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TRU Waste Form and Package Criteria Meeting

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TRU WASTE FORM AND PACKAGE CRITERIA MEETING

Sandia Laboratories
Albuquerque, New Mexico 87115

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TRU WASTE FORM AND PACKAGE CRITERIA MEETING
SHERATON OLD TOWN - ALBUQUERQUE, NEW MEXICO
APRIL 13-14, 1977

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MEETING ON
TRU WASTE FORM AND PACKAGING CRITERIA

April 13 and 14, 1977
Albuquerque, NM

Opening remarks were presented by Delacroix Davis, Jr., of ALO.

PROGRAM REMARKS

R. Glenn Bradley - Meeting Chairman, ERDA Hq/WPR

An introductory statement was made by R. Glenn Bradley of ERDA headquarters. The broad subject of the meeting was defined as the overall ERDA TRU waste management program, but discussions were to center upon performance criteria for the Waste Isolation Pilot Plant (WIPP), and their implications for the overall TRU program.

The basis for discussion was the second draft of a set of proposed WIPP criteria, which had been prepared by Sandia Laboratories and circulated for comment among contractors involved in the TRU waste management program. These criteria can potentially impact the entire TRU program.

It is hoped that the WIPP criteria can become firm this year. They must remain dynamic, and should retain enough flexibility to make minimal impact on the overall TRU program, while at the same time allowing a sensible level of risk in the WIPP, both in operations and in geologic formation integrity and stability. The criteria as generated this year will be further tested in terms of licensability, compatibility with the commercial TRU waste program, etc. Among problems raised by these necessities are the acceptability at WIPP of the existing inventory of defense wastes in terms of waste form and packaging; processing of the inventory that may be required by the criteria; necessary packaging redesign; the R&D required to determine optimum processing machines; and possible need to modify existing operations at points of TRU waste generation.

A need was stressed for greater coherence in the overall TRU waste management program. Most of the necessary work seems to be in progress, but there is diffusion of effort and a lack of common direction, leading to a need for more interaction between the organizations involved.

Presentations and comments at this meeting will furnish a basis for ERDA decisions on how to obtain near-term solutions, and optimum mechanisms for obtaining these decisions. The decisions are needed soon, and members of the complex will be asked to contribute to and comment upon them.

The primary need is to identify dates for objectives, and clearly assign responsibility for meeting them. Also needed is a general program strategy in both implementing and scheduling. As a corollary, a budget must be established, which can only be done by better defining specific needs and dates. Only in that way can the budget be made flexible enough to react to perturbations that may impact resource availability, etc. The budget will have to be defended before the ERDA budget review committees as well as before the NRC and others with whom ERDA has to interact to get the resources required to carry out the program.

Recent announcements by President Carter regarding waste management will have some effect (not yet clear) on the commercial waste management program. They probably will not significantly affect the defense waste program, because there is an existing problem which must be accommodated, although possibly program emphasis will change. Efforts which have in the past been oriented toward commercial wastes may now be labeled as being oriented toward defense wastes; for instance, in technology development for solidification of HLW. Some definitive solutions for defense wastes must be reached, and they must have high credibility if they are to minimize attacks upon and concern about the civilian nuclear power program. It is widely believed that TRU waste program, its technology, solutions, long-term disposition, repository and storage criteria, etc., will serve as the leading edge of technology evolution for commercial TRU wastes.

PROPOSED WIPP TRU WASTE FORM CRITERIA

Leo Scully, Sandia Laboratories

A major impediment to the development of a unified, coordinated national waste management program is the lack of a clear concise statement of what waste forms are acceptable for a given storage environment. The draft TRU Waste Acceptance Criteria is an attempt to generate thought and comment to assist ERDA in developing a national document that can be used not only for the WIPP, but for other repositories later. This is the second draft that has been circulated outside Sandia, after many internal drafts and discussions. The first outside draft was extensively modified after review by ERDA at Albuquerque, Idaho, and Headquarters, as well as by LASL, Mound, Rocky Flats, and EG&G. The draft generated much comment. All comments were considered and many were incorporated. The fact that all parties could not agree on what is acceptable indicates that much work remains to be done by everyone in the waste management community. This will take time and money and a coordinated effort by Headquarters, the field offices, and all contractors involved.

There are 5 major points that are especially significant:

1. Defense waste is a national problem, not just a WIPP problem. It requires a satisfactory technical solution (both from near-term and long-term safety standpoints) that is as economical as possible overall, and that is credible to the public, the intellectually honest critic or intervenor, and government bodies that must approve and/or allocate funds for program completion. To arrive at such a solution, we have visited most if not all of your operations and tried to understand your problems. We have gathered large amounts of existing documentation so we could benefit from your thinking. We have no doubt missed many notes, memos, and unpublished or uncompleted reports which bear on the problems; please pass these on to us.

   Both as an ERDA contractor and as a taxpaper, we have considered the monetary impact of some of the recommended criteria. We have tried to determine the important questions that need answers; whether the answers are available, and how we can obtain them, both for long- and short-term concerns. We did this on the thesis that if we, both ERDA and the contractors cannot ask ourselves the tough questions and deliver answers that we agree upon, how can we answer our honest critics?

2. A lot of good work and thinking has been done on waste management problems in the past. For various reasons, much of the engineering and research effort has not been funded or allowed to go to completion. We have tried to compile the existing data, place it in a salt-mine environment, and test it for applicability. We have attempted to add fresh thoughts and viewpoints.

3. Designs and conclusions that are 100% accurate and pertinent for 20-year retrievable storage are not directly applicable for geologic storage over time spans of thousands of years. A case in point is the presence of organic materials in the waste. The fact that there is technical evidence both for and against the inclusion of organics shows that more work is needed in this area before a proof-positive position can be reached.

4. Criteria on waste forms need to be dynamic, allowing for revisions as new experimental and analytic evidence points toward change. Where there is a reasonable doubt as to the safety of a given criterion, a conservative approach must be taken until more evidence reduces that doubt and makes a relaxation of criteria appropriate. A case in point: arguments for and against organics are not conclusive at this time. Until sufficient systematic hazard analyses and experimental data can be obtained on which to base a sound conclusion, little organic matter should be stored in the WIPP, and huge expenditures for incineration and fixation plants should not be made. They may not be necessary. They probably should, however, be included in long-range budget planning, if possible, anticipating that a decision can be made in the next few years of work.

5. One result of discussions on acceptance criteria will hopefully be a better understanding of the major problems and a more coordinated R&D program.

As far as possible, considering existing governmental procedures and personnel changes, ERDA needs to establish a method of long-range level-of-effort funding for waste management problems, as has been done for weapon development activities. Many existing areas of uncertainty do not have short-term or immediately definable milestones that can be programmed on or off a year at a time.

In summary, all points of view must be considered; this draft is not new or unique; differences in storage purpose and considtions must be considered; the criteria must be dynamic and must be supported with level-of-effort R&D as well as "brushfire" R&D. When a reasonable doubt exists, we must be conservative.

Discussion

Q. If we adopt conservative criteria to start with, and seek licensing on that basis, is it realistic to expect that we can later relax those criteria?

A. There are two aspects to conservatism in the criteria: one has to do with licensing and the other with long-term safety. It will be difficult, though we hope not impossible, to relax criteria having to do with licensability, and at the same time remain conservative about long-term safety. It is a problem.

Q. When the WIPP was first announced, we got the idea that it was an experimental facility; that after some period of experimentation, it would be redesigned as a disposal site. I now get the impression that you will accept wastes on the basis of some criteria and then slide into accepting different kinds of wastes on the basis of changed criteria.

A. The WIPP is considered as a demonstration unit for the first few years. "Pilot plant" is inaccurate terminology for it, because at least as far as surface facilities are concerned, it is really a full-sized operation that can be converted to a disposal site by ERDA after our assurance that we have addressed outstanding technical problems and concerns of operational safety, and that it is safe to convert. We could do that without adding anything more. During the demonstration phase, the waste that has been put there will be retrievable; in other words, we will not commit ourselves during that phase. We believe that this period of time for TRU and contact-type wastes will be relatively short; perhaps 2 or 3 years. After that we hope to convert to full-scale operation.

Q. Before we have to get involved with state officials on safety questions, we need to form some assurance that we would in fact have the manpower and funding to get wastes out of there if it became necessary.

A. The environmental impact statement on the WIPP is being prepared on the basis of a demonstration unit, not a full-scale repository. We will go through another EIS before we convert. We envision that that will be a step function, both in terms of quantities of waste handled and in specific pegpoints at which there will be an opportunity to go to the state with assurances that we have demonstrated safe operation and that we can now convert.

Q. Your WIPP criteria are so restrictive in packaging that those containers will not drive the environment. After those packages have been there for 5 or 10 years, you will say that it has been demonstrated as safe, but you will not really have tested the integrity of the salt environment at all.

A. We recognize this problem, and are trying to define a program in which we look at accelerated effects. It is difficult to convince technical people, to say nothing of the general public, that in any limited period of time we can address the concerns of 10,000 years. However, we do plan to work both in the laboratory and in the WIPP in ways that do not rely on the package as the barrier, but in which we put a waste mixture directly in contact with the salt, and perhaps in brine solutions, so that we can make very sensitive, high-resolution tests on migration, chemical effects, and other studies. We will do as much as we can in the effort to predict safety over long periods.

Q. You test shipping containers by driving them into unyielding surfaces at 80 mph or so, and people can understand that that is a test above the reasonable demands of reality. But for wastes like these in salt mines, where you have problems like thermionics, explosives, where the risk is orders of magnitude above what is reasonably expectable with mere careless handling—even if a saboteur sent you a package designed to blow up at some time—you have no such tests. As far as testing the environment itself is concerned, you might as well put bricks down there. I think this is a serious problem, and one that we cannot explain away, not only to critics, but to officials who will judge and make rules. I think we have to set the stage for a supersafe program from the beginning by such devices as using trace elements, etc. I don't see how a superpackage at the bottom of the mine proves anything about how safe it is to store wastes in salt.

A. There are two aspects to the demonstration plant. One has to do with the superpackage; we need that to prove that we can safely handle and monitor the wastes, and to protect people working in the transportation system and at the WIPP. Also, if wastes are to be retrievable, they must be in a package that will not degrade before that time. The other aspect is that we need to know how the wastes and the salt will interact if they are in direct contact, in the worst possible environment. Both these answers are needed to respond to critics, and we plan to experiment in those ways.

Q. You're going to accumulate a liability of TRU waste at the bottom of this hole, and say it's retrievable; why should that be part of your testing? Why don't you overdrive the system and develop confidence in the environment before you put that stuff down there, where you can have no real assurance that you will ever really have the money or the people to get it out? If you someday decide to retrieve, but for some reason you can't, we'll be in real trouble.

A. We don't plan to receive unlimited quantities of waste at the WIPP before we gather the data that will let us know we can retrieve safely.

Q. What do you prove by putting the designed package at the bottom of a mine?

A. In the long range, nothing. But you do prove the safety of the facility if you put wastes in direct contact with the salt.

Comment: There are two aspects that we concern ourselves with in regard to the criteria. One is that during the 30 or 40 years of the operational phase, we have to be able to handle the material, to operate safely with it, and to tolerate maximum credible accidents without losing the facility, including fire hazards, explosions, etc. In many ways, those considerations drive the criteria details. The other aspect, which cannot be ignored, is the long-term view. Many people—perhaps most—believe that a salt repository means that we'll encapsulate that waste and that thereafter it isn't going anywhere. However, there is one concern that we cannot answer: namely, possible later intrusions by man. It wouldn't be so bad if all we had to worry about were nature, geology, and geophysical phenomena. But we have to examine the risks of someone drilling into the repository; we have to evaluate what the consequences of that would be; and assess whether the risk is tolerable, and whether our criteria need to take that kind of thing into account. These studies have not been done.

Did you have a question about whether we should conduct extreme kinds of tests in the pilot plant stage, such as explosions or controlled fires?

Comment: I don't think we should put TRU waste in salt in a manmade package and then try to say that it is safe in the natural environment in a retrievable sense. I don't think you should put things in this environment at all until you have driven the system to give you assurance that natural encapsulation is superior to any manmade wrapping, unless you are willing to go to an inordinate amount of expense to keep floods and things away from that area, which is driving the system the wrong way. By packaging, you are driving the economics of the system in completely unacceptable ways for people who are trying to deal with the material.

A. Again there are two things to be considered. We would like to demonstrate what long-term full-scale operation will be like; it's even more severe when you consider heat-producing wastes because there you know the containers are not going to last for any significant length of time unless you treat them in some special way.

Q. One issue to pinpoint is how this kind of packaging will act in the salt environment for 5, 10, or 20 years. There won't be any daily information input on that.

A. There are many things we have to prove. One is that you can simply operate safely, and convince the public you can do it. In long-term effects, you don't prove a thing.

Comment: I think certainly before you put anything down there and claim it is retrievable, there ought to be a step function that shows you have driven that environment. Nobody in government today can say whether you're going to have the money to pull that stuff out 10 or 20 years from now. It is wrong to put TRU waste packages down in the mine, and accumulate a needless liability, before having driven the environment to give some assurance that you could not care less whether the stuff stayed there for the next 200 years.

