1,300
Filters (Cartridges)	4.4	120

Table 1

EXPERIENCE TO DATE

The experience to date has been excellent. To the end of July, 1981, about 20,000 cubic meters of low and medium level wastes have been received for processing and storage. In addition, about 140 tile hole facilities have been used for the storage of ion exchange columns and filters. Figure 10 presents waste receipts by category for the last four years. There have been only a very few minor on-site contamination incidents. Operating procedures and cleanup techniques have been devised in advance to minimize these occurrences and to effectively deal with them when they do occur. None of these events has resulted in any public hazard.

Using data from Figure 10, Table 2 reveals both the original total waste, and the reduced volume waste via processing. The last row reveals what one plant produces; if multiplied by 3, it would approximate closely the sum of LLRW from our three states.

4.2 COMMENTS ON REPORT #1--EVALUATION OF ALTERNATE METHODS FOR THE DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTES

Background

This article presents some important broad-base viewpoints. However, rather than using the tables of data for each alternate method as presented in the original report, a different tabulation could help in comparing these costs with those of the Ontario Hydro experience. Table 3 herein shows for each alternate method the major cost elements:

1. Total capital costs
2. Total operating costs
3. Contingency costs--30 percent of Items 1 and 2 above
4. Profit, financing, and escalation costs--approximately 80 percent of Items 1, 2, and 3
5. Total cost
6. Cost per cubic meter
7. Cost per cubic foot

The Basic Assumptions

The basic assumptions for the alternate methods of LLRW disposal were based on a comparison with the conventional Shallow-Land Burial system. The basic Shallow-Land Burial system consisted of about 494 acres of land which would handle over a 20-year period 630,000 cubic meters, or slightly over 22 million cubic feet of LLRW. It was assumed that all LLRW would come to the site in 55-gallon drums--a standard package. The costs were primarily for the building and operating of the site, and did not include the cost of off-site processing, packaging, and handling. Table 4 has eliminated the transportation costs in the original analysis so comparisons could be made to Ontario Hydro, which had no major transportation costs.

Incidentally, assuming the conventional mix of LLRW from nuclear plants, this "standard" Shallow-Land Burial site would be able to handle about fifty such plants over the twenty years, based on the assumption of about 20,000

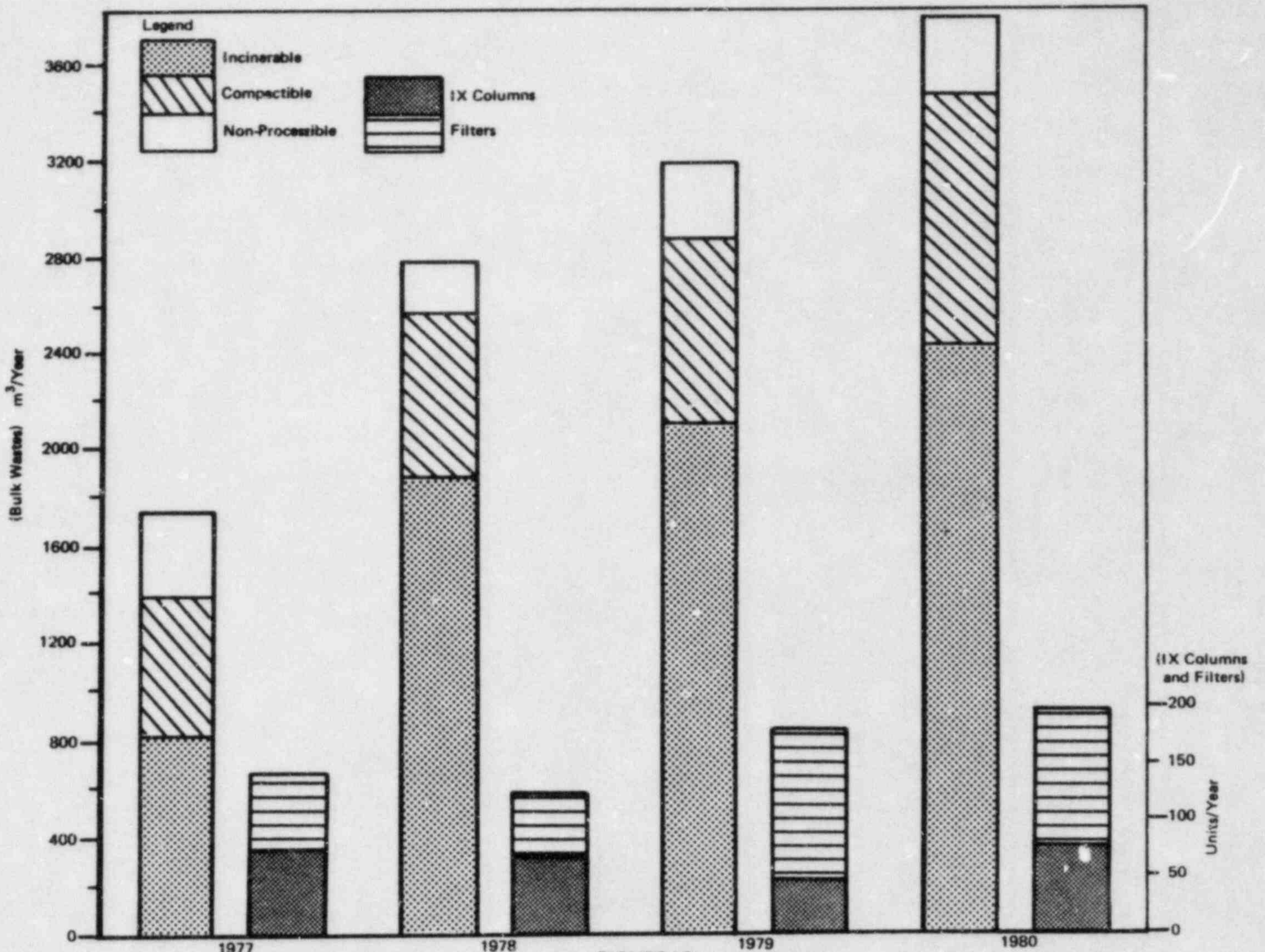


FIGURE 10
Annual Waste Receipts
at the BNPD Radioactive Waste Operations Site

REORGANIZATION OF ONTARIO HYDRO DATA

from

Figure 8, Ontario Hydro Figure 10 for 1980

	A	B	C	D	E	F	
Total Volume 4 Plants	Inciner-able	Compact-ible	Non Process-ible	"A" Reduced by 40/1	"B" Reduced by 5/1	Total of C,D,E	Overall Reduction A/F
3,800 M^3	2,400	1,100	300	60	220	580	6.5
133,000 Ft^3	84,000	38,500	10,500	2,100	7,700	20,300	6.5
For One Nuclear Plant	21,000 Ft^3	9,625	2,625	525	1,925	5,075	6.5

Table 2

Translated Cost Figures From Report 1

(Millions of Dollars)

LLRW Site Type	1 Total Capital	2 Total Operating	3 Cont. 30% of 1+2	4 Profit Financing Escalation 80% of 1+2+3	5 Total Costs 1,2,3,4	6 $/Meter^3	7 $/Ft^3
STD SLB	12	24	11	37	84	133	3.8
Improved SLB	14	24	11	40	89	141	4
Deeper Burial	19	24	13	46	102	162	4.6
Mined Cavities							
--Abandoned	7	24	9	31	71	112	3.2
--Horr Tunn	30	24	16	59	129	205	5.6
--Vert Tunn	34	24	17	64	139	221	6.3
Engineered Structures							
Above	178	25	61	271	501	795	23
Below	192	25	65	254	536	851	24

SLB - Shallow Land Burial

Table 3

to 25,000 cubic feet per year per plant. In reviewing Table 4 and seeing the elements of cost, it challenges one to use his Yankee ingenuity, and with innovation think about where, how, and in what ways these costs could be reduced. Some such assumptions have been made in the following cases--particularly in light of the Ontario Hydro experience and the needs of our three states.

Case #1. Report #1 considers just one type of engineering structure for all levels of radiation. The design reveals several special structural features; namely, two-foot thick iron loaded, concrete walls for storing the higher level of LLRW, and reactor cores, in the center of the structure. Since the original assumptions stated that only 10 percent of the total volume was higher level LLRW, the thought occurred that possibly two types of basic engineered structures might be used--one for higher level LLRW, and other structures for the remaining 90 percent of LLRW.

When one considers the cell structure of their buildings, each would handle 920 cubic meters of capacity, or 4,445 55-gallon drums. Then, knowing that a total of 685 such cells are needed, at a total cost of $178 million for the above-ground structure, and $192 million for the buried structure, even a small percentage saving would represent significant dollars. Case 01 of Table 4 shows all cost elements for their base case for one engineered structure.

Consider one innovation. By considering their type of structure for the 10 percent of the higher level LLRW at one tenth of the $192 million, approximately $20 million would be needed.

What might be built for the remaining 90 percent of the volume? A much simpler structure, similar to that of the Ontario Hydro LLSB, for perhaps one quarter of the cost, or one quarter of the difference between $192 and $20 million, or $43 million--could represent a saving of $129 million.

One might argue with the specific numbers, but the concept reveals some interesting results--particularly since both the contingency and the profit elements are generated as a percentage of the total of capital costs and operating costs. The calculations are shown in APPENDIX 3.

The results for the above assumption would reduce the cost per cubic foot from the original $24 to $9.3, when considering the reduction in all the cost elements, as shown in Case 02 of Table 4.

All of the above applies, of course to the large site which is much more than our three states would need. By estimating three nuclear plants, one in each state, the need exists for a volume of about 75,000 cubic feet per year. Over a twenty-year period this would be 1.5 million cubic feet capacity. This would be about one fifteenth of the size of the site considered in Report #1.

While capital costs would not go down directly, or 1/15, with a down scaling in capacity size for 3-state needs, they might go down by 1/7 (or half as much). Based on this assumption, the calculations were made and

ORIGINAL COST DATA ON REPORT #1 ENGINEERED STRUCTURE

PLUS NEW RESULTS VIA INNOVATIONS

Case	Comment	Capital $	Oper $	Cont	Profit	Total	$/Ft^3
01	Original Data on Engineered Structure	192	25	65	254	536	24
02	2 Bldg Types	63	25	26.4	91.2	205.6	9.3
1	"01" Scaled to Smaller Size	9	25	10.2	35.36	79	52.6
2	"1" Operated 1/2 Time	9	12	6.3	21.6	49	32
3	"1" Operated 1/4 Time	9	6	4.5	15.6	35.1	23.4
4	"3" Operated by Gov't Non-Profit	9	6	4.5	7.8	27.3	18.2

Table 4

shown on Table 4 for the operation of a scaled-down site version with two types of engineered structures; this Case #1 reveals a cost per cubic foot of $52.6.

Case #2. What other innovations are possible? When considering the size of our 3-state problem, suggestions have been made to operate only a percentage of the time. Case #2 calculates the cost elements when operating at one half time, and cutting the operating costs by one half. The cost per cubic foot has now been reduced to $32, per Table 4, Case #2.

Case #3. If the site operated at one quarter of the time where the operating costs have been cut to one quarter, the final cost per cubic foot is $23.4. This is Case #3 in Table 4.

Case #4. Another innovation might consider operating as a not-for-profit site, and going public. Obviously, the profit would not be a factor then. Some financing and escalation expenses would exist, but reducing the profit column figure by one half, an overall cost per cubic foot of $18.2 would result per Case #4, Table 4.

While the above assumptions are conjecture, they do point in the direction of what innovation might do using the established figures that have been accepted by NRC and the industry. The procedure merely took Report #1's results and compared them to some ideas used at Ontario Hydro. It combined several proven ideas into what might be an idea applicable to our 3-state potential operation.

5. SOME CONCLUSIONS

1. A review of these reports indicates that proven engineered structures do exist as an alternate means of LLRW management, at known costs.

2. The cost figures cited show that some engineered structures do create a higher cost per cubic unit volume. However, the concept of gradually shifting such retrievable material from more secure structures to less secure structures means that one could concentrate on the less expensive structures for overall economic improvements.

3. With reference to costs, we have known sources of information--the Ontario Hydro experience--which shows that costs of processing, handling, and storage can vary from $14 per cubic foot to $285 per cubic foot--depending on the method chosen.

   Report #1 reveals comparative costs on alternate methods; they range from $3.8 per cubic foot for the conventional Shallow-Land Burial to $24 per cubic foot for the engineered structure. However, these are for massive volume sites.

4. Borrowing on the above cost figures, and introducing some innovation, additional cost figures have been tabulated in Table 4 for

a site which could meet the capacity of our three states. The costs would include capital, operating and some contingency costs and cover the range from $52.6 per cubic foot to $18.2 per cubic foot.

5. When speaking of costs and viewing them overall, Report #10 reveals some important factors from past experience with Shallow-Land Burial sites. If one must exhume old wastes, because of poor management, these additional costs can be very high per the examples cited--adding anywhere from $19 per cubic foot to $40 to $180 up to $271 per cubic foot to the original costs--depending on the age of the LLRW, and the material therein.

6. In any LLRW system, insure that techniques for volume reduction of the original waste are included; Table 2 shows the considerable reductions via the Ontario Hydro experience--40/1 via incineration, and 5/1 via compaction.

7. Based on all of the above six conclusions, several major advantages can be cited for the alternate engineered structure-type of storage for LLRW.

   --The LLRW material is retrievable in the event future engineering achievements might make it less hazardous.

   --These alternate systems minimize the potential effect of leaching of material, thus minimizing the public's concern with this problem.

   --If such engineered structures were built on the site of a nuclear plant, the potential hazards of transportation and excessive handling are reduced.

6. SOME RECOMMENDATIONS

What recommendations might be made at this point? The following represent three that seem appropriate.

1. I have been invited as an observer to a DOE sponsored LLRW meeting on November 8, 1983, by the League of Women Voters in Massachusetts at the Newton, Massachusetts Marriott Motel. During this time they are having Mr. T. J. Carter of Ontario Hydro speak about their experiences. I will report further on pertinent facts applicable to our needs.

2. If the ideas herein seem worthwhile to pursue further, and the material herein has stimulated thinking on the use of Ontario Hydro experiences, consider a visit to their facility. A selected number of people could review the operation first-hand and see how it might be applicable to the three states.

3. Consider some continued effort via a more detailed analysis of alternate structures for managing LLRW, as applicable to any or all of the three states.