A. If we knew how to drive the environment to give that kind of assurance, we would do it.

Q. You can drive it by explosions, fires, flooding, tracer studies.

A. We're doing some of that. As we said, we'll be experimenting both in the lab and in-situ, to determine radioisotope migration. A lot of that kind of work has been done over the past 20 years. We're not starting from scratch. Oak Ridge, for instance, has done a lot of work on what happens when you put waste in salt, and under much more severe conditions, with heat-producing wastes, than we expect to encounter.

Comment: Concern has been expressed about the reliability of retrieval. Under existing requirements we have to send TRU waste for retrievable storage somewhere, anyway. Is the reliability going to be any greater in Idaho, where we still have to retrieve it, than in the WIPP? I'm not sure the difference in cost should be that much of a concern.

Q. Idaho people have a problem. The AEC is on record as having promised the Idaho senator that the wastes will be moved from there. The people of New Mexico don't want a similar problem. It may not make a difference to you where the stuff is in the ground, but individual states react to that. We cannot go forward with promises that can't be kept. We've got to proceed on the basis that we can give the people of New Mexico and their governor assurances that these basic issues have been addressed.

Q. Perhaps the key feature in establishing criteria as to whether organics should be placed in the repository would be a systematic hazard analysis. Is there a schedule for such an analysis?

A. There are two aspects to that question. Dr. Molecke is working on a TRU experimental program. Last week Sandia began talking to Los Alamos about implementing a test program to gather information on organic materials. The program is in a formative stage and we hope to have some answers within a year. The second part has to do with a long-range hazard analysis. To my knowledge that has not been started. We have been looking at the hazards and safety problems attendent upon retrieval and processing of all wastes as opposed to the hazards and safety problems of placing experimental waste forms in a salt mine.

Q. How will you handle special cases? Will you have a review board? Will such cases be infrequent or frequent? My questions are in reference to D&D work, where most of the special cases will be one of a kind.

A. You're referring to special cases in relation to packaging? I would guess that in the next 15-20 years the odd package would be a very frequent event as a result of decommissioning of existing and old facilities, etc. We plan to deal with those on a daily basis if that's what's required, the limitation being primarily the size of the shaft and weight restrictions on the hoists. In a one-of-a-kind operation you can make special sleds, jigs, etc. to handle it; there is more of a problem in transporting that kind of thing on the surface.

Q. The second draft of these criteria reflects some relaxation from the original. What rationales led to that relaxation?

A. We recognized that in the salt mine environment there is some quantity of organics that could be handled without problems. We also recognize that you can go to a rather large gas which will allow essentially unlimited amounts of wastes to be put in there. We have tried to arrive at what percentage of organics will be acceptable. We don't have a figure on that today; but we hope to obtain a range for it from the experiments being conducted at LASL. The same holds for explosives: there must be some quantity of explosives that can be placed in a container without risk of container rupture if the explosives detonate. As it stands, the criterion specifies one half of the amount calculated as being able to rupture the container. It's not as simple as specifying X grams of explosive or Y pounds of toxic materials. There is no way the operators or the conceptual designers can even guess at the variety of combinations that waste producers will send to us. We cannot say that 2 pounds of risky material is OK, but 2.1 pounds is not. A large part of this burden has to be on the waste generator, the packager, and the processor to calculate what percentages of what can be put in a drum, and also to mark the drum so that we know what's coming in and can take special care with packages that merit it. That's the basic reason behind the apparent looseness of the criteria.

Q. When will quantitative information be available on some of these points?

A. We'll talk about that.

Q. Is there interaction between WIPP people and the OWI complex on commercial waste?

A. Yes. Before OWI was formed, Sandia talked with commercial people, including people from AGNA and NFS. Now that OWI exists, there is a coordinated group involving Oak Ridge, OWI, and Sandia. We exchange information on special equipment development, waste criteria, packaging criteria, and other mutual problems.

Q. I understand there are studies underway dealing with acceptable percentage volumes of organics. When will this study be complete and when can we expect information?

A. The study is still in the formative stages, and no time schedule is available yet.

A. The first problem being considered in that study is the effects of gas generation on ; we build up a pressurization in the mine which may lead to cracking of the salt, which might furnish transport paths to finely divided wastes; we're looking at the longer-time hazards. The hazards of the shorter time we can handle to a degree by the type of package we use. In longer-term hazards we worry about what happens when the package is no longer there. We don't expect the packages to last over 100 years, or perhaps in some cases 1000. When the package has been breached, we want to know what happens if water gets in there and forms sludge, or if sludge is already there, or what would happen if there were pyrolytic reactions. Some experiments have been started; others are being planned. They will all be initiated shortly, but when they'll be completed is still up in the air. The gas radiolytic degradation of combustible waste, the thermal degradation, has been studied at LASL; we're asking them to extend the studies to look at conditions after facility shutdown; long-term hazards. The temperature will eventually rise to about 160°F; the pressure will slowly build to 150 atmospheres; the horizon is about 2100 feet below the surface. How are these reactions either enhanced or slowed under these conditions? None of these things has been looked at regarding a salt-mine surround. We are drafting a TRU waste experimental program; it's in very rough draft form right now. I want to assure you that we are considering what hazards there may be and how to control them if they are there. The packaging is only a temporary barrier while we're doing the experiments at WIPP. After the facility has been shut down and the package disappears, the salt itself will be the primary container, and we want to know all we can learn about that.

Q. What we need is to understand and reach technical answers, check the results and learn how long it will take to do that. You say that WIPP will accept TRU waste in the 1980's; to meet that date, when do you have to have everything else ready throughout the system, the decisions made, and from there, how long do people have to get the waste into the form you demand? It is hoped that each generator will not have to come up with a processing plant, if it is proved you can accept organics. At this moment we have to assume that you can't accept them, and must start a program plan for developing a process plant to meet your end-dates.

A. We know that you are going to have to start pulling things that have to be processed out of that backlog, but I can't give you a date when you can start that. Our present intention is to separate fixed waste forms. Whether we can accept the total mix of trash that exists in the backlog is not clear, and I can't tell you when that decision will be made.

Q. In the liquid HLW program, we're aiming our total storage at the form of glass, or concrete, or some other. That form is itself the primary container. If you do a risk analysis on that form, you can show the amounts of energy or whatever that is needed to break the form apart and disseminate the ingredients to the environment. But if you try to prove 100% that this salt mine will contain the waste, you have a hard job. You may never prove it. We had similar problems at SR when we studied bedrock; you cannot prove 100% that bedrock will not someday become inundated with water. Therefore you go back to the primary barrier of form; if you can show that the form is relatively nonleachable and relatively impervious to whatever may occur, you establish some degree of confidence that the waste will be held in its assigned spot for some long period of time. If you don't do the same thing with TRU waste, the inconsistency will be very hard to explain to the public. If you put waste in the WIPP, you're never going to convince anybody that you intend to get it out; once it is there, it is in fact terminal storage. You're licensing the facility, yet you say it's a pilot plant, and that if something goes wrong you can take the stuff out. But if something goes wrong, it may be too late, and the risk of taking it out may be greater than leaving it there. I think that the waste we put into WIPP ought to be in a form we have confidence in. If at some time after we close it up, we have a fire or something down there, how will you explain that to the public? I think we need consistency in these programs. Why do we go to glass for liquid HLW, and yet put stuff in the WIPP in something less reliable?

A. That's a valid point. But you're comparing glass being used for one purpose against some other form used for a different purpose. I don't think you can prove that glass will last 200,000 years. I can show you a salt mine that has lasted that long, but I'm not sure we can find a glass that will. We feel that the salt is the primary long-term container, and not the form itself.

Comment: In the first set of criteria we tried to decide on some sort of specification quality on leachability. If you look at some of the TRU waste you might anticipate, compared with the amount of TRU in HLW after 500 years or so, you find that you're really talking about transuranic materials for the most part, so we tried to be consistent; if you require one thing for HLW, you should require similar things for transuranics. Concentrations are about a factor of 100 in some of the TRU you have in the HLW, so you'd have to have two orders of magnitude more leachability than you are saying is necessary for compliance. We've had other problems with wastes of the kind you're talking about; not all of it can be put into concrete—many big decommissioning items, for example. On the opposite end you also have consistency problems. Are we going to take up everything that's contaminated in Idaho before 1980? You run into problems of internal consistency whichever course you take.

Bradley: I wish to correct one misapprehension. As of now, there is no decision about what waste form will be used for HLW, certainly defense HLW. Obviously vitrification is the fixation form for shipment for onsite long-term disposition. It is the reference case being examined at SR, Richland, and Idaho, but it has not been put to the test of the defense waste document or the EIS. The record should not imply that this decision has been taken by the agencies pursuing this question, in terms of long-term disposition. It is merely one of the alternatives being studied.

Comments have been made about the difficulties of milestoning the R&D effort. We recognize this, but we feel strongly that we have to write definitive scopes of what we're trying to achieve with any given R&D effort, the kinds of resources needed to carry out that work, and some identified end product. Admittedly there is uncertainty, but for a variety of reasons we must plan our resource commitments. Admittedly the results of the R&D effort may cause some reassessment and reprogramming, but nonetheless, we must have a more definitive picture of R&D scopes, milestones against R&D objectives to use for planning, our ability to articulate the program, and time frames in which to accomplish some of these objectives. In regard to organics, for example, we must explicitly scope the objectives, the work that needs to be done in getting answers, and what time and resources will be required. We need to do this throughout the R&D program for the TRU waste effort.

Q. It appears that several of the criteria will contain some sort of if-statement, meaning that a particular criterion might be acceptable now, but that experimentation over the next couple of years may make it unacceptable. How long will it be before we can get direction for those of us who are generating and storing wastes, as to what our attitude should be regarding these if-statements? For example, we put our plywood boxes in fiberglass. In the present criterion that is what I'd call an if-statement; it may be sensible, or it may prove not to be. At LASL we could be using a large number of these boxes in the near future. Should we immediately start trying to find something else, or can we proceed on the basis of the present criteria?

Bradley: I can only make a general observation. We will have a version of the performance criteria by the end of the fiscal year, and probably work will start before then on the basis of the then-current criteria for purposes of planning and assessment at each site that has major inventories, for retrieval of TRU waste, as far as getting the site contractor's best judgment about the inventory that would have to be processed.

Q. I'm not so much concerned with existing wastes as what will be generated in the next 5 to 10 years.

Bradley: In light of these criteria, we must examine present packaging practices, what may be required in package redesign by criteria then existing, and get on with designing and placing packages that would meet those criteria. I hope this will be well in hand in the 5 or 10 years. I recognize that this poses a problem until we have these in hand. I see little recourse other than to proceed with current practices in packaging.

Comment: The concept of retrievability is driving the whole system in a peculiar way. When we talk about retrievability we are talking about the mechanical feasibility of getting this material from the bottom of the hole to the surface and putting it into shipping containers. But to the people of New Mexico, retrievability means that the material will someday be taken out of the WIPP and sent out of the state. The concept is being viewed in two different ways, which puts the agency in the position of not being entirely fair to people who understand the word to mean something quite different.

The criteria are also driving packaging design in a way that it probably shouldn't be driven. Packaging criteria ought to be addressed to safety and transportation; the rules ought to be less restrictive for disposal than for these other areas. I think these factors alone merit severe examination as to whether the WIPP really needs retrievability; will it really bring us any credibility in the eyes of the public? I urge you to look at that criterion from this viewpoint; is it necessary to have anything down there retrievable?

Bradley: A retrievability option must be associated with the level of risk having to do with repository operation, or with some of the R&D work that is going on in parallel. These factors raise serious questions about the optimum waste form, in the context of both long-term management modes and impact on the integrity and stability of the formation. The option means that if you do retrieve the waste, you should do something with it, either by way of further processing or some other consideration having to do with packaging, which I think is a much less likely option. Unless a processing capability is estblished next to the WIPP, I think there's little risk in leaving the material in storage in New Mexico; but you must get it into a form suitable for long-term dispostion.

I'd like to emphasize another point. The agency takes very seriously its commitment that the retrievability option will remain valid throughout the demonstration phase of the WIPP. We do not anticipate that we will slide de facto into a long-term disposition mode without a conscious stopping point, a formal procedure by which the issue is really addressed, and a decision made in concert with the New Mexico authorities that we are ready to go into full production.

I agree that packaging is a main driving force. The issue has two dimensions: one, a certain type of packaging is necessary for transportation reasons. In large measure we've taken care of that. The other aspect is concern about packaging materials that might create a problem until we can satisfy outselves one way or the other regarding such questions as hydrogen generation, using plastic liners in drums, etc. There is a dimension in packaging associated with facility operation and long-term dispostion if we could assume that R&D efforts on such questions as hydrogen production, the degree to which we can tolerate cellulosics, etc., is on such a time frame that you could expect to get results in 4 or 5 years. That might match pretty well with your schedule in using the WIPP as a pilot plant to get answers on whether you should invoke retrievability or make design changes. I'm sure there are others here who have a better feel than I for whether 4 or 5 years is realistic in being able to get the answers we need about acceptability of waste form and packaging.

Q. The waste that is going into Idaho to sit there until 1985—what if it is combustible? If nothing has happened in 10 years, why all of a sudden are you concerned about the next 10?

Bradley: It would be bad if during the operational period for the WIPP, say 30 or 40 years, we suddenly had to challenge the packaging or other considerations, while at the same time we were defending our retrievable concept where we recognize a minimum of 20 years integrity. That's almost tantamount to saying that we've got problems with the ITSA pads. Of course it's a different situation, because we're comparing the small amount of overburden on an ITSA pad with the amount in a sealed-off mine. For example perhaps the hydrogen or gas pressure build-up might percolate out of an ITSA pad so that there wouldn't be the same level of risk associated with an interim storage mode as there would in the sealed-off portion of a salt mine. How major a problem that is I don't know. We want to look at a recent SR report on 4 or 5 of their instrumented drums, but it looks as if oxygen depletion is such that you would rather quickly be out of the period in which you worry about explosive hazard. That suggests that you could do something as simple as purging of the inert gas. These are the kinds of things we have to identify. But you're right, it creates a dilemma to say on the one hand that we have reasonable confidence in a safe lifetime of 20 years on an ITSA pad, and then say that we can't tolerate it in the WIPP.

Q. Combustion and gas generation are two big issues. I think there's a case for a rational approach to combustibles, but we can't do anything until some of the blanks are filled in. Do you intend to fill them in? We need your numbers so we can analyze them and establish conditions for a rational approach to combustibles. There are unanswered questions about long-term volumes of high-pressure gases in the salt mine, and it seems to be a different scenario to talk about near-surface storage where gas can percolate away and not cause high-pressure buildup.

A. In regard to the percent of combustiles we can tolerate today, I can only say that the LASL study is trying to establish what that percent is.

Q. We are told that we must minimize the rate and total quantity of gas produced. At some point somebody has to define what types of liners are acceptable, and give us some quantity or value as a percent of total waste, and tell us a time frame.

A. That again goes back to the experimental program that Sandia and LASL are working on.

Q. You're saying that there's nothing anybody can plan about packaging their currently generated waste acceptably until you finish the experimental program?

A. That's right. At the moment, we find decom material, plastic liners, etc., acceptable. If you have a plywood fiberglass Rocky Flats box filled with metallic TRU waste, that would be acceptable; of course the plywood box would be included in the acceptable percentage of combustibles. A fire could originate in that. If you can't prove that it's not made of organic materials, you would have to include it in that X percent.

Q. The criteria as written don't allow me to come to that conclusion.

A. Some types of plastic liners produce large quantities of gas, while others are slow producing and have little total gas production, such as high-density polyethylene, which produces little or no gas.

Q. I'm not asking for numbers, I'm saying that something has to be done that will result in some numbers.

A. If I had to pick a number today, I'd say 10%.

Q. How do you establish numbers like that?

A. The LASL program.

Q. Are we going to generate a whole new container concept just to accommodate Teflon? Why don't we outlaw Teflon?

A. I don't think that 10 pounds of Teflon will hurt anything; 10,000 pounds might. (There follows an extended discussion on possible gas-producing items).

Q. Two questions. What is your objective in placing restrictions in the criteria? Is it for worker protection in the facility? Or is it the containment activity required? And second, when you get the numbers you're looking for, what kind of QA program will you institute to make the trash meet these rigid specifications.

A. The purpose behind our specs is not retrievability. Our purpose includes operational safety aspects, fire, possible gas production, and more important, long-term storage integrity. The QA program will be centered at the packager processor, where the box is filled.

Q. How do you control laboratories, people being people? You're going to have the glass and the container sitting side by side. Your proposals are so restrictive that you can't have a program that depends on people carrying out your rules. You must have QA control. You can't just put out restrictions from a laboratory and assume that people will be guided by them.

Comment: At RF, there was concern about your mixing acceptance criteria with operational criteria; organics, for example, would be restricted to a certain volume percent in a given storage room; lots of poeple look upon that as an operational criterion, which shouldn't be here at all. Those are operator's problems and should be omitted from these acceptance criteria.

(The answer involves a long discussion on the distinction between types of criteria, Sandia does not admit the distinction, rather seeing them as overlapping.)

Comment: We are talking here about a quality concept that covers only WIPP operation as a pilot plant. When the pilot phase is over, the facility will then be open and available for the shipment of any and all wastes that now reside around the country in any and all forms. That is the situation when the facility has been declared fully operational; it does not apply during the pilot phase. When you ask what kind of things can be sent to the pilot plant, the reason we can't answer is that the individual responsible for demonstrating the adequacy of the pilot plant is going to specify what he needs to fulfill his mission, which is to determine whether we can safely retain the stuff. If I were in that position, I would want a very broad mix of wastes in a variety of packaging, to be placed in the worst possible environment, thermally insulated from the viewpoint of gas generation, so that I could observe over a finite period what the gas buildup was, and what factors contribute to gas generation. I would also want selected samples of waste so that I could look at the extreme case. Such experiments will eventually allow the definition of what kinds of processing are needed, and what form the waste should be put in. But at this moment there is no ultimate answer; if we could define those things by mere analysis of R&D, there would be no point in going through the pilot phase; we could go directly to the final solution. Like other institutions, the WIPP will operate within the three classic dimensions of operability, maintainability, and economics. But the WIPP has an additional dimension in that we must know what will happen to any given package under the maximum credible circumstance; to answer that question you want wide assistance in looking at exaggerated cases, which means asking for selected packages by which to test the maximum credible circumstance.

In the acceptance criteria, the problem is that the definition of material to be used for safety experiments is mixed up with criteria for accepting material on the basis of operability, maintainability, and economics. Those are two separate and distinct sets of acceptance criteria for the pilot plant. When we decide to go to full commercial operation, we will evolve, on the basis of that decision, a different set of criteria.

Comment: I think that's very unrealistic. It's inconsistent with the whole notion of a mine.

Comment: Even if we got decisions on new criteria by 1978, we couldn't get all the waste generators implementing that program and producing waste to those criteria before 1981 or 82. My concern is that if we come up with much more restrictive criteria than the ones we have used since 1972, we will convey to the public that those practices have not been safe.

A. The fact that they may not be safe in one environment doesn't guarantee that they won't be safe in another.

Q. Agreed. But when does the first one become unsafe? If WIPP uses today's criteria, obviously WIPP is safe for 15 years.

A. No.

Q. Then maybe we don't have a safe operation now?

A. No, it's a different situation. If we have an oil fire or rubber-tire fire in a mine, the consequences can be tremendous.

Q. I'm unclear on your primary concern regarding combustibility; is it the ultimate degradation of the material so that it produces gas, or the fire itself?

A. Combustibility really touches upon both. A fire in a mine is a very tough problem, particularly if there are radioactive particulates trapped in salt. We can accept very substantial quantities of ordinary combustible material, as long as it is properly handled. But it has to be placed in separate areas so that if a fire occurs it will be small and isolated. The second consideration is the potential of the material for high-pressure gas production over 1000-year scenarios in the mine against the long-term integrity of the salt formation.

Q. Is a fire in a mine any more grave than one in a storage tank, which is above ground and completely available to an oxygen supply?

A. Yes, it is.

(Bradley rechannels the discussion.)

Bradley: Operability, maintainability, and economics are certainly the central considerations during the pilot phase—primarily economics. But I understand Dr. Snyder to be saying that your definition of acceptability goes to the extent of actually experimenting with TRU wastes in salt to answer questions about acceptability in gas generation, etc. That surprises me. I thought there was nothing you could do in that environment that couldn't be done with the same materials in the lab. Outputs from those R&D efforts could influence adjustments in performance or acceptance criteria. There is time enough for that work to produce results on a time-frame within which you can close the pilot phase and go into production scale. Safety considerations during the pilot phase are functions of operability and maintainability, as contrasted to safety considerations that pertain to the types of materials you will be dealing with which impact performance and acceptance criteria. I sense that you are going beyond that. I don't understand that, because I feel these matters have to be answered early enough so they can be fed into the system by the time we phase out the pilot plant; we've been allotting two years for that, for planning purposes.

Snyder: In the matter of safety, we can hypothesize a number of possible situations that would be unsafe: for example, with waste containing organic or alpha-bearing material, with the possibility of generating gases, etc., the situation in a mine is exaggerated over the situation on an ITSA pad because of thermal isolation, which amounts essentially to an adiabatic situation to a first approximation. Clearly you can duplicate thermal isolation in the lab, but although you do all your R&D in the lab, full-scale, with the actual boxes to be used, with thermal insulation, and publish all the risk analyses, with reams of IBM printout to prove your case, it has been our experience in many areas, such as transportation, that all such sophisticated analysis is not nearly as convincing to the public as to be able to show the material in place, and the final product when you pull it out. So you have to be careful that you do not address the safety of the pilot plant purely on the basis of conclusions you've drawn from the R&D.

A second dimension is demonstrable evidence, for people who don't understand the science and technology, that you have satisfactorily tested the product in the environment.

The outcome is a statement that gives confidence to you, me, and the public. The fact that I may have confidence is a necessary but not sufficient condition for a final license to operate that plant; in other words, for it to be approved by the public. A problem with the nuclear industry in the past has been that it was assumed that the necessary condition to operate such a plant was that the scientist was satisfied with its safety. We are now long past that stage.

Q. The economics has two dimensions. One, it shows that you are operating and maintaining the pilot plant at minimum cost. The second deals with whether you reprocess, because you've got to weigh the cost of reducing volume V^0 to volume V^1, and the consequent volume saving in the mine; those are offsetting circumstances. We've got to address that; economics is not a single parameter.

Bradley: Most of that type of calculation can be done without having the repository operable. An added dimension to the economics issue is raised by any surprises you may encounter in terms of resources required to operate and maintain, but I'd guess that it would be a relatively small increment compared to grosser considerations such as how much additional you'd have to buy and dedicate, including possibly having to go to additional repositories for the total waste mix; you contrast this against the cost of processing, volume reduction, to result in a smaller volume to treat, and possibly there would be operational advantages to doing so. Again, I would have thought the economics primarily had to do with the resources it took to operate and maintain that facility through the demonstration phase.

Snyder: I haven't seen a breakdown of accrued costs over the 40-year life of the WIPP, broken down into capital costs and operating costs; until that can be done, I can't answer the question.

Bradley: You can take the costs of establishing the repository, plus however much you have to extrapolate from them to cover additional volume because you haven't gone through volume reduction, and contrast those against the cost of the various processing alternatives and waste fixation. You could do that before actually opening a repository.

Is there merit in setting up a group of members from the appropriate organizations, that could address the question of what kinds of wastes are acceptable in terms of plastic liners and other considerations? We may not be able to go very far with that, but at least we've identified a few things here today that are clearly unacceptable. It would be helpful to have a more systematic approach as to just what the inventory looks like. Such a group might be able to furnish a better basis for sites with large inventories that are trying to determine what reprocessing might be required. I'm not sure that it would be wholly germane in the final analysis, because what we're really looking at is whether there is a significant volume you will have to process, what kind of time you need to do it in, and what kind of capability you're trying to establish in terms of capital expenditures.

There is a need for additional study of transportation. We've had trouble determining the scope of that effort; we need to learn from various sources what's been done to date; we hopefully could use that input to get such a study underway, to add dimension to the rather extensive studies already done in this area.

We need to systematically lay out the pros and cons of an approach that would discuss a central reprocessing capability as contrasted to a multiplicity of them located around the various sites. For example, the WIPP people need to know what it might mean if they established a capability adjacent to the WIPP as contrasted to several sites; in any such comparison, I'd like to think they were proceeding from the same set of assumptions.

Q. I get a very negative feeling from all this. I get the feeling that we're never going to get there; we can't proceed until we get this or that answer; we don't know this or that. Are we going to get there, taking into account all the problems? Regardless of WIPP, I get the feeling that with all the resources in the world we won't get there in 10 years, even if we made it available. Can't we just say that we are going to tackle these problems and take certain risks, scientifically, not only administratively and politically, and try to sell it to the public? We can't look at every problem from the standpoint of its saleability to the public because the public isn't going to have enough information to make a good judgment in the final analysis anyway, and if we rely 100% on that, we won't get there either. Let's talk about how we're going to get there.

Comment: Well, one thing the discussion has done is stimulate thinking about the processing area. Most of us here are waste people. As a processor, I may put more into creating waste. I think that's a reaction as it starts getting more and more expensive—there'll be fancier decom facilities, secondary recovery, waste partitioning. Maybe we'll force it back into the plant. I don't know whether you've taken that into consideration. Once you create the waste and it's down in the mine, you're going to pay interest on that forever. I think tradeoff economic studies must be addressed.

Bradley: I'm glad to have that point of view expressed by a processor. We've been trying to promote exactly that point for 2 or 3 years, with limited success in the categories we're talking about. However, I'm not as pessimistic as I may sound. I don't think that wherever this is driving us is incompatible with where we will eventually get because of economic considerations anyway. Very shortly we have to take some set of performance criteria and start to wring out the problems. Of course there's only so far we can go with that. In the meantime planning must be on the basis of the criteria that we will have this summer. That means that we will be assessing processing alternatives that are part of our ongoing effort; incineration efforts, wherever you want to go on residual ash waste fixation. Irrespective of the criteria, you may want to go that way anyhow with waste that is now on ITSA pads, because it has a combustible label, but certainly with respect to downstream generation. That will give us a better grasp of resource implications, and I'm anxious to get some reasonable range of numbers on that sometime in this calendar year, so management can start thinking in those terms about what will be required in processing TRU waste.

Actually the question is a management decision; to some extent we will be driven by outside pressures, as we have in other aspects of the waste management program. Nonetheless, that could stretch out over a period of time; in fact, OMB and others may insist upon it.