SUPPLEMENTARY MATERIAL TO THE REPORT

APPENDICES

1. Reports Reviewed
2. Digest of Pertinent Reports
3. Basis for Calculations for the Innovative Assumptions Made on Report #1 Data

FIGURES

Ontario Hydro Figure 1, Active Liquid Waste Management System

Ontario Hydro Figure 3, Radioactive Gaseous Waste Management

Ontario Hydro Figure 5, Radioactive Solid Waste Management Flow Sheet

Ontario Hydro Figure 6, Shallow Subsurface Storage Trench Design

Ontario Hydro Figure 7, Radioactive Waste Tile Hole

Ontario Hydro Figure 8, The Quadricell Storage Facility

Ontario Hydro Figure 9, Low-Level Storage Building

Ontario Hydro Figure 10, Annual Waste Receipts

TABLES

1. Ontario Hydro Waste Generated
2. Reorganization of Ontario Hydro Data
3. Translated Cost Figures From Report #1
4. Original Cost Data on Report #1 Engineered Structure Plus New Results Via Innovations

(continued)

EXTRACTS OF TABLES FROM REPORT 1

Table	Title	Comments
2.6	Evaluation Factors and Their Weights	3 Major Factors with Relative "Importance" Assigned:
3.7	Cost Estimate Summary for "Reference" Shallow Land Burial Facility	The Basic Costs and Categories Against Which Alternate Disposal Techniques Were Compared!
3.20	Cost Estimate Summary For the Structural Disposal Facility	Similar Cost Categories to Table 3.7, Except for Being an Alternate Method
4.1	Summary of Non-Radiological Impacts for Various Alternatives	Includes Cost and Subjective Evaluation Factors--Accidents, Miles of Transport of LLRW,...
4.2	Summary of Radiological Impacts for Alternatives	Includes Cost and Subjective Evaluation Factors--Exposure Rates Both Long and Short Term
4.3	Cost Estimate Summary for Base Case Alternative Facilities	All Cost Elements; Note Size of Transportation Cost Element Which Dominates Some Alternative Totals
4.4	Summary of Unweighted Results of Evaluations for the Alternatives	Assumes All "Factors" Are of Equal Importance!
4.5	"Weighted" Comparative Analysis for Alternatives	Uses "Weights" per Table 2.6; Note that "The Panel Members Were Not in Close Agreement About the Weights to be Used"--Thus, Averages Were Used

REPORTS REVIEWED

1. "Evaluation of Alternate Methods for the Disposal of LLRW," NUREG/CR-0680, FBDU-209-03, published 7/79 by Ford, Bacon, and Davis Utah, Inc. for NRC.

2. "LLRW Management Handbook Series," DOE/LLW-137a, August 1983, EG&G Idaho, Inc.

3. "The Hittman Concept, Waste Management for Medical and Industrial LLRW Material," Hittman Nuclear and Development Corporation, Subsidiary of Westinghouse Electric Company.

4. "Ontario Hydro Waste Storage Concepts and Facilities," T. J. Carter, 1976.

5. "Radioactive Waste Management Practices at a Large Electric Utility," T. J. Carter, IAEC Presentation on October 5-9, 1981, IAEA-SR-57.

6. "NRC Staff's Environmental Impact Appraisal of LLRW Storage at TVA Seqoyah Nuclear Plant," Docket No. 30-19101, September 1982.

7. "Current Practice of Incineration of LLRW," February 1981, EG&G Idaho, EG&G-2076.

8. "Use Plan for Demonstration of Radioactive Waste Incineration," April 1982, EG&G Idaho, EG&G-2192.

9. "Regional LLRW Disposal Sites--Progress Being Made But New Sites Will Probably Not Be Ready by 1986," GAO/RCED-83-48, April 11, 1983.

10. "Insecure Land Fills: The Exhumation Option," Sierra Club, Radioactive Waste Campaign, Buffalo, New York, November 1982.

DIGEST OF PERTINENT FACTS FROM APPLICABLE REPORTS

Report #1: This work was sponsored by the United States Government and discusses five alternate methods to Shallow-Land Burial of LLRW. These include improved Shallow-Land Burial, deeper burial, disposal in mined cavities, disposal in engineered structures both above and below ground, and disposal in oceans. We have not reviewed ocean disposal. They have assigned technical, socio-political, and economic factors with different weights to each of the alternate approaches, and have evaluated them accordingly. It is based on the disposal of a constant volume of LLRW with given nuclear characteristics.

The final conclusions were that the most desirable alternative to Shallow-Land Burial were--in descending order of desirability--improved present Shallow-Land Burial practices, deeper burial, use of acceptable abandoned mines, and structurally designed disposal concepts. A pertinent quote with reference to weighting of the various factors is found on pg. 22; it states, "The panel members were not in close agreement about the weights to be used and those shown in Table 2.6 only represent the average of the weights suggested." However, both the weighted and unweighted values for the evaluation factors are displayed in Chapter 4 in the comparison matrix format. Therefore, other weights can be assigned as desired.

Another item of value in this report is that there are 78 references cited for other papers written on the subject. Incidentally, the ones that are mentioned in this report--the Ontario Hydro material--are also included.

Report #2: In discussing Disposal in Structural Facilities, the report mentioned the obvious advantages of limiting the escape of radioactivity, plus ease in monitoring for leaking radioactivity. Also, keeping the waste containers isolated from moisture would provide less difficult retrieval if the need arose.

They suggest that structural disposal facilities would be built of reinforced concrete to obtain the best durability and fire resistance at reasonable costs. Concrete has been estimated to last at least 1,000 years in contact with moist soil.

Report #3: To date, only a general bulletin has been received concerning the Hittman concept. I have talked with their representative and they are forwarding additional material on their technique. To my knowledge no such structures have been built, although some may have been proposed.

Report #4 and Report #5: Both reports cover work at Ontario Hydro which is covered in more detail in this report. Report #4 covers some of their initial efforts and Report #5 covers the latest efforts.

Report #6: This report covers thirteen LLRW storage modules built above ground and constructed of reinforced concrete. Four have been built to date, one for trash and three for resins. TVA has a five-year license from NRC to use these facilities--the concept being for interim storage only.

Report #7 and Report #8: Both reports cover LLRW which is primarily generated in academic and medical facilities.

Report #10: This report covers cases of former Shallow-Land Burial sites that have had problems of different variety. They all required the exhumation of the varied waste.

Some of the experiences concerned with early waste retrieval projects are cited. For example, one report concerned with the Idaho experience--that is, the Idaho National Engineering Laboratory Project is discussed. It demonstrated the feasibility of exhuming older, more deteriorated drums. They dug up about 6,000 cubic feet of volume including 457 drums that had been under ground from 10 to 24 years. The project took two years and $1.6 million, or $271 per cubic foot of exhumed waste. They concluded that it was clearly only a matter of a decade before drums will start to leak. In two decades the drums will practically disintegrate.

In the project at Hanford, Washington, they were concerned about one million gallons of plutonium contaminated chemical waste which were poured into one of seventeen unlined trenches that were capped with concrete. The presumption behind this disposal technology was that the earth beneath the trench would absorb the plutonium, evenly like a sponge. This sponge was supposed to hold the plutonium and prevent it from reaching the groundwater estimated to be 150 feet below. The earth did not behave as planned, and plutonium and other radionuclides began concentrating in a thin layer of soil directly beneath the trench. Core samples revealed that the six-foot deep trench contained 330 pounds of plutonium, more than five times an original estimate.

In order to remove this hazard, the trench was exhumed in 1976 to 1978. The government used remote control equipment so that workers wouldn't be exposed to high levels of alpha radiation. It took three years to design and fabricate the equipment for excavating, moving and repackaging the contaminated soil.

The Hanford exhumation cost an estimated $1.5 million according to a source at Hanford. This is approximately $40 per cubic foot of waste. Thirty percent of the $1.5 million was spent on decontaminating the equipment so that it could be used again. The cost of designing and fabricating the special equipment is not included in the $1.5 million. In 1976, the National Academy of Sciences estimated that the total cost, including equipment design and fabrication, was close to $7 million or about $186 per cubic foot of waste.

These experiences would indicate that one should look at the overall cost of managing waste--not just the disposal costs, not just the transportation costs, but the possible costs of retrieving it--that is, retrieving it in the event of a poor installation such as a mismanaged Shallow-Land Burial approach; or eventually retrieving LLRW in case new techniques become available to further decontaminate or nullify the radioactive characteristics of the material.

COST CALCULATIONS

(For the Innovative Assumptions of Table 4)

Pertinent comments from Report #1. (pgs. 145-147)

--"Basically, capital costs for constructing and providing final stabilization...are first estimated."

--"Additional costs to modify the facilities to accommodate the higher radiation level waste (10 percent of the total volume) are estimated to add 23 percent..."

--"The operating cost estimate...is based on a work force...of 10 persons for 20 years, plus 6 security personnel...for 20 years, plus on-going surveillance and monitoring for 150 years at $25,000/year." Average "total" cost per person was taken to be $50,000/year, totalling $19,750,000...plus $1,880,000 for support supplies,...

--Financing, escalation, and profit costs assume:

--"Financing charges on capital expenditures were estimated to be 7 percent for 10 years."

--"Escalation on the operating costs was estimated to occur at an annual rate of 6 percent for 10 years, then hold steady."

--"Profit was based on a 10 percent return on the total investment."

Case 02

--"High" level structure = 10% (192) = $20 million

--Assume low-level structures = 25% of remainder
= 25% (192-20) = $43 million

--Contingency $ = 30% (43+25) = $26.4 million

--Profit, etc. = 80% (43+25+26.4) = $91.2 million

Case 1

--3-state 20-year needs = 1,500,000 cubic feet

--Report 1 "standard" needs = 22,050,000 cubic feet

--3-state capacity = 1/14.7 of "standard" size

--Assume capital costs are not 1/14.7th, but 1/7th when scaled down; i.e. 1/7 (63) = $9 million

--Operating costs are still full-time at $25 million

--Other costs calculated as % per Case 02

<u>Case 2</u>

--Same as Case 1 except operate at half time, or $12 million/year

<u>Case 3</u>

--Same as Case 1 except operate at one quarter time, or $6 million/year

<u>Case 4</u>

--Same as Case 3 except non-profit, reduce calculated profit...by 1/2

TABLE 2.6

EVALUATION FACTORS AND THEIR WEIGHTS

Evaluation Factors	Relative Weight or Importance (%)
Technological Status	
• Compatibility with Waste	7.5
• Site Selection	12
• Safeguards	6.5
• Environmental Effects	11
• Availability of Techniques	10
Sociopolitical Acceptability	
• Institutional Control	11
• Public Acceptance	16
Economic Feasibility	
• Individual Consumer Costs	14
• Industrial Costs	12
	100%

TABLE 3.7 COST ESTIMATE SUMMARY FOR REFERENCE SHALLOW LAND BURIAL FACILITY

Item	Estimated Costs (Millions of Dollars) Eastern Site		Western Site	
Capital Costs				
Land Acquisition	5.00 ($10k/acre)		2.50 ($5k/acre)	
Site Studies	.50		.40	
Licensing	.32		.32	
Environmental Reports	.25		.15	
Site Preparation	0.46		0.46	
Site Fencing & Security Alarms	0.25		0.25	
On-site Structures and Roads	1.04		1.04	
Excavation of Trenches	2.35		2.35	
Backfill and Compaction	1.24		1.24	
Capital Subtotal		11.41		8.71
Engineering (5% of Subtotal)	.57		.44	
Higher Radiation Waste Facilities	.28		.28	
Total Capital Costs		12		9
Operating Costs				
Emplacement Costs	2.02		2.02	
Facility Operating Personnel	19.75		19.75	
Supplies and Equipment	1.88		1.88	
Total Operating Costs		24		24
Contingency (30% of Total Capital & Operating Costs)		11		10
Profit, Financing, and Escalation		37		33
Total Facility Costs		84		76
Transportation Costs		68		237
Total Facility plus Transportation Costs		152		313
Total Unit Costs for Waste Disposal ($/m^3)	240		500	

TABLE 3.20 COST ESTIMATE SUMMARY FOR THE STRUCTURAL DISPOSAL FACILITY

Item	Above Grade Structure: Eastern Site	Above Grade Structure: Western Site	Buried Structure: Eastern Site	Buried Structure: Western Site
	Estimated Costs (Millions of Dollars)			
Capital Costs				
Site Purchase	5.00	2.50	5.00	2.50
Site Studies	.50	.50	.50	.50
Licensing	.32	.32	.32	.32
Environmental Reports	.75	.65	.50	.40
On-site Structures	158.24	158.24	171.34	171.34
Site Preparation	0.66	0.66	0.66	0.66
Site Fencing and Security Alarm	0.25	0.25	0.25	0.25
Air Support Building	0.30	0.30	0.30	0.30
Capital Subtotal	166	163	178	176
Engineering (5% of Capital Subtotal)	8.30	8.17	8.94	8.81
Higher Radiation Waste Facilities	4.01	4.01	4.32	4.32
Total Capital Costs	178	176	192	189
Operating Costs				
Facility Operating Personnel	19.75	19.75	19.75	19.75
Emplacement Costs	3.00	3.00	3.00	3.00
Supplies and Equipment	1.88	1.88	1.88	1.88
Total Operating Costs	25	25	25	25
Contingency (30% of Total Capital & Operating Costs)	61	60	65	64
Profit, Financing, and Escalation	237	234	254	250
Total Facility Costs	501	495	536	528
Transportation Costs	68	237	68	237
Total Facility Plus Transportation Costs	569	732	604	765
Total Unit Costs for Waste Disposal ($/m^3)	900	1200	960	1200

TABLE 4.1

SUMMARY OF NON-RADIOLOGICAL IMPACTS FOR VARIOUS ALTERNATIVES[a]

Alternatives	Transportation Total Injuries	Transportation Total Fatalities	Construction Total Injuries	Construction Total Fatalities	Operation Total Injuries	Operation Total Fatalities	Cummulative Effect[b]	Normalized Effect[c]
Shallow-Land Burial-Eastern Site	8	0.60	0.61	0.01	8.1	0.09	23.7	1.0
Shallow-Land Burial-Western Site	28	2.0	0.52	0.01	8.1	0.09	57.6	2.4
Improved Burial-Eastern Site	8	0.60	0.67	0.01	8.1	0.09	23.8	1.0
Improved Burial-Western Site	28	2.0	0.61	0.01	8.1	0.09	57.7	2.4
Deeper Burial-Eastern Site	8	0.60	0.95	0.01	8.1	0.09	24.0	1.0
Deeper Burial-Western Site	28	2.0	0.85	0.01	8.1	0.09	58.0	2.4
Abandoned Mine-Eastern Site	12	0.88	0.63	0.01	8.1	0.09	30.5	1.3
Abandoned Mine-Western Site	32	2.4	0.63	0.01	8.1	0.09	65.7	2.8
New Horizontal Shaft Mine-Eastern Site	12	0.88	2.8	0.06	8.1	0.09	33.2	1.4
New Horizontal Shaft Mine-Western Site	32	2.4	2.8	0.06	8.1	0.09	68.4	2.9
New Vertical Shaft Mine-Eastern Site	12	0.88	3.3	0.07	8.1	0.09	33.8	1.4
New Vertical Shaft Mine-Western Site	32	2.4	3.3	0.07	8.1	0.09	69.0	2.9
Above Grade Structure-Eastern Site	8	0.60	10	0.12	8.1	0.09	34.2	1.4
Above Grade Structure-Western Site	28	2.0	9.9	0.12	8.1	0.09	68.1	2.9
Buried Structure-Eastern Site	8	0.60	11	0.13	8.1	0.09	35.3	1.5
Buried Structure-Western Site	28	2.0	11	0.12	8.1	0.09	69.2	2.9
Direct Ocean Dumping	32	2.4	NA[d]	NA	25	0.11	82.1	3.5
Ocean Projectile Disposal	32	2.4	NA	NA	25	0.11	82.1	3.5

a Based on disposal of 630,000 m^3 of waste over 20 years with 150 years of continued institutional control.

b Total injuries plus 10 times total fatalities.

c Normalized to SLBF eastern site case.

d NA - Not applicable. Construction of ships and ports not included.