What does that leave in terms of an inventory that you could use in starting your pilot plant operation in 1983? I don't think that's unmanageable; there will be an inventory of some sort so we can start this operation.

Comment: There's an awful lot of uncertainty and loose ends in that statement.

Bradley: But I don't view them as traumatic. We must define some of these objectives, get some efforts underway, and be able to articulate this kind of scenario for the program, so we can see whether it will stand up under the scrutiny of management and those outside the agency who might have an influence on the process.

Comment: I get the feeling that the scientific community does not think it can develop data in any time frame that will help you make a decision. I don't think that's true, but I think we need a more positive approach. We've got lots of people helping us; somewhere along the line we should be able to tackle the problems, and help the administration make whatever socioeconomic and political decisions are necessary to cut off the what-if's and come in with some direction and data. I don't think we can organize this group to get that information.

Bradley: The performance criteria represent our best judgment. While they are conservative, they do form a basis for planning the processing that will be required, and whatever package redesign may be necessary, and they may decide the issue for us in that they may cause some redirection. But they represent a reasonable approach that doesn't put any particular aspect of the program in jeopardy. We are going to be put to some effort to defend the amount of resources needed to do the job, and how will the whole question of water reactor safety work? How much conservatism is really necessary? But we are in better shape now than we were in January; the elements are beginning to fall into place, a scenario is laid out by which we can proceed, and it is reasonable in the time frames we've been advertising.

Perhaps I'm overoptimistic. There are two or three question marks in the R&D effort; we must be sure we're covering those gaps, and see whether there are others that need to be addressed, and get them lined out in terms of target dates for the end products we're looking for, and assess how that matches up with the timetables we've been talking about. Does it feed the system early enough? What about resources? Are there others we could get involved in the program who would enhance our ability to get there sooner?

In parallel with this, we can assume a set of variations and sensitivity studies bearing on possible package design. The processing area, I hope, could be built in large measure on work that's underway or has been lined out on the incineration program, and what's been done in fixation techniques on residual ash within the context of the present performance criteria. If the timetable we have, based on widely advertised dates for a repository, is going to be jeopardized by problems that we should now be able to foresee, we need to know that as soon as possible.

Comment: I can put some of your worries to rest as far as LASL is concerned. In the program we're working out with Sandia, we'll be able to come up in 2 to 2-1/2 years with some qualified limits on the allowable percent combustible: for example, on whether a fiberglass crate is satisfactory, given the criteria that have been proposed. Also for the record, we are within about a month of the touchoff date for our TDF incinerator for contaminated waste, to furnish a checkout on synthetic or uncontaminated material, which will be the follow-on for perhaps 4 to 5 years to get results into the system having to do with controlled air incineration of combustible wastes. I hope that will rest some of your worries about necessary R&D on the radiolysis of combustibility.

Someone raised a point about Teflon. Very little Teflon is used in the system right now. It's a bad actor with all those fluorides, and you also get alpha n's and specific activity actinides. If Teflon is a problem in a specific case, it can be handled as a variance. We don't see the necessity for raising that kind of bugaboo as though it were a massive problem. In short, we'll have some answers for you in the time frame that has been talked about here for the WIPP.

Comment: In our efforts to pin down something on permissible incinerable wastes, it seems to the operators, who are trying to figure out what they should be doing about the criteria, that even two years is a long time to wait, to say nothing of 4 or 5.

A. Let's just say 10%, if that's what they want to do for a first cut, but we feel that, on the basis of our background in material science, and the tests that RF has done on the fiberglass crate, that a larger number will be perfectly acceptable.

Q. We're going to have to bite the bullet on a risk analysis somewhere, some way, and if that number is 10^{-5} or 10^{-6} for a fire or disaster down in the WIPP, I think as technical guides that we don't have to worry about spending tens of millions of dollars to reduce that figure by another order of magnitude. I think the public will accept that.

Q. From an operator's standpoint, I would just as soon see these early criteria be tighter, so that we could go ahead and set aside the materials that don't meet current specs; if some work has to be done on them 5 or 10 years from now, you've got a small quantity to experiment with in the WIPP. In the meantime if the R&D says the criteria can be stretched, maybe you can use those materials just as they are. But the longer we wait, the more work we'll have to do. I urge everybody to get started on it early.

Comment: That's a point well taken. We've got a lot of designs going on in the ERDA family; if we have to design for tighter conditions, these designs and construction jobs take anywhere from 5 to 10 years; you can always back away from those if the R&D allows you to work to looser specs.

COMMERCIAL AND ERDA WASTE PACKAGING CRITERIA: POSSIBLE SIMILARITIES AND DIFFERENCES

Bob Lowrie - OWI

The OWI was set up to manage the nation's terminal waste storage program, which ERDA established to provide timely disposal for commercial waste, primarily HLW, but now expanded to cover ILW and TRU. Our charter is different from WIPP's in that Sandia people are directly responsible for design and construction of that facility. OWI is surveying the construction of all types of facilities; we manage a number of architect engineers and other groups to provide construction of our facilities. We don't get into design details as much as we exercise overall control.

Regarding the waste terminal facility program, the schedule still calls for hot operation of two waste repositories by the end of 1985. We have the added requirement that any repository with commercial waste in it will be licensed. While we're not sure what the licensing procedure will be, there have been discussions with NRC, and apparently we'll be licensed under provisions similar to those of 10 CFR 50. This is at variance with what we've been saying to the effect that we didn't need construction permits; it now appears that we will have to go the full route.

Licensing is a very important part of our program. It is perhaps the one thing that sets the commercial program apart from the ERDA defense waste program. Indeed the NRC and to some extent the DOT will set performance criteria for a number of things such as site selection. We prefer to include these performance criteria with acceptance criteria, packaging criteria, etc. Along with that go all the ramifications such as a QA program, which will be required; a safeguards program; an accountability program, etc. NRC is preparing performance criteria, with a draft to be issued in the near future. I don't know what that draft will contain, but we will have to meet it in designing our repositories. This is only a personal observation, but if there are performance and site-selection characteristics and criteria set by NRC which we have to meet, it would behoove you in the defense-waste business to read them very carefully, because you might have to meet them yourself.

The criteria for our repositories are established in cooperation with NRC, but because of the nature of the licensing program, and because of the schedule on which we are operating—a pilot plant operation by 1985—we are not at the point where the WIPP people are, of being locked into a set of acceptance criteria. We have the luxury of a little more time in which to develop our respositories.

I was asked to talk about packaging criteria for commercial and ERDA wastes.

In the proposed WIPP acceptance criteria, Section A deals with Waste Forms. We agree that something will have to be said about explosives; safeguards would require that. We have a problem in that explosive content is limited to half the quantity calculated to be necessary to breach the container in a full-scale detonation, but we're not sure of the calculations; whether it means with the explosive at the center of the package, or near the side. We probably will have to be more exact on that, but basically we're in agreement.

The same applies to pyrophorics and toxic materials. We too feel very strongly about liquids; we don't want them because they're messy, both to move and to store. Particularly for salt repositories we'd like to see them kept at as low a level as possible. There are a lot of ramifications regarding radiolysis which could play an important part in waste packaging.

We have no quarrel with the levels listed under thermal qualities in the criteria, nor do we quarrel with the nuclear criticality question. We do know that safety analyses will have to address scenarios that involve all possibilities in criticality.

It is quite possible to have TRU waste packaged so that two materials could be sufficiently close that there could be radiolysis with concrete and a consequent volume increase. It's a problem to which I don't know the answer.

Regarding waste container dimensions—our current design can probably accommodate the sorts of packages the criteria talk about, perhaps bigger if necessary; we have no arguments against packages of those sizes.

For handling purposes, we'd like to work out techniques to handle TRU waste containers. Your criteria are quite acceptable and we have no quarrel with them.

Construction materials. We have been suitably worried about the drum package, particularly when stacked. We understand they put from 6 to 10 drums on a wooden pallet, which means you have introduced combustible material. We'd suggest that propellants had better be held.

In structural design, NRC and DOT have set structural design criteria, and they may be the same as 10 CFR 173, which is currently referenced in the criteria, or they may be different. There are indications that they may become more stringent. What we'd like, and will suggest to NRC, is that structural design and certain other criteria be split off into a code covering such areas, because it will be very difficult for us to work with a set of structural design specs that are written as technical specs to the guidance—because the licensing process sets finite limits and unfortunately licensing criteria have caused us some problems.

The waste package. We don't have any quarrel with the package weighing 5000 pounds. If you take the 5 x 5 or 5 x 7 package, or something larger, and fill it with concrete in which incinerator ash is contained, you are going to have to provide for that larger weight; there's a need for a weight capacity for the facility.

Surface contamination essentially consists of a code of regulations that agrees with ERDA facility contamination levels. We cannot quarrel here; they are regulations and we have to abide by them.

We have a small problem with penetrating radiation. Some TRU wastes in the commercial end of the business have quite high concentrations; if you compact or incinerate this material you concentrate it. Tex Blomeke has calculated that it is quite possible to have as much as 100 grams of TRU materials in a 55-gallon drum of compacted wastes. We have the problem then of higher background; you stack a large number of these drums in a room, and the radiation level goes up. We may have to seriously consider limiting concentrations in drums of TRU materials to prevent our having to go to remote stacking.

We're concerned about the labeling specs, primarily because we're sure that NRC will require tamper-proof labels and seals, and we don't know what that may mean.

We need to look at retrievability. That's built into our charter, and we have to accept it. We don't know for how long, however. So we're worried about the label, how long it will last, and under what conditions, and we also worry about how much TRU material will be credited (???).

As a commercial licensed operation, we'll have to have some form of accountability, because on the shipper's invoice there will probably be something that says there is so much TRU material inside, and this will go into the composition of the inventory for the use program, by which NRC intends to keep track of all the fissionable material in the commercial business. We don't know how this will affect us, but we suspect that accountability will be a bit of a problem.

I'd like to make several points.

1. You can locate commercial facilities anywhere you like, but once that is done, NRC will set the criteria, and these could be much tighter than anything in the criteria you have here.

2. OWI and NRC criteria are not salt-specific, as yours are for the WIPP. We're looking at other formations, and this can have a profound effect upon the criteria that may be engendered.

3. We are projecting, at ERDA's request, well into the future, and there is a good chance that different criteria will be generated for the second generation of repositories on the basis of experience with the first generation.

4. The licensing process rules how the commercial part of the business works. Nobody today can say how stable the nuclear energy field will be, or can with assurance predict the charter of tomorrow, even with the NWTS repositories. If WIPP also accepted commercial waste, the criteria for both types of repositories would be identical; therefore I suggest that you pay strict attention to the criteria being developed by NRC, DOT, and EPA, and that your criteria be compatible with those. In the long run that will save us a lot of problems, because there will be no way of explaining to the public why one side of the ERDA house is doing one thing while the other side is doing another. It is essential that the scientific community get together and speak from common ground if we are ever to sell any kind of repositories to the public.

Q. Do we know what type of criteria NRC may be looking at on TRU waste versus HLW?

A. No. All we know is that they are interested in saying something about everything that goes into a repository, through regulations.

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EFFECT OF COMBUSTIBLES ON SAFETY IN WASTE REPOSITORIES

Sam C. Matthews - Union Carbide, OWI

We have a dual purpose here. One is to form a WIPP staff to study the problems; the counterpart of this is that the customer needs to be kept informed of WIPP's reasons for doing things. That's one of the reasons we're here.

We have an unusual set of problems in combining the demands of defense wastes with the problems of the nuclear industry; it boggles the imagination to think what we may be up against, particularly in the areas of safety and compliance with existing regulations. OWI is facing these problem areas front and center right now. We have two? to architect-engineers preparing conceptual designs that will be finished in July 1978, and we expect to spend upwards of $3 million with each firm. We hope to have a draft of studies that will cover a lot of things being done by the WIPP staff as they pertain to our particular problems.

We are engaged in dealing with the NRC staff, the Mining Enforcement and Safety Administration (MESA) and any others that want to become involved, to develop sensible, safe concepts for repositories, and "senible" means to us concepts that will answer the licensing requirements.

The NRC draft acceptance criteria are due out by the end of the fiscal year for comment. As for other waste forms from the national reactor program, they're not sure what they will do, but they intend to do something.

MESA at one time said that they had no interest in getting involved with WIPP, but NRC has asked them to get involved, and they have apparently agreed. I was told the other day that MESA has established a nationwide panel of about 5 experts to study waste isolation problems to see where they can best fit in. There are many areas where regulations proposed for the mining industry, or controlled by the industry, are at odds with the regulations governing the nuclear industry, and we are trying to find a compromise position.

Retrievable storage is part of our program. When we build a commercial repository, it's always been our intention never to remove that waste once it's in there. However, we plan to maintain the retrievability idea for perhaps 5 or 10 years, to verify the operation and prove maintenance, maintainability, worker safety in the repository, and that sort of thing. The main things that we are looking at, we feel will show up early, particularly the high thermal levels which can generate the most severe problems initially.

Questions of fire safety are our chief concern. We don't know of any accidents that might be inflicted on our repository that could have potentially greater consequences. We've been asked whether the waste was safer on an ITSA pad or in the repository, and where a fire could be most dangerous. The answer depends on a number of factors, and we'll get to that later.

If we look at old data from the late 1960's and early 1970's, we find that fire is the most common source of fatalities in mines. Fires and explosions have caused about 37% of all fatalities in nonmetal mines. Salt is classed as nonmetal, but does not contribute significantly.

If you look at the information that has been supplied as part of a GEIS, you realize that we are going to end up with a huge mining operation. Over about 20 years we intend to extract, at least in this concept, something like 30 to 35 million tons of salt. It will take about 7 to 10 million man-hours to do this, and using these same statistics for this kind of mining operation, we can expect to kill about 6 people and injure between 80 and 100. The percentages say that some of these people will die by fire. In our design we have to prevent this kind of thing. One reason we have to rely on old statistics is that the last major mine fire in the U.S. was in 1972. So the trend shows that things are getting better all the time, and there is an effort to increase interest in the industry in self-regulation. We don't intend to do anything in this repository to change that trend. We are at this moment writing notices to the Federal Register for even tighter fire protection regulations than presently exist for continental mines.

Let me give you an idea of what we're talking about. The Sunshine Mine in Coeur d'Alene had one of the most severe fires in U.S. history, as well as the most recent. This was a hard-rock mine that contained silver ore, which means that it was not supposed to be fire-prone. The fire started in the mine timbers at the hoist level so nobody could be hoisted out. About 100 people died, and it took 5 years to reopen the mine. The thing that scared everybody was that it showed that a fire could happen in a mine where it wasn't supposed to; it can happen anywhere in the right circumstances. In the early 1960's, in a salt mine along the coast in Louisiana there was a fire in the shaft and 13 people died; a shaft guide bearing caught fire on the way down, which caught in the timbers around the receiving station at the bottom, and again there was no way people could get out. This is the kind of thing that could happen, under our present concepts, in a low-level shaft carrying a pellet of drums.

Reg Guide 1. 7 from the Chief of NRC's Nuclear Division, deals with combustible gas concentrations, hydrogen generation, and things like that. That's the sort of thing we have to deal with. It says in effect that any materials that would yield gas should be minimized; also that the sampling system that goes with this should be exchange safety systems.

Reg Guide 1. 1. 0, Fire Protection for Nuclear Power Plants, stresses the concept of defense in depth. It says that the safety system should be isolated from combustible material, or fire protection systems should be provided that would contain a fire that consumed all combustibles present.

There is a similar guideline for fuel reprocessing plants.

Regulation 30 CFR 57, which is Safety and Health in Nonmetal Mines, has a section on fire protection which has both mandatory and voluntary standards dealing with electrical power supplies, combustibles underground, supplies of fuel, and things like that. While we don't endorse their wholesale application, we feel that some areas of mine operation that appear in 30 CFR 75, Safety and Health in Coal Mines, may be appropriate. We are looking at that right now, particularly in mines that are close to storage areas.

Because salt is fairly stable doesn't mean that it can't be gaseous. There is a whole new set of rules and considerations having to do with gassy mines. Gas is a possibility in domes that we are investigating on the Gulf coast; the Paradox Basin in Utah is a gassy area; a potash mine in that area caught fire. As I understand it, the WIPP area near Carlsbad is not considered gassy.

These are the kinds of things that are upon people's minds right now. Combustible materials are widely used. Millions of board feet of timber go into mines every year, fire-resistant but not fireproof. Ventilation tubing and other things are impregnated with materials that give off cyanide and other toxic vapors if they ever do catch fire. Plastic-based paints that cause corrosion, and asphalt-impregnated safe linings, are both used quite commonly in mines. Petroleum products such as diesel fuel, lube oil, and hydraulic fluids, are generally discouraged to the extent possible. Regulations right now allow only one day's supply of diesel fuel underground. Oil and hydraulic fluids are generally fire-resistant emulsions. Rubber-tired vehicles are a common source of fire when the brakes lock and the tires catch fire. There are very strict limits on toxic materials that can intentionally be brought into a mine.

Electrical equipment probably accounts for over half the fires in mines. We can't figure a way to escape that problem right now, because the increased mechanization of mining has generally used electrical equipment. We are now mining something like 2-1/2 million tons of salt a year, which is comparable to the largest salt mines in the U. S. More and more equipment is becoming licensed. Blasting is quite common, especially in salt mines.

Current solutions to fires in mines can be summed up in three words: water, water, and water. That is standard practice in almost every situation. We cannot rely on that entirely. We can use chemical foams, which is something we would consider. Automatic systems such as are used in nuclear facilities are not used in mines for a couple of reasons; one, they require isolation systems, and two, the types of things you put in there are hazardous to humans, and you could wind up killing more people by using such a system than you would by the fire itself.

High-solution salt water has been considered. The only practical way to use this and still keep the repository safe is to separate fire-prone areas from those that are not. Specifically, separate the mining operations from storage operations, and keep the storage operations as clean, pure, and safe as possible; though the initial cost is high, it doesn't amount to much in terms of the total life of the repository.

Some of us are involved in the separation of ventilation systems; I believe this is a feature of the WIPP design. This is not easy, especially when you're talking about a modular mining approach in which you open one set of panels, move on to another, and then control things so that the previously mined set can give you your waste coverage.

Since you will be in the mine for 30-40 years, you can afford to do things differently in the storage area than if you were in a normal 4-5 year mining operation. This means things like putting cables in conduits, which you don't see in mines very often, even though it is required. We would install permanent steel ventilation ducts instead of fire-resistant ventilation tubing; we'd install permanent utilities, ecological (???) rail systems, etc. In other words, we're going first class. It would also mean probably that we will use steel pallets for storing low-level TRU waste. The way we see them, these pallets would hold about 12 drums containing 600,000 to 800,000 cubic feet, with concrete in them, and stack them two high; we'd have a large load on a small area, and we'd need the strength of structural steel. The other thing is we don't intend to compromise the conditions we've created in the repository by introducing combustibles; we're not prepared to use any combustibles in any percentage.

We will undoubtedly use electrical equipment. Today's mines bring as much as 13 kVa down the hole right to the base; and below that is 440 volts, which is still pretty big. Nowadays coal mines run 4160 (???) down there fairly routinely, probably to 13.2 kVa. So we're talking about great power consumption underground. Even in the storage room we don't see any way to avoid that. We will have 60 or so low-speed conveyors, and connecting to those at some point we have 15 HLW waste transporters and 5 or 6 TRU transporters. Then, while we may use conventional blasting to open initial areas before storage, we are thinking seriously about electrical continuous equipment underground. But we have not ruled out the possibility of continuing to use conventional drill tubes and blast technology for excavating the mines. It's a little cheaper in the long run, and it's something we know how to do.

There are philosophical differences between the way mines operate and the way nuclear facilities operate. In the mine, the first priority when something goes wrong is to save the people. The Mining Engineer's Handbook gives details, most of which have to do with training management about how to rescue people after a disaster, and training employees to know what to do. The point is to get the people out first and worry about the facility second.

Our problem in this area is that probably 80 or 90 percent of the people we have working in the mine are not mine-trained people; they are in the waste-handling business, radioactive equipment operators, etc. It will be a serious problem to properly train and maintain a proper level of indoctrination for these people.

There is also the fact that in general, nuclear facilities operate on the reverse of that idea: save the facility first and then worry about the people.

One standard practice in current mines that is bothersome from a nuclear point of view is the use of reverse ventilation. Most mine ventilation systems can be reversed if necessary. It is not something that is done casually; it requires the permission of the mine superintendent and sometimes the federal inspector. It is a major decision in a mine disaster; it implies that you've lost control of the situation, and that you don't know exactly what will happen when you do it. In some cases by blowing air the other way you can blow a fire out or away from people, but if you don't know where the people are, you could blow it right onto them. We anticipate putting in a system of this sort; the question is whether we should do it in the storage area as well. I don't know of any nuclear facility that can reverse its ventilation flow.

We are going to try very hard to insure that we don't have a fire in the mine. Our present approach is not to introduce combustibles into the mine; we think NRC is in sympathy with this, but we haven't tried to pin them down on this issue.

I might say a few words about the criteria developed for the Lyons salt mine six years ago. In many cases these were the starting point for what we've talked about so far. Lyons was not subject to regulation by the NRC. They did not have any form of retrievability, because Lyons was to be backfilled immediately after waste placement. If we are constrained initially to keep retrievable storage, this consideration alters that picture. Lyons did not accept explosives or pyrophorics; at least their criteria so dictated. They did accept combustibles on two conditions: they required fire-resistant packaging inside the steel container, and the container had to withstand internal combustion for 10 minutes without significant external damage. It seems to me that some of the criteria proposed for WIPP are even more relaxed than that.

We do not have the luxury of considering shipments on an individual basis; the production rates we expect at our facilities are just too high. We are talking about processing a 50-pound drum of TRU waste every four minutes, and that doesn't allow us time to think about things on an individual basis.

It has been proposed that we post a fire limit of one minute; we know of no mine-rated fire protection system that will react that fast. We know of no position legally or technically that would allow us to accept combustibles on a percent volume basis; there may be some allowance in terms of total input for the facility, but on a percentage basis the more you get, the bigger your problems become. OWI's facility personnel probably will not take the responsibility for properly distributing combustibles if we should ever take them into the mine.

As far as we can see, there are no criteria of any significance on toxic materials; as long as you label a package as toxic, you can send it. This is probably in conflict with MESA regulations, but we concur with the principle.

We would concur in the use of liners as defined in ERDA manual 0511, which says that if it has incombustible materials inside, it is incombustible.

If we ran into a situation that required us to retrieve any of this material, our attitude would change on a lot of things. It would affect how we mine the facility, and how we would operate it. If the waste is in a non-retrievable mode subject to long-term safety analyses, we don't see any immediate problem. Also, if combustible materials were fixed in concrete, and mixed up uniformly throughout the drum, we don't see any problems over a long period that will affect it one way or the other.

I have a few comments on asphalt. We are concerned about sales in this country of German-made systems for reactors that call for bitumenization of reactor low-level wastes. Asphalt is not used in mines anywhere for anything, other than asphalt-based paints. The potential hazards of receiving LLW drums filled with asphalt are enough to drive you crazy. We have data on hydrogen evolution and evolution of other gases, and in terms of the numbers of drums we intend to pack into a room, we see no way to avoid precluding the admission of asphalt.

(A presentation by George Barr of Sandia on "The Case Against Combustibles", which follows Lowrie's talk is to be published as a separate paper later in 1977.)

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CHARACTERIZE TRU WASTE INVENTORIES AND RELATE CHARACTERIZATION TO PROPOSED CRITERIA

George Wehmann, INEL → Idaho Nat'l Eng. Lab.
H. E. Hootman - SRL (p. 49)
H. Zweifel - ARHCO (p. 61)

I would like to interject some realism into this conference. Out problem differs from that of OWI because theirs is of the future, and ours is today.

I think the idea of scoping this session to only low-radiation TRU waste is useful, but when are you going to start dealing with intermediate-level waste, because we're sorting that out too?

We must also consider the possibility of establishing two categories: the waste of the present generation, and future waste. That may be where some of our disagreements come, because some of us are talking about today and others about tomorrow. Even the term "tomorrow" needs defining, because if you were to get a decision in calendar 1977, you couldn't get it implemented much before calendar 1981, so the present actually extends for several years into the future before you could begin to implement new criteria.

I note that the current proposed criteria allow up to 200 grams per drum. We ran calculations on the older category of 42 grams per drum, and we found that, out of something like 47,000 drums, 1000 contained more than 42 grams.

Regarding heat generation at INEL; we'll have 10 watts per drum, but we ran a computer program on this, on the basis of criteria established by Sandia at 2.5 watts, and we found that only one drum out of 8700 exceeded 2.5 watts, and only three boxes out of 500; so 2.5 watts per drum would not be an obstacle. I note that you have now increased that figure to 3.5 watts.

I think we're all in agreement on surface contamination, and we see no problem with the new criteria on radiation levels.

It therefore appears to me that it all boils down to the major issue of combustion. either gas-generation or actual fire. I will leave the gas-generation problem to the LASL people, but I would like to talk about the fire problem.

Let's get a few things straight; I'm not against more restrictive criteria for the future, but I am gravely concerned about applying those criteria today, because we've done a lot of work on combustion. I like the idea of retrievability in the repository, but I'd also ask for a definition, because nothing says that you can't put waste into cells that are backfilled with salt and still retrieve it, so what do we mean when we say that we will maintain open retrievability in the repository? Frankly, I'd like to see it done away with. We're going to make the waste so glorified that we're not going to want to call it waste and keep it down there. In the last four years we in Idaho have had to store 66,000 drums, over 4,000 boxes, and about 125 bins, so we've had some experience on managing low-level TRU waste.

From here on, I'm going to be speaking from the record. You should understand that we hardly generate one drum a year at INEL; it all comes in from other sites, mostly from Rocky Flats and Mound. We do receive some uranium 233 from Bettis. Incidentally, that's in a 6-inch container, which is a steel pipe about 20 inches long and is completely encircled with Cellotex. So you can see there's a bit of a problem there. We also get waste from Chicago, and we'll talk about that in a moment.

I will briefly go through the record system used for all TRU waste stored at INEL. This record has to be completed for every container that comes to INEL. Because it is computerized, each month we can summarize the waste from each different facility. For example in February the predominant number of containers is in the category of noncompactible and noncombustible (see Figure 1). We can ask the computer to tell us about all containers that exceeded by more than 50% the allowable nuclide content, which is 200 grams; therefore we get a printout of each container that exceeded 100 grams.