TABLE 4.2

SUMMARY OF RADIOLOGICAL IMPACTS FOR ALTERNATIVES (mrem/yr)[a]

Alternative	Long Term Effects: Inhalation	Long Term Effects: Direct Gamma	Long Term Effects: Food	Short Term Effects: Transportation	Short Term Effects: Well Water Consumption	Short Term Effects: Single Container Accidents	Cummulative Effect[b]	Normalized Effect[c]
Shallow-Land Burial-Eastern Site	60	340	620	10	80	200	1310	1.0
Shallow-Land Burial-Western Site	60	340	620	30	40	200	1290	1.0
Improved Burial-Eastern Site	51	290	530	10	77	150	1108	0.8
Improved Burial-Western Site	51	290	530	30	35	150	1086	0.8
Deeper Burial-Eastern Site	0	0	0	10	77	150	237	0.2
Deeper Burial-Western Site	0	0	0	30	35	150	215	0.2
Abandoned Mine-Eastern Site	0	0	0	14	0	100	114	0.1
Abandoned Mine-Western Site	0	0	0	38	0	100	138	0.1
New Horizontal Shaft Mine-Eastern Site	0	0	0	14	0	100	114	0.1
New Horizontal Shaft Mine-Western Site	0	0	0	38	0	100	138	0.1
New Vertical Shaft Mine-Eastern Site	0	0	0	14	0	100	114	0.1
New Vertical Shaft Mine-Western Site	0	0	0	38	0	100	138	0.1
Above Grade Structure-Eastern Site	120	680	620	10	9	100	1539	1.2
Above Grade Structure-Western Site	120	680	620	30	6	100	1556	1.2
Buried Structure-Eastern Site	120	680	620	10	9	100	1539	1.2
Buried Structure-Western Site	120	680	620	30	6	100	1556	1.2
Direct Ocean Dumping	0	0	1	38	0	200	239	0.2
Ocean Projectile Disposal	0	0	0	38	0	200	238	0.2

(a) Dose rates are calculated on consident basiter alternatives, but are not predictive of exposures to any single individual at actual sites.

(b) Sum of long and short term effects, even though times of occurance may be different. No Individual will receive a dose of this size. The cumulative effect is presented only for comparisons among the alternatives.

(c) Normalized to SLBF eastern case.

TABLE 4.3

COST ESTIMATE SUMMARY FOR BASE CASE ALTERNATIVE FACILITIES ($MILLIONS)

Alternative	Capital Costs	Operating Costs	Contingency	Financing, Escalation & Profit	Total Facility Costs	Transportation Costs	Total Costs	Total Unit Costs ($/m^3)	Normalized Costs *
Shallow-Land Burial-Eastern Site	12	24	11	37	84	68	152	240	1.0
Shallow-Land Burial-Western Site	9	24	10	33	76	237	313	500	2.1
Improved Buiral-Eastern Site	14	24	11	40	89	68	157	250	1.0
Improved Burial-Western Site	11	24	10	36	81	237	318	500	2.1
Deeper Burial-Eastern Site	19	24	13	46	102	68	170	270	1.1
Deeper Burial-Western Site	16	24	12	42	94	237	331	520	2.2
Abandoned Mine-Eastern Site	7	24	9	31	71	102	173	280	1.1
Abandoned Mine-Western Site	7	24	9	31	71	271	342	540	2.3
New Horizontal Shaft Mine-Eastern Site	30	24	16	59	129	102	231	370	1.5
New Horizontal Shaft Mine-Western Site	30	24	16	59	129	271	400	630	2.7
New Vertical Shaft Mine-Eastern Site	34	24	17	64	139	102	241	380	1.6
New Vertical Shate Mine-Western Site	34	24	17	64	139	271	410	650	2.7
Above Grade Structure-Eastern Site	178	25	61	237	501	68	569	900	3.8
Above Grade Structure-Western Site	176	25	60	234	495	237	732	1200	4.8
Buried Structure-Eastern Site	192	25	65	254	536	68	604	960	4.0
Buried Structure-Western Site	189	25	64	250	528	237	765	1200	5.1
Direct Ocean Dumping	4	74	23	75	176	271	447	710	3.0
Ocean Projectile Disposal	4	484	146	467	1101	271	1372	2200	9.1

* Normalized to SLBF eastern site costs.

TABLE 4.4

SUMMARY OF UNWEIGHTED RESULTS OF EVALUATIONS FOR THE ALTERNATIVES

Alternatives	Evaluation Factors								
	Compatibility with Waste	Site Selection	Safeguards	Environmental Effects	Availability of Techniques	Institutional Control	Public Acceptance	Consumer Costs	Industrial Costs
Shallow-Land Burial-Eastern Site	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Shallow-Land Burial-Western Site	1.0	0.9	1.0	1.7	1.0	1.0	1.0	2.1	2.1
Improved Burial-Eastern Site	1.0	0.9	1.0	0.9	1.0	1.0	0.9	1.0	1.0
Improved Burial-Western Site	1.0	0.9	1.0	1.6	1.0	1.0	0.9	2.1	2.1
Deeper Burial-Eastern Site	1.0	1.2	0.9	0.6	1.1	1.1	0.8	1.1	1.1
Deeper Burial-Western Site	1.0	1.1	0.9	1.3	1.1	1.1	0.8	2.2	2.2
Abandoned Mine-Eastern Site	1.0	1.5	0.8	0.7	1.2	1.2	0.8	1.1	1.1
Abandoned Mine-Western Site	1.0	1.4	0.8	1.4	1.2	1.2	0.8	2.3	2.3
New Horizontal Shaft Mine-Eastern Site	1.0	1.4	0.8	0.8	1.3	1.2	0.7	1.5	1.5
New Horizontel Shaft Mine-Western Site	1.0	1.3	0.8	1.5	1.3	1.2	0.7	2.7	2.7
New Vertical Shaft Mine-Eastern Site	1.0	1.3	0.8	0.8	1.3	1.2	0.7	1.6	1.6
New Vertical Shaft Mine-Western Site	1.0	1.2	0.8	1.5	1.3	1.2	0.7	2.7	2.7
Above Grade Structure-Eastern Site	1.0	0.9	1.2	1.3	1.1	1.1	0.9	3.8	3.8
Above Grade Structure-Western Site	1.0	0.8	1.2	2.0	1.1	1.1	0.9	4.8	4.8
Buried Structure-Eastern Site	1.0	0.9	1.1	1.4	1.1	1.1	0.9	4.0	4.0
Buried Structure-Western Site	1.0	0.8	1.1	2.0	1.1	1.1	0.9	5.1	5.1
Direct Ocean Dumping	1.0	1.2	0.5	1.8	1.0	1.2	1.4	3.0	3.0
Ocean Projectile Disposal	1.0	1.4	0.5	1.8	1.3	1.2	1.2	9.1	9.1

TABLE 4.5

WEIGHTED COMPARATIVE ANALYSIS FOR ALTERNATIVES

	Evaluation Factors									
	Compatibility with Waste	Site Selection	Safeguards	Environmental Effects	Availability of Techniques	Institutional Control	Public Acceptance	Consumer Costs	Industrial Costs	Weighted Comparison*
Weight	0.08	0.12	0.06	0.11	0.10	0.11	0.16	0.14	0.12	
Alternatives										
Shallow-Land Burial-Eastern Site	0.08	0.12	0.06	0.11	0.10	0.11	0.16	0.14	0.12	1.0
Shallow-Land Burial-Western Site	0.08	0.11	0.06	0.19	0.10	0.11	0.16	0.29	0.25	1.4
Improved Burial-Eastern Site	0.08	0.11	0.06	0.10	0.10	0.11	0.14	0.14	0.12	0.96
Improved Burial-Western Site	0.08	0.11	0.06	0.18	0.10	0.11	0.14	0.29	0.25	1.3
Deeper Burial-Eastern Site	0.08	0.14	0.05	0.07	0.11	0.12	0.13	0.15	0.13	0.98
Deeper Burial-Western Site	0.08	0.13	0.05	0.14	0.11	0.12	0.13	0.31	0.26	1.3
Abandoned Mine-Eastern Site	0.08	0.18	0.05	0.08	0.12	0.13	0.13	0.15	0.13	1.1
Abandoned Mine-Western Site	0.08	0.17	0.05	0.15	0.12	0.13	0.13	0.32	0.28	1.4
New Horizontal Shaft Mine-Eastern Site	0.08	0.17	0.05	0.09	0.13	0.13	0.11	0.21	0.18	1.2
New Horizontal Shaft Mine-Western Site	0.08	0.16	0.05	0.17	0.13	0.13	0.11	0.38	0.32	1.5
New Vertical Shaft Mine-Eastern Site	0.08	0.16	0.05	0.09	0.13	0.13	0.11	0.22	0.19	1.2
New Vertical Shaft Mine-Western Site	0.08	0.14	0.05	0.17	0.13	0.13	0.11	0.38	0.32	1.5
Above Grade Structure-Eastern Site	0.08	0.11	0.07	0.14	0.11	0.12	0.14	0.53	0.46	1.8
Above Grade Structure-Western Site	0.08	0.10	0.07	0.22	0.11	0.12	0.14	0.67	0.58	2.1
Buried Structure-Eastern Site	0.08	0.11	0.07	0.15	0.11	0.12	0.14	0.56	0.48	1.8
Buried Structure-Western Site	0.08	0.10	0.07	0.22	0.11	0.12	0.14	0.71	0.61	2.2
Direct Ocean Dumping	0.08	0.14	0.03	0.20	0.10	0.13	0.22	0.42	0.36	1.7
Ocean Projectile Disposal	0.08	0.1[illegible]	0.03	0.20	0.13	0.13	0.19	1.27	1.09	3.3

* Weighted Comparison is the sum of the weighted evaluation factors for each alternative. Higher values indicated less desirability.

APPENDIX E

INDIVIDUAL WORKSHOPS

TABLE OF CONTENTS

Final Workshop Instructions for Chairmen and Participants

Wednesday, May 2, 1:45 p.m. - 5:00 p.m.

Introduction

The workshop participants will be asked to review written materials on various disposal alternatives prior to the meeting, primarily a summary of the report by the U.S. Army Corps of Engineers, "Alternative Methods for Disposal of Low-Level Radioactive Wastes," NUREG/CR-3774, Vol. 1, April 1984, which was mailed to them on April 18, 1984. In addition, they shall receive additional information during the morning session as shown in the agenda. Each of the four workshops will focus on three technologies which is all that can be discussed thoroughly during the time allotted for workshops. If there is additional time at the completion of the assigned technologies, each workshop may address the other technologies of their choosing. Each workshop will address a different set of disposal technologies, but all will deal with shallow land burial under 10 CFR 61 for comparative purposes (See Table 1). All participants will be encouraged to remain in their assigned workshops. Selection of participants will be essentially on a random basis with correction for any obvious imbalance, such as all participants from one State in one workshop.

The main points and the results of the discussion will be recorded by the workshop rapporteur on wall charts -- large sheets of paper prearranged on the walls of the room to provide a permanent group memory and a point of reference for subsequent discussion. Also, the wall charts should be left on the walls at the end of the day's workshop for participants in other workshops to examine the proceedings after hours if they wish.

Step 1. Workshop Orientation

Estimated time: 10 Minutes (1:45 p.m. - 1:55 p.m.)

Only State participants with tent cards are permitted to sit at the square tables. State observers, industry, and Federal observers, and other observers may be seated at the table at the discretion of the chairmen. Non-State people should be used as a resource at the discretion of the chairmen.

The chairmen will walk through the workshop tasks in the following steps. The essential steps should be outlined on the wall charts if the chairmen think that it is desirable. Figure 1 gives the essential steps that all participants will be following. At the end of the morning session some time will be available to explain the workshop instructions so everyone should have an idea of what to do.

Table 1 Workshop Assignments

Workshop Room:	Blue Forest Hills	Red Newport	Purple Wimbledon/Sea Pines	Black Grand Prix
Chairman:	Kevin McCarthy Northeast Compact	Dante Ionata Northeast Compact	Lee Jager Midwest Compact	Don Schott Midwest Compact
Rapporteur	Richard Smith Northeast Compact	Jeanette Eng Northeast Compact	Rose Marie Carr Kentucky	Teri Vierima Midwest Compact
NRC Assistants:	Dean Kunihiro	Faith Brenneman	Roland Lickus Gary Sanborn	Steve Romano
Technologies to be considered				
Reference:	Shallow land burial (10 CFR 61)	Shallow land burial (10 CFR 61)	Shallow land burial (10 CFR 61)	Shallow land burial (10 CFR 61)
Alternatives:	Aboveground vaults	Earth mounded concrete bunkers	Aboveground vaults	Belowground vaults
	Belowground vaults	Augered holes	Earth mounded concrete bunkers	Mined cavities

State Participants:

Burgess	ND	Aaroe	WV	Brothers	NW Compact	Boright	VT
Collins	MD	Avant	TX	Cartwright	IL	Bohlinger	Central Compact
Gerusky	PA	Byer	MD	Dornsife	PA		
Kucera	MO	Cooper	IL	Godwin	SE Compact	Chapman	MA
Kurhtz	NJ	Eisengrein	NH	Kany	ME	Dunkleberger	NY
Peery	Central Compact	Erganian	IN	Merges (Youngblood)	NY	Kolpa	IA
		Johnson	MA			Quillin	OH
Rimawi	NY	Risch	KY	Parr	NH	Roth	PA
Joel Smith	SD	Strohl	WI	Pittman	MD	Seel	ME
Wight	NH			Richie	MN	Whitman	Rocky Mt Compact
Willaford	IL			Thompson	OH		
Wrenn	VA					Williams	IL

Toward a Systematic Approach to the Evaluation of Shallow Land Burial and Alternative Disposal Technologies

Workshop Objectives: To develop a systematic approach to the evaluation of shallow land burial and alternative disposal technologies

To develop a detailed listing and ranking of the advantages and disadvantages of the technologies considered

Workshop Instructions:

1. Convene with other participants in assigned workshop and review workshop tasks.

2. Complete the listing of the important technical, economic, institutional and sociopolitical factors shown in Figure 2 that need to be considered in selecting a disposal option.

3. Identify the advantages and disadvantages for each factor of shallow land burial and the disposal alternatives under consideration.

4. Determine what data and information are available and what data and information are needed to describe each factor completely for the disposal technologies under consideration.

5. Rate the factors according to impact and importance.

6. Discuss potential methods for selecting a disposal technology.

7. Discuss rating results.

8. Reconvene in Wimbledon Room to hear presentation on storage licensing.

9. Chairmen will present results and summarize discussion at closing plenary.

Figure 1 Instructions for Participants

Step 2. Complete the Listing of Factors

Estimated time: 20 Minutes (1:55 p.m. - 2:15 p.m.)

Each workshop will be asked to review Figure 2, "Technical, Economic, Institutional, and Sociopolitical Factors," which will be distributed at registration along with Figure 1, which is the instructions for the participants. Everyone will also have the benefit of the morning session and especially the State reports that deal with many of these factors. Each workshop will have the opportunity to review the factors and restructure the list, add new factors, or delete existing factors. The Chairmen should strive to achieve timely completion of the discussion in about 20 minutes. Relevant points and the results will be recorded on the wall charts in the same way as in Step 1.

Step 3. Identify Advantages and Disadvantages of the Disposal Technologies

Estimated time: 90 Minutes (2:15 p.m. - 3:45 p.m.)

For each of the three technologies, each participant will write down during a 15 minute period of idea generation his or her own list of the advantages and disadvantages of technical/institutional factors using as a reference point shallow land burial as described in 10 CFR 61. Following the silent idea generation period, a loose "round-robin" would ensure, where each participant presents several advantages and disadvantages for the factors under consideration. The process would continue until ideas are exhausted. Proceedings would be recorded as in Step 1 using the wall charts. After the discussion of technical/institutional factors is completed, a second silent idea generation period would be provided for the economic/sociopolitical factors. This is followed by presentation of ideas and recording on wall charts. Step 3 concludes with an open discussion of the idea generation phase to provide time for clarification or disagreement. Divergent opinions would be noted on the wall sheets. This step provides the backbone of the entire workshop and should be completed.