Another record that is kept divides the waste according to its combustibility. Nearly 3000 boxes have been received at INEL that are noncompactible and noncombustible. When you add the compactible, it shows nearly 3400 boxes that contain noncombustible material (see Figure 2). But by the criteria that are being established, or could be established, they would be ruled combustible. That's part of the problem. The other part is that the major generators are using boxes, and we can expect an increase in the number of boxes over the number of drums in the next 5 years. It appears to me that we will have well over 6000 boxes by the time WIPP is ready to start receiving. Remember that the contents of these boxes are defined by the waste generator as being noncombustible. The problem is that he supplies them.

We use plywood between our tiers of drums for stacking stability, and we ran some fire calculations with the plywood. In a cell 80 feet wide by 100 by 150 feet, with the drums stacked five high, you can get about 16,000 drums in the cell. Calculations indicate that there then remains in that cell only enough oxygen to support combustion in about 60% of the plywood in one box. Wood will burn, but it must have oxygen available if it is to do so; that is a reality.

Rocky Flats extensively tested boxes both from internal fire and where ignition is furnished externally; I think most of you have seen the report on that study.

Factory (???) Mutual has made a fire survey of INEL, and they questioned the way we store boxes. A testing program will get underway in October that will investigate the fire potential from external sources.

In short, we have a lot of boxes and will have lots more before you get criteria implemented, and perhaps all of them could be excluded because of the design of the box.

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IDAHO OPERATIONS OFFICE
U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
INEL TRANSURANIC CONTAMINATED WASTE CONTAINER INFORMATION SYSTEM

STORED TRANSURANIC WASTE CONTAINER DATA

YEARLY SUMMARY REPORT
FEB 1977

AREA OF ORIGIN	* * * * CONTAINERS * * * * TOTAL NUMBR	VOLUME (CU METERS)	WEIGHT (POUNDS)	* * * * * * * NUCLIDE DATA(GRAMS) * * * * * * * PU	PRIMARY NUCLIDE U-233	******	******	SECONDARY NUCLIDE AM-241	TH-232	PU-239	******	* * WASTE DESCRIPTION * * COMP COMB	COMP NCOMB	NCOMP COMB	NCOMP NCOMB
MOUND LAB															
DRUMS	128	27	80,013												128
ROCKY FLATS															
DRUMS	420	87	169,306	3,152				153							420
BOXES	72	228	166,080	1,095								42			30
TSA TOTAL															
DRUMS	548	114	249,319	3,152				153							548
BOXES	72	228	166,080	1,095								42			30
GRAND TOTAL															
DRUMS	548	114	249,319	3,152				153							548
BOXES	72	228	166,080	1,095								42			30

Figure 1

SdWhite
3-4-77

Stored TRU Waste Container Data
Record-To-Date

	Drums				%	Boxes				%	Bins				%
	Comb/Comb	Comp/N-Comb	N-Comp/Comb	N-Comp/N-Comb	N-comp/N-comb to total	Comp/Comb	Comp/N-Comb	N-Comp/Comb	N-Comp/N-Comb	N-comp/N-comb to total	Comp/Comb	Comp/N-Comb	N-Comp/Comb	N-Comp/N-Comb	N-comp/N-comb to total
Mound Lab															
1975	27	1	42	2137	97%	0	0	0	48	100%	0	0	0	0	
1976	21	0	12	898	96%	0	0	0	0		0	0	0	0	
Rocky Flats															
1972	6630	555	1	8481	54%	0	94	0	881	90%	0	0	0	0	
1973	3853	402	35	4688	52%	5	152	1	786	83%	0	0	0	0	
1974	1875	104	55	4081	67%	43	106	45	582	75%	0	0	0	0	
1975	594	1	23	3763	86%	23	20	127	295	63%	0	0	0	0	
1976	351	0	2	2412	87%	105	7	13	367	75%	0	0	0	0	
ANL-E															
1974	0	0	0	0		0	0	0	0		48	0	0	0	
1975	0	0	0	0		0	0	0	0		34	0	0	1	3%
1976	0	0	0	0		0	0	0	0		42	0	0	0	
Battelle															
1973	73	0	16	30	25%	0	0	0	0		0	0	0	0	
1974	257	0	33	156	35%	0	0	0	0		6	0	0	0	
1975	272	0	0	315	54%	0	0	0	0		0	0	0	0	
1976	267	0	0	276	51%	0	0	0	0		0	0	0	0	
ILTSF (ANL-E)															
1976	23	0	0	17	43%	0	0	0	0		0	0	0	0	
	14247	1063	219	27254	64%	176	379	186	2959	80%	124	0	0	1	1%

Figure 2

We now have 124 bins which come from ANLE. The bins are 4 x 5 x 6 feet, and are made of carbon steel. Inside each are eight drums. The waste inside these drums, which is itself inside a liner, is being defined as combustible. I think that a certain envelope should be defined as combustible. I think that a certain envelope should be defined to say that even if there is combustible material inside, that container by definition is noncombustible. Those 124 bins represent about 992 drums, which would be a lot of bins and drums to open.

Certainly there is opportunity for fire, but I think many things can be done about it, particularly engineering the facility to minimize fire hazard. I think you will find that nobody recommends using diesel fuel in a mine. There are engineering concepts in designing a facility that will minimize the requirements, but there has to be a separation between future criteria and perhaps modified criteria for the present generation of wastes. I'm sure that before the WIPP becomes operational, there'll be at least 6000 fiber-coated plywood boxes at Idaho that contain noncombustible material, and I hope no one will entertain the idea of opening them. I think we should give serious thought to a separate shaft and separate criteria for handling this waste, rather than to just say that everything we're doing today is going to have to meet tomorrow's criteria.

(In response to a question.) Our storage pad above ground is basically 150 feet wide by 700 feet long, and we chop it into 80-foot increments. We use about a 3-foot wall of earth between our cells, and we could retrieve the waste if we had to, so the definition of retrievability in the repository I think ought to come under question.

same title as previous paper

CHARACTERIZE TRU WASTE INVENTORIES AND RELATE CHARACTERIZATION TO PROPOSED CRITERIA

H. E. Hootman - SRL

At the Savannah River Laboratory, our waste storage area is located between two chemical separation areas. The waste is in an old burial ground where the alpha TRU was put in trenches. We have a new burial ground which I'll describe later, and that's where we have our present surface storage pad.

For those of you who've never seen this, here is a picture of the type of alpha waste storage that was used before 1965; a cardboard box of waste with a covering. After 1965, we put alpha waste that amounted to over a tenth of a curie per package into concrete culverts with reinforced walls and sealed at both ends. In 1974 we started putting waste that was over 10 megacuries per gram in drums, and continued putting waste that was greater than a tenth of a curie per package in the culverts. Our surface storage modes had a hurricane bag (???) over the front part of the package.

We also use monoliths. Several times when we modified our process we had large hoppers in which plutonium had been processed, which were too large to put into culverts, so we put them in fiber boxes, put the boxes in holes, and grouted cement around them. These we do not consider as retrievable for two reasons: one, we don't think the concrete is strong enough structurally to withstand being pulled out, and two, we don't know for sure that it isolates the water from what's inside the grout. We now have about 200 of these monliths in sizes up to 1600 cu. ft. We discontinued making these monoliths about 5 years ago.

Another form of waste is process vessels that came from the process canyon where the beta-gamma background was so high that you couldn't tell whether it were TRU waste or were merely contaminated by it. In this particular case we exhumed a process canyon vessel that was buried in 1957. The background radiation was low enough so that we could do an assay, and we found that it was less than 10 nanocuries per gram.

These are the four major types of stored waste that we would probably ship to a repository at some future time (Figure 1). In each of the four categories, we show the volume and the activity. In each case we are doing a separate cost/benefit analysis to determine whether it is worthwhile to process these, or even to exhume them for the purpose of further operations.

	Volume, ft^3	Activity, Ci
Retrievable Storage	290,000	300,000
Monoliths	27,000	4,200
Earthen Trench	60,000[a]	3,600
Process Vessels	?	?

a. If preprocessed at SRP to remove uncontaminated soil.

Figure 1. Stored Waste Possibly Shipped Off-Site

Let me describe some of the containers that we might use if we do not process them but simply ship them to some site exactly as they are. First there is the reinforced concrete culvert, (Figure 2) which is 7-1/2 feet tall and 7 feet in diameter, has walls 6 inches thick, and weighs about 9 tons unfilled.

Instead of using 55-gallon drums, we use a concrete box about 4 feet high by 2 1/2 feet square, with walls about 4 inches thick (Figure 3). These are for higher activity waste from our high-level canyon. Of course we have the 55-gallon drums, which are used at all ERDA sites, but for waste that we can't get into those drums we use a fiberglass-reinforced plastic (FRP) box (Figure 4). These are for heating elements (???) that you can't get into drums. We go on to polyethylene from this FRP box.