BREAK: A 10-minute break is suggested. (3:45 p.m. - 3:55 p.m.)

Step 4. Data and Information Needs Identification

Estimated time: 20 Minutes (3:55 p.m. - 4:15 p.m.)

An open discussion is held of data and information availability and the need for further information on specific technologies. It may be appropriate to add advantages and disadvantages regarding data and information availability for various factors as they affect a specific technology. A separate wall chart will be used to record data and information needs for individual technologies.

Step 5. Public Comment Period

Estimated Time: 15 minutes (4:15 p.m. - 4:30 p.m.)

TECHNICAL

10 CFR 61 Subpart C - Performance Objectives

- o protection of the general population from releases of radioactivity
- o protection of individuals from inadvertent intrusion
- o protection of individuals during operations
- o stability of the disposal site after closure

Status of Technology Development

- o conceptual, demonstration or existing practice
- o licensing time frames

Siting Constraints

- o site availability

ECONOMIC

Present Value Cost

- o licensing cost
- o capital cost
- o operating cost
- o transportation to site
- o closure and stabilization
- o institutional control

Financial Risk

- o risk and expected rate of return
- o public vs. private initiative

Consumer Cost/Pricing

- o impact of waste generator
- o impact on institutional, medical, industrial and electric utility customers

Cost of Delay

- o extended storage pending disposal
- o research and development needs

INSTITUTIONAL

Federal Regulation-NRC

- o time to process applications

Agreement State Regulation

- o time to develop program
- o time to process applications

Non-Radiological State Regulation

- o land use control
- o environmental
- o site ownership

SOCIOPOLITICAL

Public Acceptance of Risk

- o perceived vs. real risk
- o State vs. local consideration of risk

Public Acceptance of Transportation Risk

- o perceived vs. real risk
- o State vs. local consideration of risk

Socioeconomic Impacts

- o land use
- o local economy
- o public service (roads, schools, fire protection, etc.)

Figure 2 Technical, Economic, Institutional and Sociopolitical Factors

Step 6. Factor Rating

Estimated time: 30 Minutes (4:30 p.m. - 5:00 p.m.)

The participants will be asked to read over the information on the wall sheets and each will fill out four factor rating questionnaires. The sheets will rate importance and factor impact (favoring, disqualifying or inhibiting). Factor impact is completed for each of the three technologies. The enclosed Figures 3 and 4 present our thinking on construction of these rating forms. (Editor's note: Figures 3 and 4 are included in filled out form with the workshop results.) Rating results will be collected from each participant and compiled by the rapporteurs before the start of the morning workshop. At a minimum, State participants should have their rating forms compiled. State observers, industry, NRC, other Federal, and other observers can have their ratings compiled if they wish to participate and the chairmen agree. Otherwise, NRC will compile them.

Thursday, May 3, 8:30 a.m. - 10:00 a.m.

Step 7. Discuss Methods for Selecting A Disposal Technology

Estimated time: 30 Minutes (8:30 a.m. - 9:00 a.m.)

An open discussion will be held of potential decisionmaking concepts for selecting a disposal technology and proceeding with facility development. The workshop will not be asked to select or endorse a method unless this seems to emerge naturally. Rather, the steps needed to reach a decision are to be discussed, such as, further research and development, economic and engineering studies, information, briefing of key officials, and public meetings.

Step 8. Discuss Rating Results

Estimated time: 60 Minutes (9:00 a.m. - 10:00 a.m.)

The rapporteurs will present the results of the compilation of the rating questionnaires completed the previous day. This will be followed by open discussion under direction of the workshop chairmen. The workshop will then discuss key observations to be presented with the rating results at the closing plenary.

BREAK: 15 Minutes (10:00 a.m. - 10:15 a.m.)

Step 9. Final Report Preparation

Estimated time: 45 Minutes (10:15 a.m. - 11:00 .m.)

While the participants of the four workshops are reconvened for a presentation on storage licensing, the chairmen, with the aid of their rapporteurs, will prepare their reports for the closing plenary.

Step 10. Closing Plenary

Estimated time: 11:00 a.m. - 1:00 p.m.

Each of the four Chairmen will present the results of the individual sessions to the reconvened group. The time allotted is 20 minutes for each Chairman plus 10 minutes for questions and answers.

WALL CHARTS AND RATINGS

BLUE WORKSHOP

Blue Workshop Wall Charts - Aboveground and Belowground Vaults and Shallow Land Burial

Additional Factors

Technical

(1) Monitoring (Operational & Institutional)

(2) Avoidance of Environmental Contamination

(3) Ability of Technology To Deal With Special Waste Forms

(4) Require Volume Reduction?

(5) Transportation Availability

(6) Modeling Capability

(7) Other Waste Characteristics

(8) Retrievability

(9) Ability To Survive Disaster

(10) Ease of Construction & Repair

Economic

(1) Transportation

(2) Insurance Availability

(3) Fees for Host Community - onsite inspections

(4) Cost Distribution

Institutional

(1) RCRA

Sociopolitical

(1) Host Community Compensation

(2) Property Values

Aboveground Vaults
Technical/Institutional Factors

Advantages	Disadvantages
- Retrievability - Repair - Monitoring - Easier To Site - Less Restricted by Weather	- Structural Durability? - Greater Potential for Exposure in Long-Term - Loss of Geological Protection - Waste Form Modification - Fire Protection - Additional Time Required for Licensing

Aboveground Vaults
Economic/Sociopolitical Factors

Advantages	Disadvantages
- Public Acceptance - Costs of Remedial Action* (Short-Term Fix) - Political/Public Liabilities - RCRA Compliance	- Time to Process Application - Up Front Capital Costs - Operating Costs - Increased Institutional Costs

Belowground Vaults
Technical/Institutional Factors

Advantages	Disadvantages
- Improved Monitoring - Retrievability* - Minimal Subsidance - Additional Barrier = Intrusion = Environmental - Greater Structural Stability	- Additional Shielding Required - Geochemical Reactions - Additional Time Required for Licensing

Belowground Vaults
Economic/Sociopolitical Factors

Advantages	Disadvantages
- Improved Infiltration Control (Technical) - Public Acceptance - RCRA Compliance - Political/Public Liabilities - Costs of Remedial Action	- Present Value Costs - Time to Process Application - Operating Cost - Increased Capital Cost - Increased Institutional Costs - Increased Consumer Costs - Increased R&D Costs

* These issues stimulated a lot of discussion

Blue Workshop - Data Needs, Methods for Selecting Technology and Public Comment Period

Data Needs

- Insurance Availability
- Cost/Benefit Analysis
- Non-Radiological Hazards
  RCRA Relationship
- Worker Protection Modeling
- Criteria for Aboveground Sites
- Systems Approach Using Optimal
  Use of Alternative Technologies
- Consideration of Roofs for
  All Weather Operation
  (Needed Now)
- Public Opinion Polls
- Technical Benefits of
  Alternatives

Methods For Selecting Technology

- Presentations to Organized
  Groups
- What Is The Role of The
  Public?

Public Comment Period

- 10 CFR 61 should be viewed
  as a question not an answer
- We should be honest about not
  having all the answers.
- Need Information on costs
  of segregation

13/ State
0/ Industry
0/ NRC
0/ Other Federal
0/ Observer
13

Figure 3. Factor Rating (Blue)

Rate the Factors in Terms of Importance

Support with a Few Words

	IMPORTANCE				
	Critical	Important	Somewhat important	Not important	Don't know
TECHNICAL					
10 CFR 61 Subpart C-Performance Objectives:					
o Protection of the general population from releases of radioactivity	13				
o Protection of individuals during inadvertant intrusion	6	5	2		
o Protection of individuals during operations	7	6			
o Stability of the disposal site after closure	10	3			
Status of Technology Development					
o conceptual, demonstration, or existing practice	1	5	6		
o licensing time frames	1	2	7	3	
Siting Constraints					
o site availability	6	6	1		

Figure 3. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Importance

Support with a Few Words

	IMPORTANCE				
	Critical	Important	Somewhat important	Not important	Don't know
ECONOMIC					
Present Value Cost					
o licensing cost	1	5	5	2	
o capital cost		10	3		
o operating cost		11	2		
o transportation to site	1	4	8		
o closure and stabilization	7	5	1		
o institutional control	7	6			
Financial Risk					
o risk and expected rate of return		8	3		2
o public vs. private initative		7	3	1	2
Consumer Cost/Pricing					
o impact on waste generator	1	7	5		
o impact on instituional, medical, industrial and electric utility customers	1	8	4		
Cost of Delay					
o extended storage pending disposal	2	6	5		
o research and development needs		9	4		

Figure 3. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

INSTITUTIONAL	Critical	Important	Somewhat important	Not important	Don't know
Federal Regulation-NRC					
o time to process applications	4	3	4	2	
Agreement State Regulation					
o time to develop program	1	6	2	4	
o time to process applications	2	4	5	2	
Non-Radiological State Regulation					
o land use control	1	5	7		
o environmental	5	6	2		
o site ownership	3	6	3	1	

Figure 3. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

SOCIOPOLITICAL	Critical	Important	Somewhat important	Not important	Don't know
Public Acceptance of Risk					
o perceived vs. real risk	6	7			
o State vs. local consideration of risk	6	4	3		
Public Acceptance of Transportation Risk					
o perceived vs. real risk	5	3	5		
o State vs. local consideration of risk	4	2	7		
Socioeconomic Impacts					
o land use	2	5	6		
o local economy	2	8	3		
o public service (roads, schools, fire protection, etc.)	1	6	5	1	

13/ State
0/ Industry
0/ NRC
0/ Other Federal
0/ Observer
13

Figure 4. Factor Rating (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	10		3
o Protection of individuals from inadvertant intrusion	10		3
o Protection of individuals during operations	12		1
o Stability of the disposal site after closure	6		7
Status of Technology Development			
o conceptual, demonstration, or existing practice	9		4
o licensing time frames	11		1
Siting Contraints			
o site availability	2		10

gure 4. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete vaults
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	13		
o capital cost	13		
o operating cost	13		
o transportation to site	7		4
o closure and stabilization	5		8
o institutional control	5		8
Financial Risk			
o risk and expected rate of return	9	1	1
o public vs. private initiative	5	1	3
Consumer Cost/Pricing			
o impact on waste generator	9	1	2
o impact on institutional, medical industrial and electric utility customers	10	1	1
Cost of Delay			
o extended storage pending disposal	9	1	1
o research and development needs	10	1	

Figure 4. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

INSTITUTIONAL	Favor	Disqualify	Inhibit
Federal Regulation-NRC			
o time to process applications	13		
Agreement State Regulation			
o time to develop program	12		1
o time to process applications	12		1
Non-Radiological State Regulation			
o land use control	8		4
o environmental	7		5
o site ownership	7	1	3

Figure 4. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

SOCIOPOLITICAL	Favor	Disqualify	Inhibit
Public Acceptance of Risk			
o perceived vs. real risk		3	11
o State vs. local consideration or risk	1		10
Public Acceptance of Transportation Risk			
o perceived vs. real risk	1	1	11
o State vs. local consideration of risk	2	1	8
Socioeconomic Impacts			
o land use	6	1	5
o local economy	6	1	4
o public service (roads, schools, fire protection etc.)	7	1	3

13/ State
0/ Industry
0/ NRC
0/ Other Federal
0/ Observer
13

Figure 4. Factor Rating (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- ✓/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	7		6
o Protection of individuals from inadvertant intrusion	10		3
o Protection of individuals during operations	3		10
o Stability of the disposal site after closure	6		6
Status of Technology Development			
o conceptual, demonstration, or existing practice	1		10
o licensing time frames	1		12
Siting Contraints			
o site availability	13		

Figure 4. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- ✓/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete vaults
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	2		11
o capital cost	1		11
o operating cost	3		9
o transportation to site	8	2	2
o closure and stabilization	6	1	6
o institutional control	5		7
Financial Risk			
o risk and expected rate of return	3	1	7
o public vs. private initiative	3	1	5
Consumer Cost/Pricing			
o impact on waste generator	2	1	10
o impact on institutional, medical industrial and electric utility customers	1	1	11
Cost of Delay			
o extended storage pending disposal	3		9
o research and development needs	3		10

Figure 4. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- ✓/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications			13
Agreement State Regulation			
o time to develop program	2		10
o time to process applications	2		11
Non-Radiological State Regulation			
o land use control	8		4
o environmental	8		4
o site ownership	7		4

Figure 4. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- ✓/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	12		1
o State vs. local consideration or risk	10		2
Public Acceptance of Transportation Risk			
o perceived vs. real risk	10		2
o State vs. local consideration of risk	9	1	
Socioeconomic Impacts			
o land use	8		3
o local economy	7	2	3
o public service (roads, schools, fire protection etc.)	6		5

13/ State
0/ Industry
0/ NRC
0/ Other Federal
0/ Observer
13

Figure 4. Factor Rating (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- ✓/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

	IMPACT		
	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	11		2
o Protection of individuals from inadvertant intrusion	11		2
o Protection of individuals during operations	9		4
o Stability of the disposal site after closure	13		
Status of Technology Development			
o conceptual, demonstration, or existing practice	5		8
o licensing time frames	4		8
Siting Contraints			
o site availability	12		1

Figure 4. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- ✓/ Below ground vaults
- __/ Earth mounded concrete vaults
- __/ Mined cavities
- __/ Augered holes

	IMPACT		
	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	3		9
o capital cost	1		11
o operating cost	4		8
o transportation to site	8		2
o closure and stabilization	8		4
o institutional control	7		3
Financial Risk			
o risk and expected rate of return	6	1	5
o public vs. private initiative	5	1	4
Consumer Cost/Pricing			
o impact on waste generator	4	1	7
o impact on institutional, medical industrial and electric utility customers	5	1	7
Cost of Delay			
o extended storage pending disposal	4		9
o research and development needs	3		10

Figure 4. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
__/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
☑/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	2		11
Agreement State Regulation			
o time to develop program	2		11
o time to process applications	2		11
Non-Radiological State Regulation			
o land use control	10		3
o environmental	10		2
o site ownership	9		4

Figure 4. Factor Rating (Cont'd.) (Blue)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
__/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
☑/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	12		1
o State vs. local consideration of risk	10		1
Public Acceptance of Transportation Risk			
o perceived vs. real risk	9		3
o State vs. local consideration of risk	9		1
Socioeconomic Impacts			
o land use	11		1
o local economy	8		3
o public service (roads, schools, fire protection etc.)	7		3

WALL CHARTS AND RATINGS

RED WORKSHOP

Red Workshop Wall Charts - Earth Mounded Concrete Bunkers, Augered Holes and Shallow Land Burial

Additional Factors

Economics	Institutional	Technical
o Insureability (Ability to obtain insurance)	o Quality of Management	o Risk Management (Ease of Monitoring & Retrievability)
	o Quality of Regulatory Oversight	o Types and Forms of waste which can be disposed
	o Operating Characteristics	

Red Workshop - Advantages and Disadvantages of Alternate Technology As Compared to Shallow Land Burial

---

Technical

o Protect Population
  A.H. + smaller volume per disposal unit
  E.M. + away from ground water
o Protect Intruder
  E.M.   concret monoliths
o Protect Worker
  A.H. + smaller disposal units
  E.M. - greater handling
o Stability after Closure
  E.M. - middle layer (tumuli) instability
o Risk Management
  E.M. + retrievable
o Waste types/forms
  A.H. - irregular waste shape (contaminated equipment)
  E.M. + handle greater variety

Status of Technology
o concept, existing
  E.M. -
o Licensing time
  E.M. - inexperience

Siting Constraints
o Availability
  E.M. 0

Note: + equals advantage
      = equals disadvantage
      0 equals no difference
      A.H. = augered holes
      E.M. = Earth mounded concrete bunkers

Economic

Present Value Cost
o licensing
o Capital
  A.H. need more land
o operating
  A.H. + higher unit costs
       - slower rate of disposal
  E.M. -
o transport
o closure & stability
  E.M. +
o institutional

Financial Risk
o risk & expected rate of return
  E.M. 0 regulated profit
  A.H. 0 " "
o public vs. private

consumer cost
o waste generator
  E.M. - more costly
  A.H. - more costly

Cost of Delay
o storage
o R&D

Institutional

Federal Regulations

o time to license
  E.M. - longer
  A.H. 0 longer

Agreement State
o time to develop program
  1
  A
o time to license
  E.M. - longer
  A.H. 0

Non-Radiological Requirements
o land use
  A.H. - takes land surface out of use
  A.M. 0
o environmental
o site ownership

Sociopolitical

Public Accept Risk
o perceived vs. real
o State vs. local

Public Accept Transport risk
o perceived/real
  E.M. + less volume to dispose because of its costliness
o State/local

Socioeconomic Impacts
o land use
  A.H. -
  E.M. 0
o local economy
o public services

Red Workshop - Data and Information Needs

Augered Holes: lines and retrievable

want info on use of different types of backfill and expected performance
want info on performance of various liners
cost information, pull from existing operating examples. Tie cost to each step of facility development operation, etc.
What tyne of pre-treatment is needed?

Earth mounded Concrete Bunkers

want info on performance of various liners
cost information, pull from existing operating examples. Tie cost to each step of facility development operation, etc.
What type of pre-treatment is needed?

insurance info relative to source of waste

E-30

11/ State
2/ Industry
1/ NRC
0/ Other Federal
5/ Observer
19

Figure 3. Factor Rating (Red)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
TECHNICAL					
10 CFR 61 Subpart C-Performance Objectives:					
o Protection of the general population from releases of radioactivity	19				
o Protection of individuals during inadvertant intrusion	14	4	1		
o Protection of individuals during operations	16	3			
o Stability of the disposal site after closure	17	2			
o Waste type/Forms	6	3	1		
o Risk Management	1	3	1		
Status of Technology Development					
o conceptual, demonstration, or existing practice	5	10	3	1	
o licensing time frames	2	9	7	1	
Siting Constraints					
o site availability	9	8	1		1
o Retrievability	2	4			
o Waste Separation		1			

Figure 3. Factor Rating (Cont'd.) (Red)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
ECONOMIC					
Present Value Cost					
o licensing cost		5	13	1	
o capital cost		10	8		
o operating cost		11	7		
o transportation to site		4	9	4	
o closure and stabilization	7	8	3		
o institutional control	8	8	1	1	
o Insurance	2	3	3		
Financial Risk					
o risk and expected rate of return		5	9	4	
o public vs. private initative		7	6	5	
Consumer Cost/Pricing					
o impact on waste generator	1	6	9	2	
o impact on instituional, medical, industrial and electric utility customers	1	6	10	1	
Cost of Delay					
o extended storage pending disposal	3	7	6	2	
o research and development needs	6	5	5	2	

Figure 3. Factor Rating (Cont'd.) (Red)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
INSTITUTIONAL					
Federal Regulation-NRC					
o time to process applications	1	7	10	1	
Agreement State Regulation					
o time to develop program	2	12	4	1	
o time to process applications	2	7	8	2	
Non-Radiological State Regulation					
o land use control	5	7	4	1	2
o environmental	5	11			2
o site ownership	3	6	1	4	3
Quality of management	5	3			
Quality of regulatory oversight	4	4			
Operating characteristics	2	3			

Figure 3. Factor Rating (Cont'd.) (Red)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
SOCIOPOLITICAL					
Public Acceptance of Risk					
o perceived vs. real risk	15	1	3		
o State vs. local consideration of risk	7	11	1		
Public Acceptance of Transportation Risk					
o perceived vs. real risk	7	4	6	2	
o State vs. local consideration of risk	5	7	5	1	
Socioeconomic Impacts					
o land use	3	9	6	1	
o local economy	1	6	12		
o public service (roads, schools, fire protection, etc.)	4	5	10		

10/ State
2/ Industry
1/ NRC
1/ Other Federal
4/ Observer
18

Figure 4. Factor Rating (Red)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
_/ Above ground vaults
_/ Below ground vaults
_/ Earth mounded concrete bunkers
_/ Mined cavities
_/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	9	2	7
o Protection of individuals from inadvertant intrusion	8	1	9
o Protection of individuals during operations	13	1	4
o Stability of the disposal site after closure	5	2	11
Status of Technology Development			
o conceptual, demonstration, or existing practice	13	1	4
o licensing time frames	13	2	2
Siting Contraints			
o site availability	3	3	10

Figure 4. Factor Rating (Cont'd.) (Red)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
_/ Above ground vaults
_/ Below ground vaults
_/ Earth mounded concrete vaults
_/ Mined cavities
_/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	15	1	
o capital cost	15		
o operating cost	13		2
o transportation to site	9	1	2
o closure and stabilization	4	3	9
o institutional control	4	2	9
Financial Risk			
o risk and expected rate of return	10	3	1
o public vs. private initiative	8	2	4
Consumer Cost/Pricing			
o impact on waste generator	14		2
o impact on institutional, medical industrial and electric utility customers	15		1
Cost of Delay			
o extended storage pending disposal	8	1	6
o research and development needs	9		6

Figure 4. Factor Rating (Cont'd.) (Red)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
_/ Above ground vaults
_/ Below ground vaults
_/ Earth mounded concrete bunkers
_/ Mined cavities
_/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	13	1	2
Agreement State Regulation			
o time to develop program	13		3
o time to process applications	11	1	3
Non-Radiological State Regulation			
o land use control	9	3	4
o environmental	7	3	6
o site ownership	8	1	5

Figure 4. Factor Rating (Cont'd.) (Red)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
_/ Above ground vaults
_/ Below ground vaults
_/ Earth mounded concrete bunkers
_/ Mined cavities
_/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk		6	12
o State vs. local consideration or risk	1	7	9
Public Acceptance of Transportation Risk			
o perceived vs. real risk	2		14
o State vs. local consideration of risk	3	1	12
Socioeconomic Impacts			
o land use	5	4	9
o local economy	7	1	8
o public service (roads, schools, fire protection etc.)	5	1	9

10/ State
2/ Industry
1/ NRC
1/ Other Federal
3/ Observer
17

Figure 4. Factor Rating (Red)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
✓/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	15		2
o Protection of individuals from inadvertant intrusion	16		1
o Protection of individuals during operations	7	1	9
o Stability of the disposal site after closure	13		4
Status of Technology Development			
o conceptual, demonstration, or existing practice	4		13
o licensing time frames	2		15
Siting Contraints			
o site availability	10	1	4

Figure 4. Factor Rating (Cont'd.) (Red)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
✓/ Earth mounded concrete vaults
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	5		12
o capital cost	1		14
o operating cost	5		10
o transportation to site	9	1	1
o closure and stabilization	10		4
o institutional control	11		3
Financial Risk			
o risk and expected rate of return	7	1	4
o public vs. private initiative	4	1	3
Consumer Cost/Pricing			
o impact on waste generator	5	1	9
o impact on institutional, medical industrial and electric utility customers	5	1	9
Cost of Delay			
o extended storage pending disposal	8		6
o research and development needs	7		8

Figure 4. Factor Rating (Cont'd.) (Red)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- _/ Shallow land burial (10 CFR 61)
- _/ Above ground vaults
- _/ Below ground vaults
- ✓/ Earth mounded concrete bunkers
- _/ Mined cavities
- _/ Augered holes

IMPACT

INSTITUTIONAL	Favor	Disqualify	Inhibit
Federal Regulation-NRC			
o time to process applications	1		15
Agreement State Regulation			
o time to develop program	2		13
o time to process applications	1		14
Non-Radiological State Regulation			
o land use control	7	1	6
o environmental	9		5
o site ownership	4		6

Figure 4. Fector Rating (Cont'd.) (Red)

Rate the Fac..urs in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- _/ hallow land burial (10 CFR 61)
- _/ Above ground vaults
- _/ Below ground vaults
- ✓/ Earth mounded concrete bunkers
- _/ Mined cavities
- _/ Augered holes

IMPACT

SOCIOPOLITICAL	Favor	Disqualify	Inhibit
Public Acceptance of Risk			
o perceived vs. real risk	12	1	4
o State vs. local consideration or risk	11		5
Public Acceptance of Transportation Risk			
o perceived vs. real risk	9	1	3
o State vs. local consideration of risk	9		3
Socioeconomic Impacts			
o land use	9	1	6
o local economy	12		2
o public service (roads, schools, fire protection etc.)	7		4

10/ State
2/ Industry
1/ NRC
1/ Other Federal
4/ Observer
18

Figure 4. Factor Rating (Red)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
✓/ Augered holes (with liners)

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	17		1
o Protection of individuals from inadvertant intrusion	17		1
o Protection of individuals during operations	15	1	2
o Stability of the disposal site after closure	16		1
Status of Technology Development			
o conceptual, demonstration, or existing practice	11		7
o licensing time frames	9	1	8
Siting Contraints			
o site availability	10	1	6

Figure 4. Factor Rating (Cont'd.) (Red)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete vaults
__/ Mined cavities
✓/ Augered holes (with liners)

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	7	1	8
o capital cost	8		8
o operating cost	8		8
o transportation to site	9	1	1
o closure and stabilization	13		2
o institutional control	13		2
Financial Risk			
o risk and expected rate of return	8	1	3
o public vs. private initiative	7	1	2
Consumer Cost/Pricing			
o impact on waste generator	5		9
o impact on institutional, medical industrial and electric utility customers	6		8
Cost of Delay			
o extended storage pending disposal	12		2
o research and development needs	10		6

Figure 4. Factor Rating (Cont'd.) *(Red)*

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- ☑ Augered holes *(with liners)*

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	5	1	9
Agreement State Regulation			
o time to develop program	5	1	11
o time to process applications	5	1	10
Non-Radiological State Regulation			
o land use control	6		9
o environmental	9		5
o site ownership	6	1	3

Figure 4. Factor Rating (Cont'd.) *(Red)*

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- ☑ Augered holes *(with liners)*

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	17		1
o State vs. local consideration or risk	15		1
Public Acceptance of Transportation Risk			
o perceived vs. real risk	9		4
o State vs. local consideration of risk	9		4
Socioeconomic Impacts			
o land use	5		12
o local economy	12		2
o public service (roads, schools, fire protection etc.)	8		3

WALL CHARTS AND RATINGS

PURPLE WORKSHOP

Purple Workshop Wall Charts - Aboveground Vaults, Earth Mounded Concrete Bunkers and Shallow Land Burial

Additional Factors

Technical	Economic	Institutional	Sociopolitical
Development or Demonstration of Experience to Build Public Confidence	None	Risk Assessment Education Capability	Public Understanding of Risk
		Building Management Credibility	Public Acceptance of Risk/Benefit
		Building Confidence in Post Licensing Oversight	Public Acceptance of Technology
		Surveillance & Enforcement	

Purple Workshop - Advantages and Disadvantages

Factors	Shallow Land Burial		Aboveground Vaults		Earth Mounded Concrete Bunkers	
Technical	Advantage	Disadvantage	Advantage	Disadvantage	Adv - Add all from vaults	Dis-Add all from vaults
Protection of the population from general releases	1) Not as vulnerable to weather and seismic factors 2) May be easier to install air & water monitors (Disagreed) 3) Effective in arid environment	1) Intrusion of groundwater 2) Releases to air from placement & gas accumulation 3) Technical/ operational factors not fully demonstrated 4) Site Characterization & predictability 5) Uncertainty about future performance of natural barrier	1) Visually observable 2) Has retrievability 3) No probability of groundwater intrusion 4) Greater control over surface water movement 5) Could install fire fighting equipment <u>disagree not passive</u> 6) Does not depend on waste form solely for long term structural stability	1) Releases of radioactivity 2) Possibility of breach of vault 3) More susceptible to external events 4) Susceptible to fires 5) No soil adsorption (Disagreed) 6) Increased maintenance (Disagreed)	1) Does not depend solely on waste form for long term structural stability 2) Less susceptible to fire 3) Control potential surface water interaction	1) Increased maintenance (Disagreed)

* (Disagreed) means consensus was not reached by purple workshop.

Purple Workshop - Advantages and Disadvantages (continued)

Factors	Shallow Land Burial		Aboveground Vaults		Earth Mounded Concrete Bunkers	
	Advantage	Disadvantage	Advantage	Disadvantage	Advantage	Disadvantage
Financial Risk Rate of Return Closing the site Stabilizing the site	1) If sited & operated according to 61, not too expensive at closure 2) Less risk for long term stability	1) Capital costs are higher than closure cost 2) Public doesn't understand new waste form qualification requirements 3) If problems occur more expensive to correct		1) Require more maintenance over the long term, thus, more costly (Disagreement) 2) Capital costs will be higher than for shallow land burial		1) Require more maintenance over the long term, thus more costly (Disagreement) 2) Capital costs will be higher than for shallow land burial
Surveillance & Monitoring		1) More difficult		1) Lack of experience with alternate technologies		1) Lack of experience with alternate technologies
Public Understanding & Acceptance of Risk		1) Public least accepting of burial	1) Public more accepting of above ground facility		1) Public more accepting of below ground bunker than shallow land burial	

Purple Workshop - Information Needs

Shallow Land Burial	Aboveground Vaults	Earth Mounded Concrete Bunkers
←	Waste Stream Characteristics	→
Demos	Demos	Demos
Data on variable geologic acceptability	Data on variable geologic acceptability	Data on variable geologic acceptability
←	Better coordination of geohydrologic data interpretation	→
←	Generic design of hydrologic models	→
	← Performance of synthetic materials, i.e,, expected lifetime	→

Purple Workshop - <u>Process to Select Technology</u>

1) Establish a development group and identify the regulatory agency as an information resource.

2) In process selection, should focus on development group
   a) consensus building
   b) cross representation
   c) citizen involvement
   d) legislative involvement

3) Characterize waste stream based on total hazard.

4) Access to a generic
   cost/benefit analysis
   risk/benefit
   → identifies available technologies

5) Design an open, publicly accessible process, i.e., NEPA, Joint Review Process on Energy Projects.

6) Establish a site screening process and criteria for screening (should include regulatory criteria).

7) Developing good communication tools to present conceptual design to non-technical people.

8) Make field visits to actual sites or admit none are available.

9) Explore, identify community improvements, as incentives.

10) Address safety issues on a technology specific basis as a community incentive.

11) Establish a regulatory need on a technology specific basis.