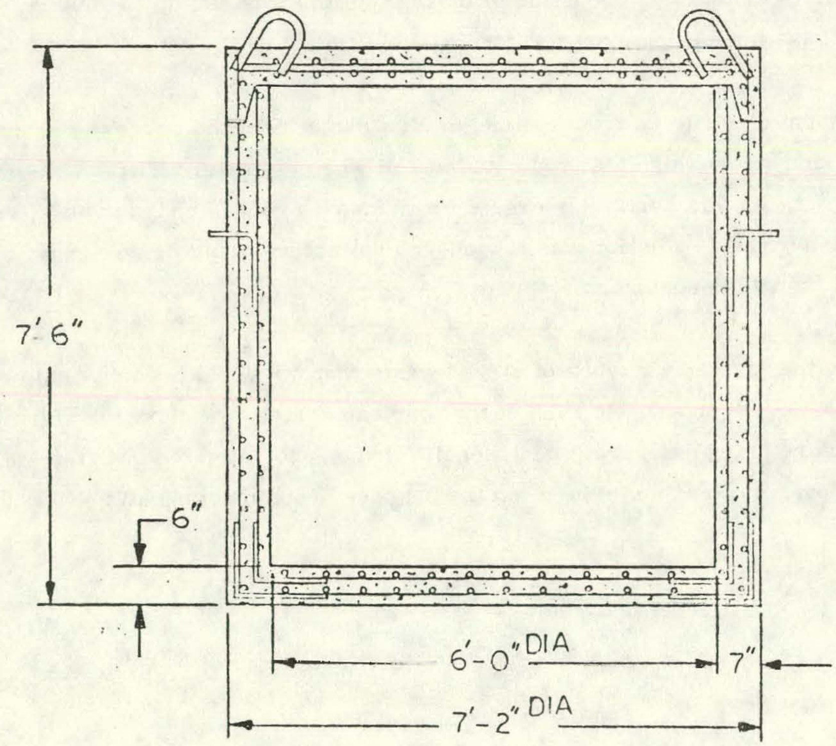

Figure 2. Concrete Culvert

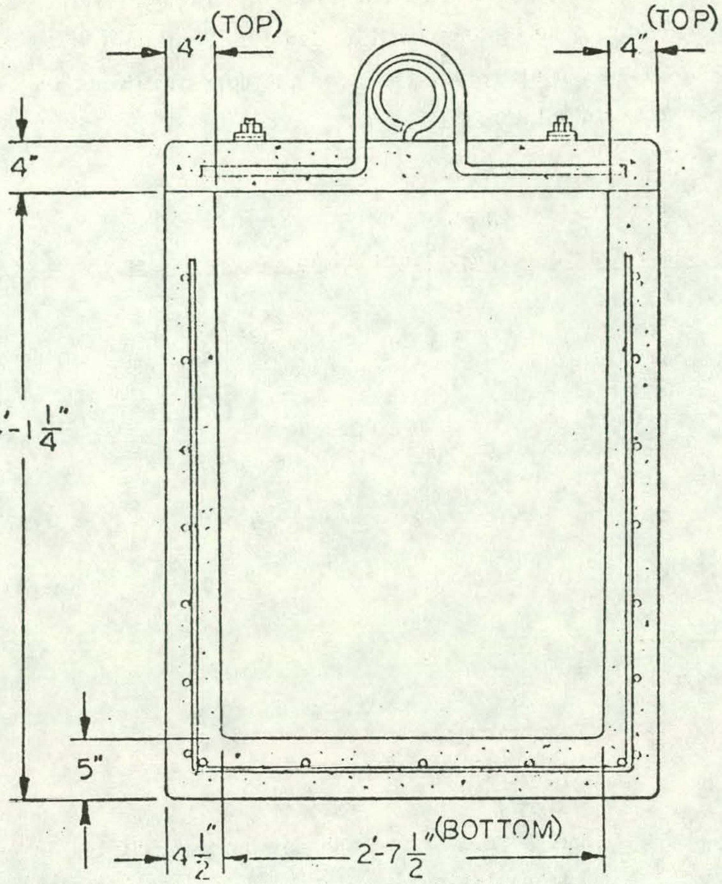

Figure 3. Concrete Box

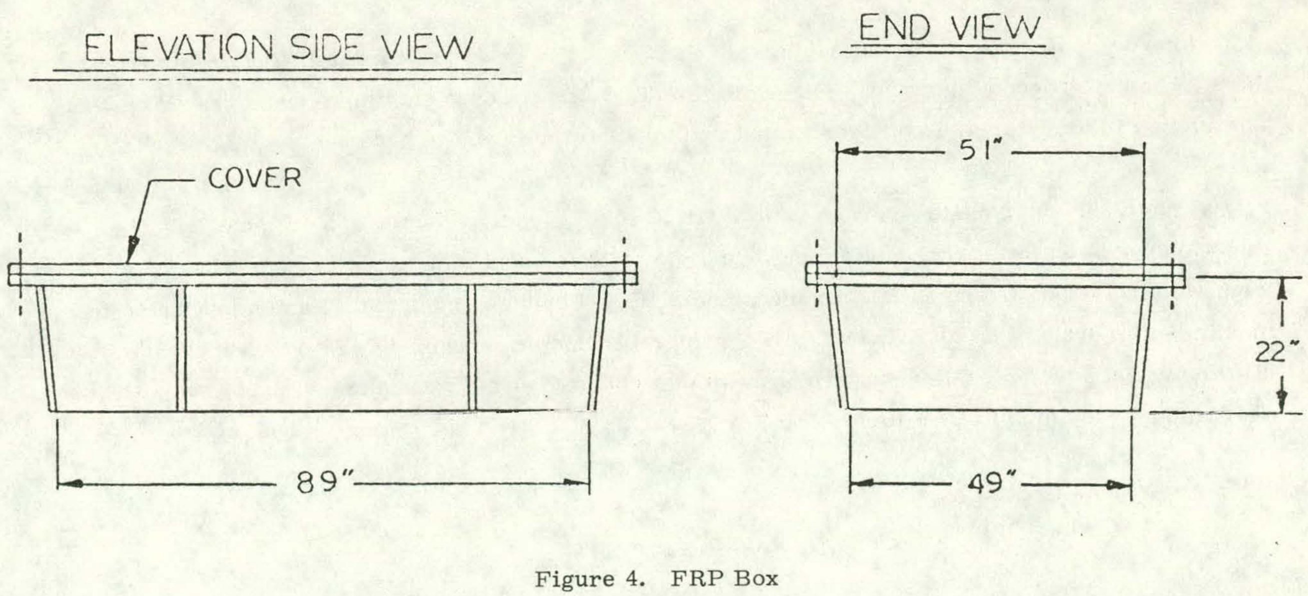

Figure 4. FRP Box

I've discussed the kinds of containers that might be shipped; now I'll show what might be in those containers (Figure 5). The isotopes will be uranium, neptunium, Pu 238 and 239, curium, and californium. These are not all really TRU, but the concentrations are sufficiently high that it would be better not to exclude them.

Isotope	Waste Origin	Number of Containers[a]	Activity, Curies[b]	Dose mrem/hr (Surface)
^{238}Pu	Mound	25	212,000	45 mrem/hr
^{238}Pu	SRP	280	67,500	1 mrem/hr
^{239}Pu	SRP	350	4,500	5 mrem/hr
^{244}Cm	SRL	42	16,000	100 mrem/hr
^{252}Cf	SRL	3	0.05	negligible

a. Containers

Dimensions:	5' OD by 5' high
Weight (loaded):	9.5 tons
Volume:	85.6 ft^3
Waste Form:	ash and noncombustibles in cement matrix
Encapsulation:	½ inch carbon steel (inner)
	½ inch stainless steel (outer)

b. Decayed to year 1989.

Figure 5. Processed Retrievably Stored TRU Solid Waste from the Savannah River Plant in the 1986-1996 Period

I have a histogram of the distribution of the number of grams of Pu 238 in 250 drums from the SRL burial ground (Figure 6). The average is 2 grams, but the maximum drum has 20 grams. Therefore in the criteria, I consider I must use maximum to average because of this spread.

In Pu 239, our max-to-average ratio is 18 to 105, or about a factor of 7 (Figure 7). The Pu 238 depends on the source, but from Mound the ratio is about a factor of 9; waste that we got from LASL is about 2, and FRP waste runs about 10. In curium and curium fission products, the maximums in drums that contain both are considerably higher, around 40. My main message in all this is that you can't talk about averages in this context, and if you talk maximums, you will overdesign everything by a factor of 2 to 20.

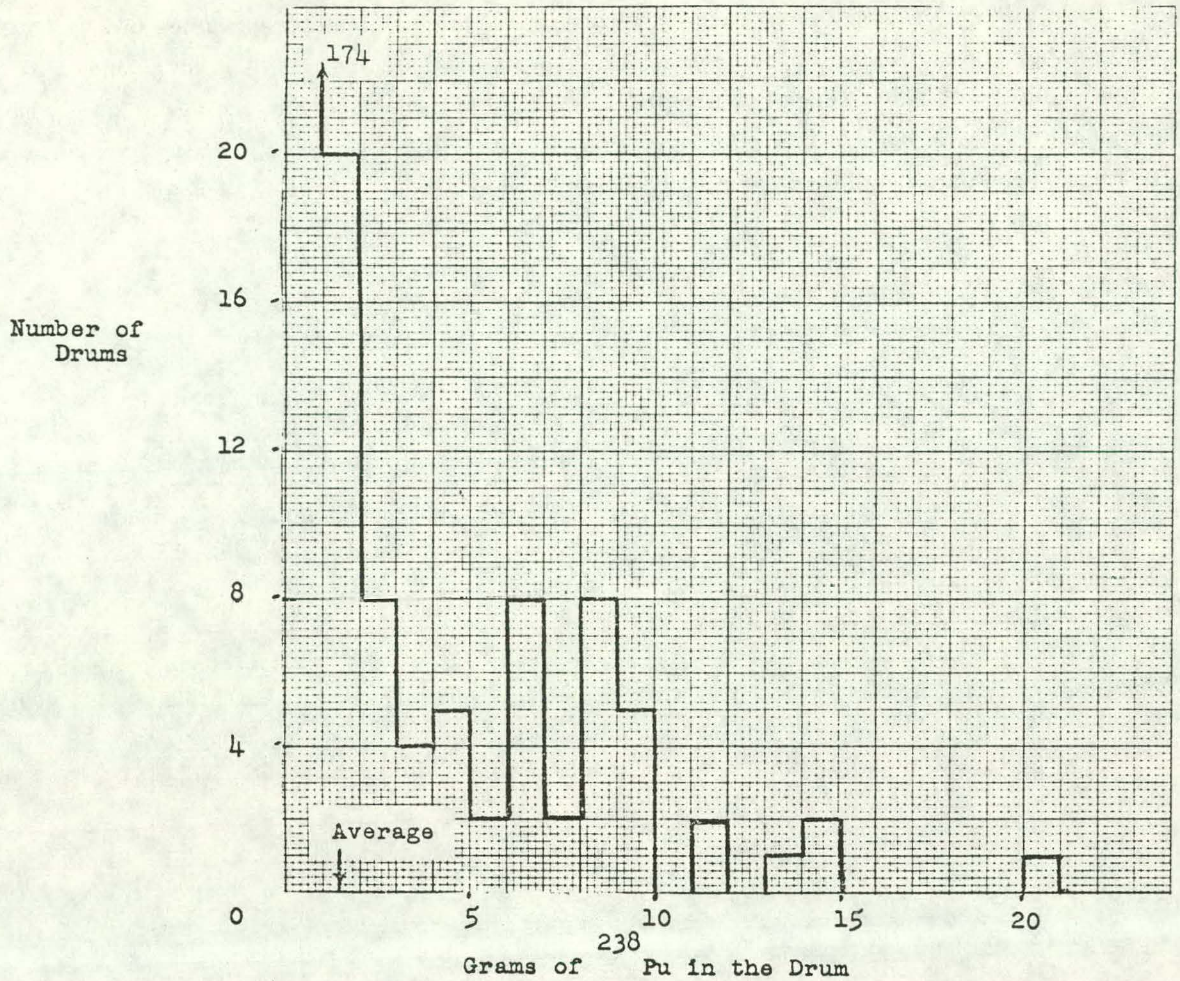

Figure 6. Variation in ^{238}Pu in Waste Drums

Nuclide	Average	Maximum
^{239}Pu, g	18	105
^{238}Pu, g		
a) Mound	15	117
b) LASL	17	40
c) SRP	2.5	22
^{244}Cm		
a) Cm g	1	20
b) F.P. Ci	40	900

Figure 7. Activity Distribution in Waste Containers

Let's talk qualitatively about gassing in waste. Figure 8 shows stored wastes in instrumented drums in the culvert. This particular drum had 140 curies of Pu 238, which is 80 grams, with mainly noncombustibles wrapped in with PVC. I've used two ordinates and one abscissa; total pressure over a period of over 400 days has gone up to about 2 psi. With spring coming, temperatures rise and so does pressure in the drum; it's still going up at 500 per day (? ? ?) though I haven't got the data plot here.

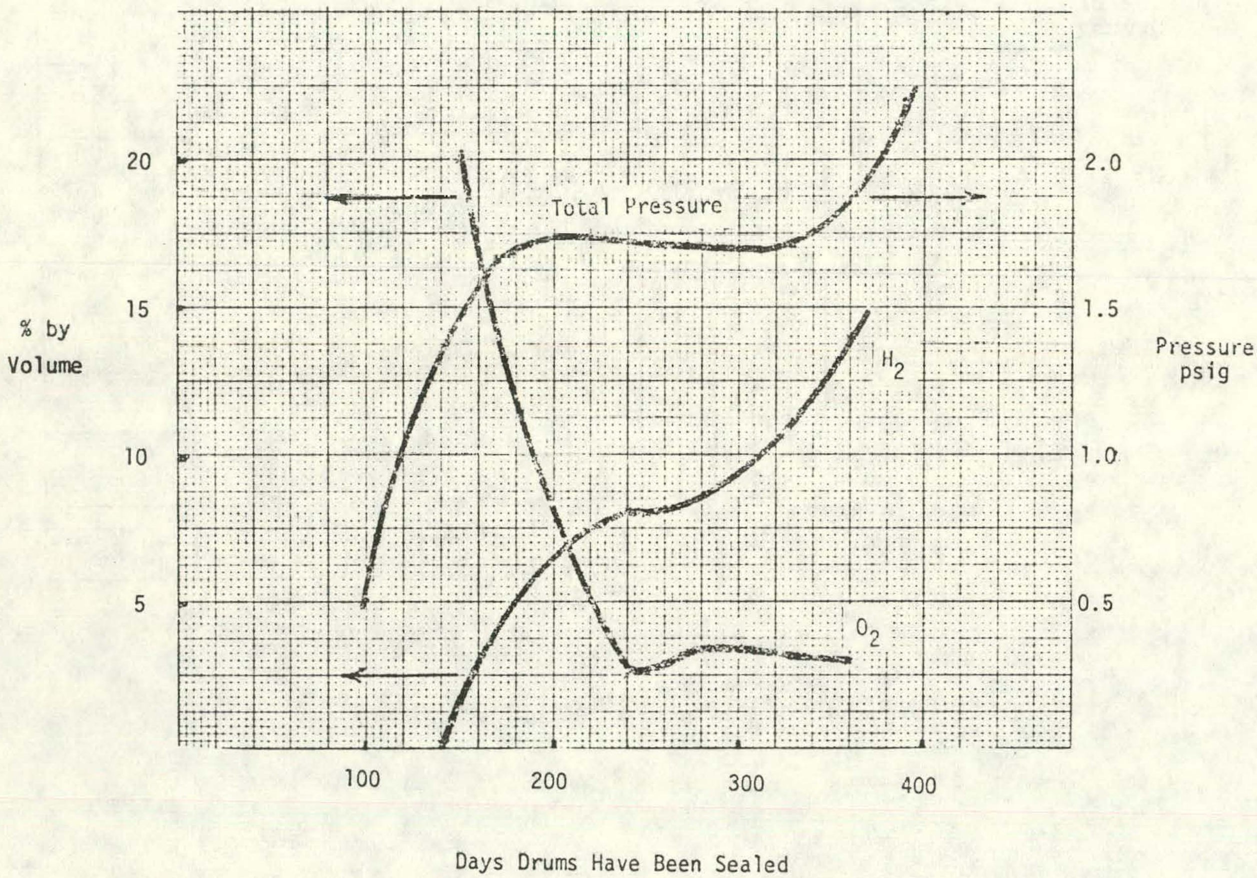

Figure 8. Radiolytic Gas Generation in Waste Storage Drums

We've taken gas samples and have complete accounts of organic components. Figure 8 also shows the percent volume of oxygen and hydrogen as a function of time. Those familiar with explosive mixtures can see that there's a period here when you get out on the hydrogen curve above about 4 or 5%, and the oxygen drops to about 4%; there's a period of 80 to 100 days during which you have a theoretically explosive mixture in that waste drum.

Regarding the numbers of containers to be shipped—if we ship them as they are to a repository, you will have about 18,000 drums, or about 800 culverts (Figure 9). That adds up to about 400,000 cu. ft. of waste, including the containers. If we processed this onsite and put it in supercontainers, we'd have about 700 containers containing 60,000 cu. ft. of waste, which is a volume reduction of about 7.