10/ State
1/ Industry
6/ NRC
0/ Other Federal
1/ Observer
12

Figure 3. Factor Rating (Purple)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
TECHNICAL					
10 CFR 61 Subpart C-Performance Objectives:					
o Protection of the general population from releases of radioactivity	11	1			
o Protection of individuals during inadvertant intrusion	5	1	6		
o Protection of individuals during operations	7	4	1		
o Stability of the disposal site after closure	10	1			
Status of Technology Development					
o conceptual, demonstration, or existing practice	1	8	2	1	
o licensing time frames		7	3	1	1
• Develop/Demonstration to build Public Confidence	2	6	1		
Siting Constraints					
o site availability	5	4	3		

1

Figure 3. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
ECONOMIC					
Present Value Cost					
o licensing cost	1	2	7	2	
o capital cost	2	4	6		
o operating cost	1	5	6		
o transportation to site	2	6	3	1	
o closure and stabilization	5	6	1		
o institutional control	4	8			
Financial Risk					
o risk and expected rate of return	1	4	2	4	1
o public vs. private initative	1	3	3	4	1
Consumer Cost/Pricing					
o impact on waste generator	1	5	5	1	
o impact on instituional, medical, industrial and electric utility customers	4	2	5	1	
Cost of Delay					
o extended storage pending disposal	1	7	3		1
o research and development needs	1	5	4	1	1

2

E-47

Figure 3. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
INSTITUTIONAL					
Federal Regulation-NRC					
o time to process applications	1	4	7		
Agreement State Regulation					
o time to develop program		6	6		
o time to process applications		5	6		
Non-Radiological State Regulation					
o land use control	3	5	4		
o environmental	7	5			
o site ownership	3	5	3		
Risk Assessment/Education	4	3			
Management Capability	3	2	1		
Building Confidences/ Surveillance & Enforcement	5	2	1		

Figure 3. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
SOCIOPOLITICAL					
Public Acceptance of Risk					
o perceived vs. real risk	6	4	1		
o State vs. local consideration of risk	1	6	3		
Public Acceptance of Transportation Risk					
o perceived vs. real risk	4	6	2		
o State vs. local consideration of risk	2	7	1		1
Socioeconomic Impacts					
o land use	3	5	3		
o local economy	2	5	5		
o public service (roads, schools, fire protection, etc.)	2	4	6		
Public Understanding of Risk	4	2			
Public Acceptance Risk/Benefit	2	2			
Public Acceptance of Technology	2	2			

10/ State
1/ Industry
0/ NRC
0/ Other Federal
1/ Observer
12

Figure 4. Factor Rating (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	6	1	4
o Protection of individuals from inadvertant intrusion	4		7
o Protection of individuals during operations	8		2
o Stability of the disposal site after closure	3	1	6
Status of Technology Development			
o conceptual, demonstration, or existing practice	6	2	5
o licensing time frames	8		3
Siting Contraints			
o site availability	4		6

Figure 4. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete vaults
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	8	2	1
o capital cost	8	3	1
o operating cost	5	3	2
o transportation to site	5	1	2
o closure and stabilization	4	2	5
o institutional control	4	1	3
Financial Risk			
o risk and expected rate of return	4	2	2
o public vs. private initiative	2	3	2
Consumer Cost/Pricing			
o impact on waste generator	5	4	2
o impact on institutional, medical industrial and electric utility customers	5	4	2
Cost of Delay			
o extended storage pending disposal	3	3	2
o research and development needs	5	3	2

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Figure 4. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✔/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	6	1	3
Agreement State Regulation			
o time to develop program	4	2	4
o time to process applications	4	1	3
Non-Radiological State Regulation			
o land use control	2	2	4
o environmental	2	2	6
o site ownership	3	2	3

Figure 4. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✔/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	2	2	6
o State vs. local consideration or risk	1	3	6
Public Acceptance of Transportation Risk			
o perceived vs. real risk	1	3	6
o State vs. local consideration of risl	1	3	5
Socioeconomic Impacts			
o land use	2	3	6
o local economy	3	4	1
o public service (roads, schools, fire protection etc.)	3	4	1

[illegible]/ State
1/ Industry
0/ NRC
0/ Other Federal
1/ Observer
12

Figure 4. Factor Rating (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
__/ Shallow land burial (10 CFR 61)
✓/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	7		3
o Protection of individuals from inadvertant intrusion	8		4
o Protection of individuals during operations	3		6
o Stability of the disposal site after closure	6		4
Status of Technology Development			
o conceptual, demonstration, or existing practice	4	1	6
o licensing time frames	3	1	5
Siting Contraints			
o site availability	8	1	2

E-50

Figure 4. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
__/ Shallow land burial (10 CFR 61)
✓/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete vaults
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	3	1	6
o capital cost	3	1	7
o operating cost	3	1	5
o transportation to site	2	3	2
o closure and stabilization	3	1	1
o institutional control	6	1	1
Financial Risk			
o risk and expected rate of return	3	2	3
o public vs. private initiative	2	4	1
Consumer Cost/Pricing			
o impact on waste generator	3	1	5
o impact on institutional, medical industrial and electric utility customers	3	1	5
Cost of Delay			
o extended storage pending disposal	2	1	4
o research and development needs	2	1	5

E-51

Figure 4. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- ✓/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	2		6
Agreement State Regulation			
o time to develop program	2	1	5
o time to process applications	2	1	5
Non-Radiological State Regulation			
o land use control	6	1	2
o environmental	6	1	2
o site ownership	6	1	

Figure 4. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- ✓/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	11		1
o State vs. local consideration or risk	10	2	
Public Acceptance of Transportation Risk			
o perceived vs. real risk	4	1	3
o State vs. local consideration of risk	3	3	2
Socioeconomic Impacts			
o land use	6	3	1
o local economy	3	3	1
o public service (roads, schools, fire protection etc.)	2	3	1

9/ State
1/ Industry
0/ NRC
0/ Other Federal
1/ Observer
11

Figure 4. Factor Rating (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- __/ Below ground vaults
- ✓/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	5	1	3
o Protection of individual from inadvertant intrusion	6	1	4
o Protection of individuals during operations	1	1	7
o Stability of the disposal site after closure	6	1	3
Status of Technology Development			
o conceptual, demonstration, or existing practice	3	2	6
o licensing time frames	2		7
Siting Contraints			
o site availability	6	1	3

Figure 4. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- __/ Below ground vaults
- ✓/ Earth mounded concrete vaults
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	3	1	4
o capital cost	3	2	4
o operating cost	4	1	4
o transportation to site	3	2	2
o closure and stabilization	7	1	3
o institutional control	6	1	2
Financial Risk			
o risk and expected rate of return	4	2	2
o public vs. private initiative	3	3	1
Consumer Cost/Pricing			
o impact on waste generator	1	2	4
o impact on institutional, medical industrial and electric utility customers	2	1	5
Cost of Delay			
o extended storage pending disposal	1	1	5
o research and development needs	2	1	4

Figure 4. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
☑ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	1		8
Agreement State Regulation			
o time to develop program	1	1	6
o time to process applications	4	2	4
Non-Radiological State Regulation			
o land use control	4	2	1
o environmental	4	2	1
o site ownership	6	1	

Figure 4. Factor Rating (Cont'd.) (Purple)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
☑ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	6	1	3
o State vs. local consideration or risk	6	1	3
Public Acceptance of Transportation Risk			
o perceived vs. real risk	3		4
o State vs. local consideration of risk	3	1	3
Socioeconomic Impacts			
o land use	4	3	2
o local economy	4	2	
o public service (roads, schools, fire protection etc.)	3	3	1

WALL CHARTS AND RATINGS

BLACK WORKSHOP

Black Workshop Wall Charts - Belowground Vaults, Mined Cavities and Shallow Land Burial

Additional Factors

Technical

Performance Objectives

- Protection of Public
- Protection of Inadvertant Intruders
- Protection of Workers
- Post-Closure Stability and Control

Status of Technology

- Conceptual, Demonstration or Existing Practice
- Licensing Time Frame

Site Suitability

* - Ease of Remedial Action
* - Waste Form Restrictions
* - 40 CFR 264 and other Federal requirements

Economic

Present Value Cost

- Licensing
- Capital
* - Waste Treatment
- Operating
- Transportation
- Closure and Stabilization
- Institutional Control
* - Regulatory
* - Potential Remedial Action

Financial Risk

- Rate of Return
- Public vs. Private

* Consumer Cost

- Generators
- Utility customers
- Other customers

Cost of Delay

- Extended storage pending disposa
- R & D needs
* - Cost of Incentive Package

Institutional

Federal

- Time to Process Applications
* - Time and Willingness to Develop Alternatives
* - Number of Agencies Involved

Agreement State

- Time to Develop Programs
- Time to Process Applications

Non-Radiological Regulation

- Land Use
- Environment
- Site Ownership

* Flexibility

* Compact Regulation

Sociopolitical

Public Acceptance

- Perceived Risk
* - Real Risk
- State consideration
* - Local consideration

Socioeconomic

- Land Use
- Local Economy
- Public Service
* - Property Values

Note: Additional factors are marked by asterisks. Changes are indicated by underlining.

Black Workshop - Pros and Cons and Information Needs

Shallow Land Burial

PRO

- Federal regulations in place
- Inexpensive up front costs (Excluding legal costs)
- Low worker exposure
- Protection from tornados, plane crashes, etc.
- Time for development & licensing (Excluding litigation)
- Visual impact

CON

- Land intensive
- Past technical problems
- Ease & cost of remedial action
- Site suitability (tough to find)
- Non-radiological hazards
- Some waste pre-treatment required
- Not suitable for all waste
- Extensive litigation
- Public acceptability

Information Needs

- Long-term isolation capabilities
- Waste packaging options
- Standardization
- Engineered barrier options

Black Workshop - Pros and Cons and Information Needs (continued)

BELOW-GROUND VAULTS

PRO	CON
Low worker exposure	Cost of development & operation (excluding legal costs)
Engineered barrier:	Lack of operating experience
- groundwater protection potential (assuming proper site)	Site suitability (tough to find)
Remedial action	Seismic susceptibility
Protection from tornados, etc.	Technical (guidance) regulations not in place
Intruder protection	Waste packaging requirements
Visual impact	Land intensive
Public acceptability (at State level)	

Information Needs

More cost information

Long-term isolation capabilities

Clarification of Federal role in R & D

Black Workshop - Pros and Cons and Information Needs (continued)

Mined Cavities

PRO	CON
Meets performance objectives for public protection	Costs
Protection from intrusion	Remedial Action
Protection from tornadoes	Site suitability
Visual impact	Worker exposure
Public acceptability (at State level)	Lack of technical regulations
	Time for development & licensing

Information Needs

More cost information

Long-term isolation capabilities

Clarification of Federal role in R & D

General Information Needs for All Technologies

Alternatives to disposal

Assistance in compiling, summarizing and distributing existing information on all alternatives

More meetings

Clarification of Federal agency roles (regulatory roadmap)

Better projections of waste volumes and types

12/ State
0/ Industry
0/ NRC
0/ Other Federal
0/ Observer
12

Figure 3. Factor Rating *(Black)*

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat Important	Not important	Don't know
TECHNICAL					
10 CFR 61 Subpart C-Performance Objectives:					
o Protection of the general population from releases of radioactivity	12				
o Protection of individuals during inadvertant intrusion	6	4	2		
o Protection of individuals during operations	8	4			
o Stability of the disposal site after closure	12				
Status of Technology Development					
o conceptual, demonstration, or existing practice	2	7	3		
o licensing time frames		4	7	1	
Siting Constraints					
o site ~~availability~~ *suitability*	6	5			
Ease of remedial action	4	6	1		
Waste form restrictions		7	3	1	
40 CFR 264 and other Federal restrictions	1	5	2	1	3

Figure 3. Factor Rating (Cont'd.) *(Black)*

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat Important	Not important	Don't know
ECONOMIC					
Present Value Cost					
o licensing cost		1	11		
o capital cost		4	8		
o waste treatment		5	5	1	
o operating cost		3	7	2	
o transportation to site		2	7	3	
o closure and stabilization		5	7		
o institutional control		4	6	2	
o regulatory		5	4	2	
o potential remedial action	2	5	3	1	
Financial Risk					
o risk and expected rate of return	1	3	6	1	1
o public vs. private initative		1	7	2	2
Consumer Cost/Pricing					
o impact on waste generator		2	8	5	
o impact on institutional, medical *and* industrial ~~and electric utility~~ customers		4	6	2	
o impact on utility customers		1	5	6	
Cost of Delay					
o extended storage pending disposal		5	5	2	
o research and development needs	4	2	4	1	1
Cost of incentive package	1	3	4	1	2

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Figure 3. Factor Rating (Cont'd.) (Black)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
INSTITUTIONAL					
Federal Regulation-NRC					
o time to process applications	1	5	5	1	
o time to develop	2	6	2	1	
o number of agencies involved	1	6	3	1	
Agreement State Regulation					
o time to develop program		5	4	1	1
o time to process applications		6	3	1	1
Non-Radiological State Regulation					
o land use control	1	4	4	2	
o environmental	2	6	1	2	
o site ownership	1	4	3	2	1
Flexibility	1	2	3	3	
Compact regulations		4	2	3	

Figure 3. Factor Rating (Cont'd.) (Black)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
SOCIOPOLITICAL					
Public Acceptance of Risk					
o perceived ~~vs. real~~ risk	5	5			
o real risk	6	3	1		
o State ~~vs. local~~ consideration of risk	6	3	1		
o local consideration of risk	5	5			
Public Acceptance of Transportation Risk					
o perceived vs. real risk					
o State vs. local consideration of risk					
Socioeconomic Impacts					
o land use	1	7	3	1	
o local economy		5	5	2	
o public service (roads, schools, fire protection, etc.)		5	5	2	
o property values		4	3	3	

12/ State
0/ Industry
0/ NRC
0/ Other Federal
0/ Observer
12

Figure 4. Factor Rating (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
TECHNICAL				
10 CFR 61 Subpart C - Performance Objectives				
o Protection of the general population from releases of radioactivity	3		5	2
o Protection of individuals from inadvertant intrusion	3		5	2
o Protection of individuals during operations	8		1	1
o Stability of the disposal site after closure	1		6	3
Status of Technology Development				
o conceptual, demonstration, or existing practice	4	1	3	3
o licensing time frames	8		1	2
Siting Contraints				
o site suitability ~~availability~~	3	1	3	4
Ease of remedial action	3		4	1
Waste form restrictions	3		4	1
40 CFR 264 and other Fed. restrictions	1	1	4	2

Figure 4. Factor Rating (Cont'd.) (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete vaults
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
ECONOMIC				
Present Value Cost				
o licensing cost	7		1	2
o capital cost	8			2
o waste treatment	2		3	3
o operating cost	8			2
o transportation to site	1	1	1	6
o closure and stabilization	1	1	3	5
o institutional control	1	1	3	5
o regulatory	2		1	4
o potential remedial action	1	1	3	2
Financial Risk				
o risk and expected rate of return	3		1	6
o public vs. private initiative	4			6
Consumer Cost/Pricing				
o impact on waste generator	7			3
o impact on institutional, medical and industrial ~~and electric utility~~ customers	6			4
o impact on utility customers	5			4
Cost of Delay				
o extended storage pending disposal	5		2	3
o research and development needs	4		3	3
Cost of incentive package	2		2	3

Figure 4. Factor Rating (Cont'd.) **(Black)**

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
INSTITUTIONAL				
Federal Regulation-NRC				
o time to process applications	7			2
o time to develop	4		2	2
o number of agencies involved			3	4
Agreement State Regulation				
o time to develop program	5		1	4
o time to process applications	5		1	4
Non-Radiological State Regulation				
o land use control	2		6	2
o environmental	1		5	3
o site ownership	2		2	4
Flexibility	3		1	5
Compact regulation	2			6

Figure 4. Factor Rating (Cont'd.) **(Black)**

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
SOCIOPOLITICAL				
Public Acceptance of Risk				
o perceived ~~vs. real~~ risk		5	3	1
o real risk	1	4	2	1
o State ~~vs. local~~ consideration or risk		2	5	1
o local consideration of risk		4	3	1
Public Acceptance of Transportation Risk				
o perceived vs. real risk				
o State vs. local consideration of risk				
Socioeconomic Impacts				
o land use		1	6	1
o local economy	1	1	1	5
o public service (roads, schools, fire protection etc.)			2	6
o property values		1	4	2

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12/ State
0/ Industry
0/ NRC
0/ Other Federal
0/ Observer
12

Figure 4. Factor Rating (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- ✓/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
TECHNICAL				
10 CFR 61 Subpart C - Performance Objectives				
o Protection of the general population from releases of radioactivity	7		1	
o Protection of individuals from inadvertant intrusion	7		1	
o Protection of individuals during operations	4		2	1
o Stability of the disposal site after closure	6		1	
Status of Technology Development				
o conceptual, demonstration, or existing practice	2		5	
o licensing time frames	1		6	1
Siting Contraints				
o site availability	4		3	1
Ease of remedial action	5			
Waste form restrictions	3		2	
40 CFR 264 and other Federal requirements	2		2	1

Figure 4. Factor Rating (Cont'd.) (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- ✓/ Below ground vaults
- __/ Earth mounded concrete vaults
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
ECONOMIC				
Present Value Cost				
o licensing cost	2		5	
o capital cost	1		6	1
o waste treatment			4	6
o operating cost			5	3
o transportation to site		1		5
o closure and stabilization	6		1	1
o institutional control	5		1	1
• regulatory	2		2	1
• potential remedial action	5		1	
Financial Risk				
o risk and expected rate of return	2		1	4
o public vs. private initiative	1		1	5
Consumer Cost/Pricing				
o impact on waste generator	1		5	1
o impact on institutional, medical and industrial ~~and electric utility~~ customers	1		3	3
o impact on electric utility customers			4	3
Cost of Delay				
o extended storage pending disposal			5	2
o research and development needs			7	
Cost of incentive package	1		1	3

E-65

Figure 4. Factor Rating (Cont'd.) (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- ✓/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
INSTITUTIONAL				
Federal Regulation-NRC				
o time to process applications	1		6	
o time to develop			6	
o number of agencies involved	1		2	
Agreement State Regulation				
o time to develop program			5	2
o time to process applications			5	2
Non-Radiological State Regulation				
o land use control	1		5	
o environmental	4			2
o site ownership	2		1	3
Flexibility	1			4
Compact regulation			1	4

Figure 4. Factor Rating (Cont'd.) (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- ✓/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
SOCIOPOLITICAL				
Public Acceptance of Risk				
o perceived ~~vs. real~~ risk	3		2	2
o real risk	4		1	1
o State ~~vs. local~~ consideration of risk	4		1	1
o local consideration of risk			3	2
Public Acceptance of Transportation Risk				
o perceived vs. real risk				
o State vs. local consideration of risk				
Socioeconomic Impacts				
o land use			4	2
o local economy			2	5
o public service (roads, schools, fire protection etc.)			1	7
o property values			2	4

11/ State
0/ Industry
0/ NRC
0/ Other Federal
0/ Observer
11

Figure 4. Factor Rating (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
✓/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
TECHNICAL				
10 CFR 61 Subpart C - Performance Objectives				
o Protection of the general population from releases of radioactivity	4		1	
o Protection of individuals from inadvertant intrusion	4		1	
o Protection of individuals during operations	2		3	
o Stability of the disposal site after closure	4		1	
Status of Technology Development				
o conceptual, demonstration, or existing practice	1		2	1
o licensing time frames			3	1
Siting Contraints				
o site ~~availability~~ suitability		1	3	
Ease of remedial action	1		3	
Waste form restrictions	2			2
40 CFR 264 and other Federal restrictions	1		1	2

Figure 4. Factor Rating (Cont'd.) (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete vaults
✓/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
ECONOMIC				
Present Value Cost				
o licensing cost			3	1
o capital cost			1	4
o waste treatment	1		2	1
o operating cost			2	2
o transportation to site				4
o closure and stabilization	2			2
o institutional control	2			1
• regulatory			2	2
• potential remedial action			1	4
Financial Risk				
o risk and expected rate of return				4
o public vs. private initiative				4
Consumer Cost/Pricing				
o impact on waste generator			2	2
o impact on institutional, medical and industrial ~~and electric utility~~ customers			2	2
o impact on utility customers			1	4
Cost of Delay				
o extended storage pending disposal			3	
o research and development needs			1	3
Cost of incentive package				1

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Figure 4. Factor Rating (Cont'd.) (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
✓/ Mined cavities
__/ Augered holes

IMPACT

INSTITUTIONAL	Favor	Disqualify	Inhibit	Don't Know
Federal Regulation-NRC				
o time to process applications			4	
o time to develop			3	1
o number of agencies involved			2	1
Agreement State Regulation				
o time to develop program			3	1
o time to process applications			3	1
Non-Radiological State Regulation				
o land use control	2			2
o environmental	2			2
o site ownership	1			3
Flexibility			1	3
Compact regulation				4

Figure 4. Factor Rating (Cont'd.) (Black)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
✓/ Mined cavities
__/ Augered holes

IMPACT

SOCIOPOLITICAL	Favor	Disqualify	Inhibit	Don't Know
Public Acceptance of Risk				
o perceived ~~vs. real~~ risk	2			2
o real risk	2		1	1
o State ~~vs. local~~ consideration or risk	2			2
o local consideration of risk			2	2
Public Acceptance of Transportation Risk				
o perceived vs. real risk				
o State vs. local consideration of risk				
Socioeconomic Impacts				
o land use	2		1	
o local economy	1		1	1
o public service (roads, schools, fire protection etc.)			1	2
o property values			1	3

APPENDIX F

NRC SUPPORTING DATA

TABLE OF CONTENTS

KEY

Blue Workshop - B
Red Workshop - R
Purple Workshop - P
Black Workshop - K

Note: The large numbers in the "important columns" represent the total of the individual workshops. The small numbers to the right of the large numbers represent, from top to bottom, the blue, red, purple and black workshops, respectively.

B	R	P	K	
13	11	10	12	46/ State
0	2	1	0	3/ Industry
0	1	0	0	1/ NRC
1	0	0	0	1/ Other Federal
1	5	1	0	7/ Observer
15	19	12	12	58 Total

Figure 3. Factor Rating

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
TECHNICAL					
10 CFR 61 Subpart C-Performance Objectives:					
o Protection of the general population from releases of radioactivity	57	1			
o Protection of individuals during inadvertant intrusion	33	14	16		
o Protection of individuals during operations	40	17	1		
o Stability of the disposal site after closure	51	6			
Status of Technology Development					
o conceptual, demonstration, or existing practice	9	31	15	2	
o licensing time frames	3	23	25	6	1
Siting Constraints					
o site availability *site suitability	28	23	5		1

Figure 3. Factor Rating (Cont'd.)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

	Critical	Important	Somewhat important	Not important	Don't know
ECONOMIC					
Present Value Cost					
o licensing cost	2	14	37	5	
o capital cost	2	29	26		
o operating cost	1	31	23	2	
o transportation to site	5	22	24	5	
o closure and stabilization	19	26	12		
o institutional control	19	24	1	1	
Financial Risk					
o risk and expected rate of return	2	20	22	9	4
o public vs. private initative	1	18	20	13	5
Consumer Cost/Pricing					
o impact on waste generator	3	20	29	5	
o impact on institutional, medical, industrial and electric utility customers (* other / utility)	6	16	21	2	
Cost of Delay					
o extended storage pending disposal	6	26	20	4	1
o research and development needs	12	21	18	4	2

Figure 3. Factor Rating (Cont'd.)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

INSTITUTIONAL	Critical	Important	Somewhat important	Not important	Don't know
Federal Regulation-NRC					
o time to process applications	7	20	27	4	
Agreement State Regulation					
o time to develop program	3	31	16	5	1
o time to process applications	4	23	23	6	1
Non-Radiological State Regulation					
o land use control	11	21	20	3	2
o environmental	20	28	6	2	2
o site ownership	11	21	11	7	4

Figure 3. Factor Rating (Cont'd.)

Rate the Factors in Terms of Importance

Support with a Few Words

IMPORTANCE

SOCIOPOLITICAL	Critical	Important	Somewhat important	Not important	Don't know
Public Acceptance of Risk					
o perceived vs. real risk (+ perceived/real)	29	12	4		
o State vs. local consideration of risk (+ State/local)	15 +6/5	22 +3/5	7 +1/0		1
Public Acceptance of Transportation Risk					
o perceived vs. real risk	17	13	14	2	
o State vs. local consideration of risk	11	16	14	2	1
Socioeconomic Impacts					
o land use	9	27	19	2	
o local economy	5	24	27	2	
o public service (roads, schools, fire protection, etc.)	7	20	28	3	

B	R	P	K	Total	
13	10	10	12	45	State
0	2	1	0	3	Industry
0	1	0	0	1	NRC
1	1	0	0	2	Other Federal
1	4	1	0	6	Observer
15	18	12	12	57	

Figure 4. Factor Rating

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	21	3	19
o Protection of individuals from inadvertent intrusion	26	1	26
o Protec[illegible]dividuals during [illegible]s	44	1	8
o Stability of the disposal site after closure	16	3	30
Status of Technology Development			
o conceptual, demonstration, or existing practice	34	4	16
o licensing time frames	41	2	7
Siting Contraints			
o site availability	14	4	28

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: ✓/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete vaults
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	45	3	2
o capital cost	46	3	1
o operating cost	41	3	4
o transportation to site	24	3	9
o closure and stabilization	16	5	23
o institutional control	15	4	23
Financial Risk			
o risk and expected rate of return	26	6	5
o public vs. private initiative	20	6	9
Consumer Cost/Pricing			
o impact on waste generator	37	5	6
o impact on institutional, medical industrial and electric utility customers	38	5	4
Cost of Delay			
o extended storage pending disposal	27	5	11
o research and development needs	30	4	11

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Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- ✓/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	41	2	6
Agreement State Regulation			
o time to develop program	36	2	9
o time to process applications	33	2	9
Non-Radiological State Regulation			
o land use control	22	5	19
o environmental	18	5	23
o site ownership	21	4	14

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- ✓/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	2	16	32
o State vs. local consideration of risk	3	13	29
Public Acceptance of Transportation Risk			
o perceived vs. real risk	3	4	32
o State vs. local consideration of risk	6	5	26
Socioeconomic Impacts			
o land use	13	10	25
o local economy	17	7	15
o public service (roads, schools, fire protection etc.)	15	6	16

B	P		
13	10	23	/ State
0	1	1	/ Industry
0	0	0	/ NRC
1	0	1	/ Other Federal
1	1	2	/ Observer
15	12	27	

Figure 4. Factor Rating

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: _/ Shallow land burial (10 CFR 61)
✓/ Above ground vaults
_/ Below ground vaults
_/ Earth mounded concrete bunkers
_/ Mined cavities
_/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	15 8/7	0 0/0	10 7/3
o Protection of individuals from inadvertant intrusion	19 [illegible]	0 0/0	8 [illegible]
o Protection of individuals during operations	7 [illegible]/3	0 0/0	16 [illegible]
o Stability of the disposal site after closure	13 [illegible]	0 0/0	11 7/4
Status of Technology Development			
o conceptual, demonstration, or existing practice	5 [illegible]	1 0/1	18 12/6
o licensing time frames	4 1/3	1 0/1	19 14/5
Siting Contraints			
o site availability	23 15/8	1 0/1	2 0/2

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: _/ Shallow land burial (10 CFR 61)
✓/ Above ground vaults
_/ Below ground vaults
_/ Earth mounded concrete vaults
_/ Mined cavities
_/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	5 2/3	1 0/1	19 13/6
o capital cost	4 1/3	1 0/1	19 [illegible]
o operating cost	6 3/3	1 0/1	16 [illegible]
o transportation to site	11 [illegible]/2	5 [illegible]	5 [illegible]/2
o closure and stabilization	16 [illegible]	[illegible]	7 [illegible]
o institutional control	13 [illegible]/6	1 0/1	8 [illegible]
Financial Risk			
o risk and expected rate of return	6 3/3	3 [illegible]	12 9/3
o public vs. private initiative	6 4/2	5 4/1	6 5/1
Consumer Cost/Pricing			
o impact on waste generator	5 2/3	2 1/1	17 12/5
o impact on institutional, medical industrial and electric utility customers	4 1/3	2 1/1	18 13/5
Cost of Delay			
o extended storage pending disposal	6 4/2	1 0/1	14 10/4
o research and development needs	5 3/2	1 0/1	17 12/5

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Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- ☑ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	2	0	21
Agreement State Regulation			
o time to develop program	4	1	19
o time to process applications	4	1	19
Non-Radiological State Regulation			
o land use control	16	1	6
o environmental	16	1	6
o site ownership	15	2	4

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- ☑ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- __/ Mined cavities
- __/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	20	0	2
o State vs. local consideration of risk	22	2	2
Public Acceptance of Transportation Risk			
o perceived vs. real risk	15	1	5
o State vs. local consideration of risk	13	4	2
Socioeconomic Impacts			
o land use	15	3	4
o local economy	11	5	4
o public service (roads, schools, fire protection etc.)	9	3	6

B	K		
13	12	25	State
0	0	0	Industry
0	0	0	NRC
1	0	1	Other Federal
1	0	1	Observer
15	12	27	

Figure 4. Factor Rating

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
✓/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	20 13/7	0 :	3 [illegible]
o Protection of individuals from inadvertant intrusion	20 [illegible]	0 :	3 [illegible]
o Protection of individuals during operations	14 [illegible]	0 :	6 [illegible]
o Stability of the disposal site after closure	21 [illegible]	0 :	1 [illegible]
Status of Technology Development			
o conceptual, demonstration, or existing practice	7 5/2	0 :	15 [illegible]
o licensing time frames	5 [illegible]	0 :	16 [illegible]
Siting Contraints			
o site availability	18 [illegible]	0 :	16 [illegible]

1

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Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
✓/ Below ground vaults
__/ Earth mounded concrete vaults
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	5 3/2	0 0/0	16 [illegible]/5
o capital cost	2 1/1	0 0/0	19 [illegible]/6
o operating cost	4 [illegible]/0	0 :	15 10/5
o transportation to site	9 9/0	1 0/1	3 3/0
o closure and stabilization	15 9/6	0 :	6 5/1
o institutional control	13 8/5	0 :	5 4/1
Financial Risk			
o risk and expected rate of return	8 6/2	1 1/0	8 7/1
o public vs. private initiative	6 5/1	1 1/0	6 5/1
Consumer Cost/Pricing			
o impact on waste generator	5 4/1	1 1/0	14 9/5
o impact on institutional, medical industrial and electric utility customers	5 5/0	1 1/0	14 9/4/3
Cost of Delay			
o extended storage pending disposal	6 6/0	0 :	14 [illegible]
o research and development needs	4 4/0	0 :	18 11/7

2

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Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
✓/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	3 2/1	0 :	19 9/8
Agreement State Regulation			
o time to develop program	2 2/0	0 :	20 13/7
o time to process applications	2 2/0	0 :	20 3/7
Non-Radiological State Regulation			
o land use control	12 11/1	0 :	8 1/5
o environmental	15 11/7	0 :	2 2/0
o site ownership	12 11/2	0 :	5 7/7

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
✓/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	18	0 :	2
o State vs. local consideration or risk	14	0 :	3
Public Acceptance of Transportation Risk			
o perceived vs. real risk	10	0 :	3 :
o State vs. local consideration of risk	10	0 :	1 :
Socioeconomic Impacts			
o land use	12 :	0 :	5
o local economy	9	0 :	5
o public service (roads, schools, fire protection etc.)	8	0 :	4

R	P		
10	9	19	State
2	1	3	Industry
1	0	1	NRC
1	0	1	Other Federal
3	1	4	Observer
17	11	28	

Figure 4. Factor Rating

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
✓/ Earth mounded concrete bunkers
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	20 15/5	1 0/1	5 2/3
o Protection of individuals from inadvertant intrusion	22 16/6	1 0/1	5 1/4
o Protection of individuals during operations	8 7/1	2 1/1	16 9/7
o Stability of the disposal site after closure	19 [illegible]	1 0/1	7 4/3
Status of Technology Development			
o conceptual, demonstration, or existing practice	7 4/3	2 1/1	19 13/6
o licensing time frames	4 2/2	0 0/0	22 15/7
Siting Contraints			
o site availability	16 10/6	2 1/1	7 4/3

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
✓/ Earth mounded concrete vaults
__/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	8 5/3	1 0/1	16 7/9
o capital cost	4 1/3	2 1/1	18 11/7
o operating cost	9 5/4	1 0/1	14 7/7
o transportation to site	12 9/3	3 1/2	3 1/2
o closure and stabilization	17 [illegible]	1 0/1	7 4/3
o institutional control	17 [illegible]	1 0/1	5 3/2
Financial Risk			
o risk and expected rate of return	11 7/4	3 1/2	6 4/2
o [illegible]blic vs. private initiative	7 4/3	4 1/3	4 3/1
Consumer Cost/Pricing			
o impact on waste generator	6 5/1	3 1/2	13 9/4
o impact on institutional, medical industrial and electric utility customers	7 5/2	2 1/1	14 8/6
Cost of Delay			
o extended storage pending disposal	9 8/1	1 0/1	11 6/5
o research and development needs	9 8/1	1 0/1	12 8/4

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Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: _/ Shallow land burial (10 CFR 61)
_/ Above ground vaults
_/ Below ground vaults
✓/ Earth mounded concrete bunkers
_/ Mined cavities
_/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	2	0	23
Agreement State Regulation			
o time to develop program	3	1	19
o time to process applications	5	2	18
Non-Radiological State Regulation			
o land use control	11	3	7
o environmental	13	2	6
o site ownership	12	1	6

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: _/ Shallow land burial (10 CFR 61)
_/ Above ground vaults
_/ Below ground vaults
✓/ Earth mounded concrete bunkers
_/ Mined cavities
_/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	18	2	7
o State vs. local consideration or risk	17	1	8
Public Acceptance of Transportation Risk			
o perceived vs. real risk	12	1	7
o State vs. local consideration of risk	12	1	6
Socioeconomic Impacts			
o land use	13	4	8
o local economy	16	2	2
o public service (roads, schools, fire protection etc.)	10	3	5

K.
11/ State
0/ Industry
0/ NRC
0/ Other Federal
0/ Observer
11 (Only 5 are valid.)

Figure 4. Factor Rating

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
__/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
✓/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
TECHNICAL				
10 CFR 61 Subpart C - Performance Objectives				
o Protection of the general population from releases of radioactivity	4		1	
o Protection of individuals from inadvertant intrusion	4		1	
o Protection of individuals during operations	2		3	
o Stability of the disposal site after closure	4		1	
Status of Technology Development				
o conceptual, demonstration, or existing practice	1		2	1
o licensing time frames			3	1
Siting Contraints				
o site availability		2	3	

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
__/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete vaults
✓/ Mined cavities
__/ Augered holes

IMPACT

	Favor	Disqualify	Inhibit	Don't Know
ECONOMIC				
Present Value Cost				
o licensing cost			3	1
o capital cost			1	3
o operating cost			2	1
o transportation to site				2
o closure and stabilization	2			1
o institutional control	2			1
Financial Risk				
o risk and expected rate of return				3
o public vs. private initiative				3
Consumer Cost/Pricing				
o impact on waste generator			2	2
o impact on institutional, medical industrial ~~and electric utility~~ customers			2	1
o utility customers			2	1
Cost of Delay				
o extended storage pending disposal			3	
o research and development needs			1	2

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- ✓/ Mined cavities
- __/ Augered holes

IMPACT

INSTITUTIONAL	Favor	Disqualify	Inhibit	Don't Know
Federal Regulation-NRC				
o time to process applications			4	
Agreement State Regulation				
o time to develop program			3	1
o time to process applications			3	1
Non-Radiological State Regulation				
o land use control	2			2
o environmental	2			2
o site ownership	1			3

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
- __/ Shallow land burial (10 CFR 61)
- __/ Above ground vaults
- __/ Below ground vaults
- __/ Earth mounded concrete bunkers
- ✓/ Mined cavities
- __/ Augered holes

IMPACT

SOCIOPOLITICAL	Favor	Disqualify	Inhibit	Don't Know
Public Acceptance of Risk				
o perceived ~~vs. real~~ risk	2			2
real risk	2			1
o State ~~vs. local~~ consideration or risk	2			2
local risk			2	
Public Acceptance of Transportation Risk				
o perceived vs. real risk				
o State vs. local consideration of risk				
Socioeconomic Impacts				
o land use	2		1	1
o local economy	1		1	2
o public service (roads, schools, fire protection etc.)			1	3
o property values			1	3

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R
10/ State
2/ Industry
1/ NRC
1/ Other Federal
4/ Observer
18

Figure 4. Factor Rating

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
__/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
☒/ Augered holes (with liners)

IMPACT

	Favor	Disqualify	Inhibit
TECHNICAL			
10 CFR 61 Subpart C - Performance Objectives			
o Protection of the general population from releases of radioactivity	17		1
o Protection of individuals from inadvertant intrusion	17		1
o Protection of individuals during operations	15	1	2
o Stability of the disposal site after closure	16		1
Status of Technology Development			
o conceptual, demonstration, or existing practice	11		7
o licensing time frames	9	1	8
Siting Contraints			
o site availability	10	1	6

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology:
__/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete vaults
__/ Mined cavities
☒/ Augered holes (with liners)

IMPACT

	Favor	Disqualify	Inhibit
ECONOMIC			
Present Value Cost			
o licensing cost	7	1	8
o capital cost	8	)	8
o operating cost	8	0	8
o transportation to site	9	1	1
o closure and stabilization	13	0	2
o institutional control	13	0	2
Financial Risk			
o risk and expected rate of return	8	1	3
o public vs. private initiative	7	1	3
Consumer Cost/Pricing			
o impact on waste generator	5	0	9
o impact on institutional, medical industrial and electric utility customers	6	0	8
Cost of Delay			
o extended storage pending disposal	12	0	2
o research and development needs	10	0	6

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Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
✓ Augered holes (with liners)

IMPACT

	Favor	Disqualify	Inhibit
INSTITUTIONAL			
Federal Regulation-NRC			
o time to process applications	5	1	9
Agreement State Regulation			
o time to develop program	5	1	11
o time to process applications	5	1	10
Non-Radiological State Regulation			
o land use control	6	0	9
o environmental	9	0	5
o site ownership	6	1	3

Figure 4. Factor Rating (Cont'd.)

Rate the Factors in Terms of Impact for Each of the Three Technologies

Support with a Few Words

Technology: __/ Shallow land burial (10 CFR 61)
__/ Above ground vaults
__/ Below ground vaults
__/ Earth mounded concrete bunkers
__/ Mined cavities
✓ Augered holes (with liners)

IMPACT

	Favor	Disqualify	Inhibit
SOCIOPOLITICAL			
Public Acceptance of Risk			
o perceived vs. real risk	17	0	1
o State vs. local consideration or risk	15	0	1
Public Acceptance of Transportation Risk			
o perceived vs. real risk	9	0	4
o State vs. local consideration of risk	9	0	4
Socioeconomic Impacts			
o land use	5	0	12
o local economy	12	0	2
o public service (roads, schools, fire protection etc.)	8	0	3

APPENDIX G

NRC AND DEPARTMENT OF ENERGY REFERENCE LISTS

TABLE OF CONTENTS

State Workshop on Shallow Land Burial and Alternative Disposal Concepts
May 2-3, 1984

REFERENCES AVAILABLE IN INDIVIDUAL WORKSHOPS

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0. "Alternative Methods for Disposal of Low-Level Radioactive Wastes - Task 1: Description of Methods and Assessment of Criteria." U.S. Army Engineer Waterways Experiment Station, prepared for the U.S. Nuclear Regulatory Commission, NUREG/CR-3774, April 1984.

1. "The Role of the State in the Regulation of Low-Level Radioactive Waste," NUREG-0962, March 1983.

2. "Draft Environmental Impact Statement on 10 CFR Part 61 'Licensing Requirements for Land Disposal of Radioactive Waste;" NUREG-0782, Volumes 1, 2, 3 and 4, September 1981.

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4. "Branch Position - Low-Level Waste Burial Ground Site Closure and Stabilization," Revision 1, May 17, 1979.

5. "Branch Technical Position - Site Suitability, Selection and Characterization," NUREG-0902, April 1982.

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7. "Technical Position - Funding Assurances for Closure, Postclosure, and Long Term Care of Low-Level Waste Disposal Facility," June 1982.

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9. "Technical Position on Waste Form," May 1983, Rev. 0.

10. "Final Waste Classification and Waste Form Technical Position Papers," May 11, 1983.

11. "Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste," Regulatory Guide 4.18, June 1983.

12. "Parameters for Characterizing Sites for Disposal of Low-Level Radioactive Waste," NUREG/CR-2700, May 1982.

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14. "Screening of Alternative Methods for the Disposal of Low-Level Radioactive Wastes," NUREG/CR-0308, October 1978.

15. "Proceedings of the Symposium on Low-Level Waste Disposal, Site Suitability Requirements," NUREG/CP-0028, CONF-812118, Vol. 1, September 1982.

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17. "Proceedings of the Symposium on Low-Level Waste Disposal, Facility Design, Construction, and Operating Practices," NUREG/CP-0028, CONF-820911, Vol. 3, March 1983.

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19. "Biomedical Waste Disposal," 10 CFR Part 20, Federal Register, Vol. 46, No. 47, March 11, 1981, pp. 16230-16234.

20. "Effective Radioactive Waste Management at Medical and Academic Institutions," July 20, 1981.

21. "Memorandum to All Medical Licensees," June 4, 1981.

22. "Memorandum to All Medical and Academic Licensees," June 25, 1980.

23. "Memorandum to All Industrial Licensees," September 12, 1980.

24. "Storage of Low-Level Radioactive Wastes at Power Reactor Sites," Generic Letter 81-38, November 10, 1981.

25. "Letter to the Honorable Michael S. Dukakis, Governor of Massachusetts," April 13, 1984.

26. "Letter to the Honorable Judy Kany, Maine State Senator," January 5, 1984.

27. "Letter to the Honorable Anthony S. Earl, Governor of Wisconsin," November 7, 1983.

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29. "Letter to the Honorable Olympia J. Snowe, U.S. House of Representatives," April 18. 1984.

30. "The Impact on Low-Level Radioactive Waste Burial Sites of Waste From Decommissioning Commercial Light Water Power Reactors," March 10, 1983.

31. "State Surveillance of Radioactive Material Transportation," NUREG-1015, February 1984.

Availability of NRC Publications

1. The NRC Public Document Room, 1717 H Street, N.W., Washington, DC 20555

2. The NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555

3. The National Technical Information Service, Springfield, VA 22161.

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TABLE 1. NATIONAL LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT PROGRAM PUBLICATIONS

Order Number	Document Title/Report Number	Being cataloged at NTIS*	Available At NTIS	Price Paper Copy/ Microfiche
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DE83013941	Public Comment on Managing Low-Level Radioactive Wastes: A Proposed Approach (DOE/LLW-3)		X	PC 19.00 MF 4.50
DE83003583	Criteria Needs for Siting, Licensing, Operation, Closure, Stabilization and Decommissioning of Commercial Shallow Land Disposal Sites for Radioactive Waste (DOE/LLW-4T)		X	PC 10.00 MF 4.50
DE83003842	Institutional Radioactive Wastes with Restrictions for Land Burial Disposal Sites and Environmental Methods to Manage Such Waste (DOE/LLW-5T)		X	PC 8.50 MF 4.50
DE83003145	Directions in Low-Level Waste Management Series: Planning State Policy on Low-Level Radioactive Waste (DOE/LLW-6Ta)		X	PC 10.00 MF 4.50
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DE83007470	Directions in Low-Level Waste Management Series: The Siting Process: Establishing a Low-Level Waste Disposal Facility (DOE/LLW-6Tc)		X	PC 8.50 MF 4.50
DE83009734	Directions in Low-Level Waste Management Series: An Analysis of Low-Level Waste Disposal Facility and Transportation Costs (DOE/LLW-6Td)		X	PC 10.00 MF 4.50
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	Application of a Proposed Waste Classification System to the Evaluation of Relative Hazards of Phosphate Products and Wastes (DOE/LLW-24T)	X		
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DE83011442	A Planner's Guide to Low-Level Radioactive Waste Disposal (DOE/ID/12180-T1)	Also available from American Planning Association 1313 E. 60th St., Chicago, IL 60637	X	PC 10.00 MF 4.50
	Regional Low-Level Radioactive Waste Disposal Sites--Progress Being Made But New Sites Will Probably Not Be Ready by 1986 (GAO/RCED-83-48)	Available from General Accounting Office P.O. Box 6015, Gaithersburg, MD 20760 202-275-6241		Free
DE84004134	Proceedings of the Fifth Annual Participants' Information Meeting DOE Low-Level Waste Management Program (CONF-8308106)		X	PC 53.50 MF 4.50

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12. SUPPLEMENTARY NOTES

13. ABSTRACT (200 words or less)

Three of the major conclusions reached by State participants were the following: (1) Significant data gaps and information needs have to be addressed before timely State decisionmaking can be accomplished. State participants felt a generic cost/risk/benefit analysis for all viable alternatives would be useful and might best be performed by the Federal government on behalf of the States. (2) Recognizing the imprecision in summarizing overall attitudes of the workshop participants, alternative disposal concepts that appear to be the most favorably perceived when rank ordered by "critical" factors are augered holes with liners, belowground vaults, earth mounded concrete bunkers, aboveground vaults and mined cavities. (3) The public appears to place greater confidence in disposal methods that incorporate man-made engineered barriers because of some past problems at closed shallow land burial facilities. Concern was expressed by workshop participants that the public may not consider the perceived risks associated with shallow land burial to be acceptable. In addition to the four 10 CFR Part 61 Subpart C performance objectives, public acceptance of risk was considered to be a critical factor by State officials in selecting a disposal technology. The States should take the lead in pursuing development-oriented analyses, such as detailed concept engineering and economic feasibility studies. It is not within the purview of NRC responsibility to undertake such studies.

14. DOCUMENT ANALYSIS – a. KEYWORDS/DESCRIPTORS

low-level radioactive waste disposal
shallow land burial
augered holes
belowground vaults
earth mounded concrete bunkers
aboveground vaults
mined cavities
10 CFR Part 61

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