Off-Site Processing	Onsite Processing
18,000 55-gal drum	700 Containers
760 Culverts	
500 Concrete Boxes	
380 Fiberglass Boxes	
120 Boxes - X	
410,000 ft^3	60,000 ft^3

Figure 9. Containers to be Shipped

Several years ago we made an option diagram covering alternatives for ultimate disposal of our wastes (Figure 10). We decided to keep solid waste onsite, without processing or anything. Then we looked at the other extreme, following the most rigorous path for treating the waste; it involved processing it, reducing the volume, fixing it in a matrix, and putting it in a package that would allow it to be stored on the surface at an RSF for up to a century, or if a repository is available, putting it there within that 100-year span. The process in general involves removing the wastes from our different sizes of containers, and opening the inner packages. The combustibles are sorted from the noncombustibles, and the combustibles are incinerated. The noncombustibles are treated for size reduction. You don't get much volume reduction from these; not more than a factor of 3, but mostly we were just trying to decontaminate it to the point where it can just be buried onsite; it would have a value of below 10 nanocuries per gram, which is what we used as a design basis. The residue that was greater than 10 nanocuries per gram we grouted in concrete and encapsulated in a container that we felt would meet requirements for either an RSF or a federal repository. Figure 11 is a conceptual idea of what that container might be. It is a right cylinder, 6 feet tall overall, with 5 feet of inside storage. It has an inner liner of 1/2-inch-thick carbon steel which is fixed to a larger base plate for handling, but it forms a mold where you take the chopped-up noncombustibles and drop them, plus the ash, into the containers. Then you make one solid monolithic grout. It has an external 1/2-inch stainless steel container; we don't encapsulate the waste to protect the outside from the waste, but to protect the waste from the outside environment. We are trying to make it all environmentally intact on the surface for long periods, so the carbon steel liner protects the stainless steel from anything that might be in the waste to corrode it, and the carbon steel is protected by the stainless steel on the outside from environmental and weather effects. This container would weigh 10 tons loaded. The maximum temperature would be 62°C with half a kilogram of Pu 238 in it. Maximum pressure would be 100 psig, which is a lot. You wouldn't expect to pack these on one another. There could also be a pressure buildup because of radiolysis of the water and concrete. Criticality will be limited to 5 kilograms; we have a different criticality limit because we've got a different matrix. We have concrete in there, or we may have the ash in glass. No graphite, however. In the criteria there is a reference to a particular type of special permit that allows 200 grams of plutonium and 200 pounds of graphite. Not all

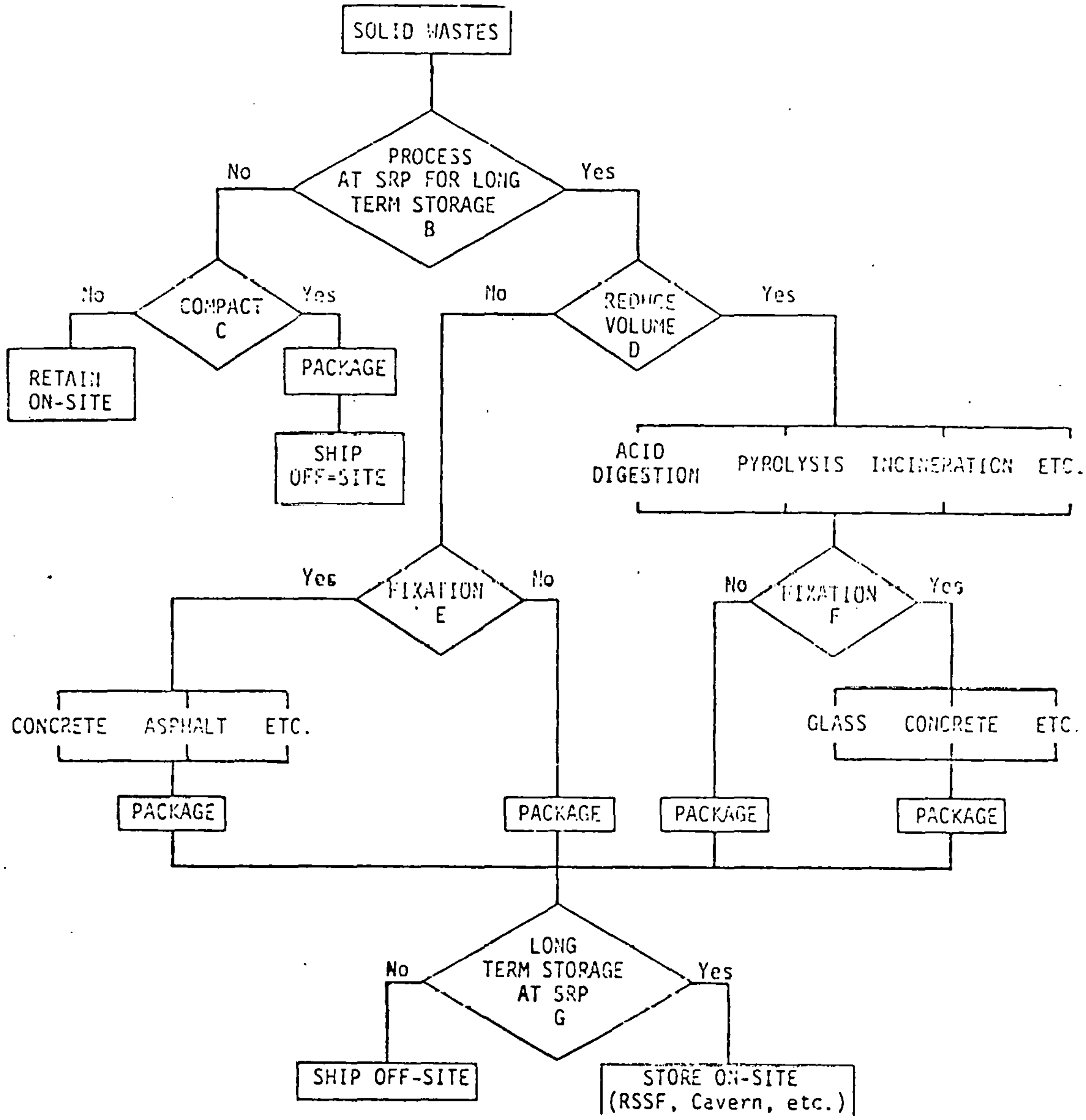

Figure 10. Option Diagram for Management of Category B Wastes (TRU Wastes Stored in Concrete Culverts)

sites have similar processes. The surface reading is very low on this. Figure 12 shows the surface dose rate, assuming you put your hand on the surface at the midpoint of the container at about the 3-foot level. Again we need to consider the maximum-to-average ratio. If you had 100 mrem per hour from this curium waste and some fission products, the volumes are too large to make the radioactivity distribution homogeneous, so you'll have a variation of as much as 20 in this particular case. In unprocessed waste, if we took it with the containers, the 400,000 cu. ft. total, the dose level would be about 1/3 less, but that would be because to get to 700 containers we would have reduced the volume by a factor of about 9. At the same time, however, the concrete grout gives self-absorption and a lower dose.

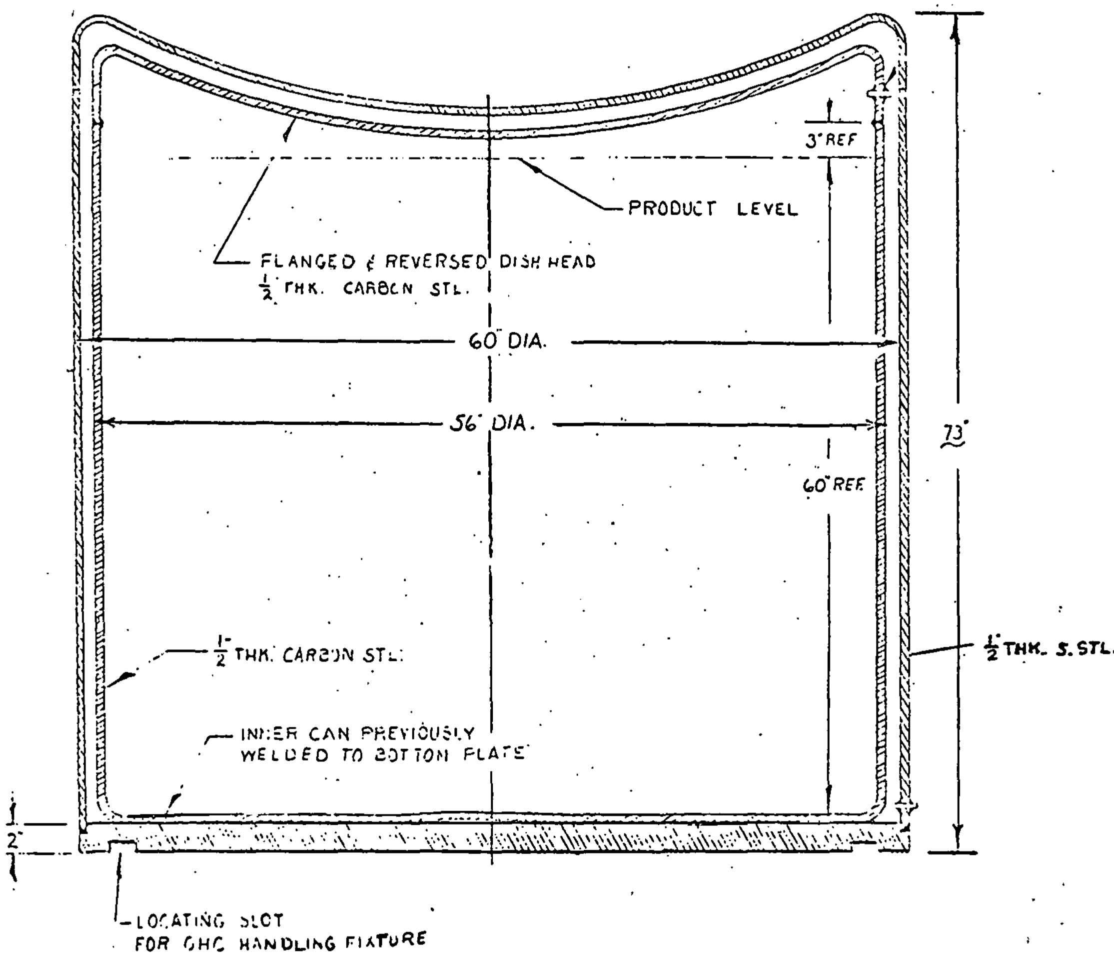

Figure 11. Conceptual Long-Term TRU Solid Waste Storage Container

Isotopic Contamination	^{238}Pu		^{239}Pu	^{244}Cm	^{252}Cf
Waste origin	Mound	SRP/SRL	SRP	SRL	SRL
Waste volume, ft^3	9,000	132,000	155,000	28,000	6,000
Total activity, Curies	212,000	67,500	4,500	16,000	0.05
Operational doses, rem					
Sorting	1.31	0.32	6.24	30.46	0.34
Volume reduction					
• Combustibles	1.05	3.03	26.60	287.94	3.25
• Noncombustibles	16.20	0.58	5.08	54.98	0.62
Fixation & encapsulation	0.90	0.17	1.51	16.38	0.18
Total isotopic dose, rem	19.46	4.10	36.01	389.76	4.39
Basis					
Specific dose rate, mrem/hr/g	0.7	0.7	0.33	{1190 F.P. 143	$31(10^6)$
Fraction neutron dose	0.42	0.42	0.78	0.10	0.94

Figure 12. Unshielded Radiation Dose Burden from Processing Solid Transuranic Wastes in the 1986 - 1996 Period

Now, what does it cost us to manipulate this waste, not in dollars, but in man rates of exposure? If you look at the different types of isotopes and the different operations involved in this conceptual processing, you can see that curium 244, which is less than 10% of the total volume of waste, contributes over 80% of the dose, and that's in the incineration of the combustibles and the curium fraction. It appears, then, that you can avoid 80% of that dose by not doing anything with the curium waste at all, but just putting it into the final container, shielded by about a foot and a half of concrete, and not telling anybody about it. This sort of possibility has not been mentioned today. I've been amazed at how qualitative rather than quantitative the discussions have been so far.

In the case of radiolysis of concrete, matrix and stabilization have been watchwords here. I've plotted gas buildup based on G factors which were measured with a curium 244 source in a concrete capsule. I checked the conceptual design of our supercontainer, and plotted against our inventory of material to see how much gas should be generating (Figure 13). For the first 700 years the Pu 238 contributed to the hydrogen and oxygen which make up the major constituents as far as pressurization in the container is concerned. The decayed helium is very low; we're getting most of our pressure buildup in the first 70 years of storage. If you carry it out beyond that, you see that Pu 239 comes into play when several half-lives have passed.

Isotope	Half-lifes t 1/2	Time Years	Material Kg, Decayed	Standard Cubic Feet			
				He	H_2	O_2	Total
^{238}Pu	1	88	9	30	$3.3(10^5)$	$1.2(10^5)$	$4.5(10^5)$
	2	176	13.5	45	5.0	1.8	6.8
	3	263	15.75	52	5.8	2.1	7.9
	4	351	16.9	56	6.2	2.2	8.4
	5	440	17.4	58	6.4	2.3	8.7
	7	615	17.9	60	6.6	2.4	9.0
^{239}Pu	0.075	615	1.24	4	$0.4(10^5)$	$0.2(10^5)$	$0.6(10^5)$
	1	24,390	25	83	8.6	3.1	12
	2	40,700	43.75	146	15	5.4	20
	7	170,730	49.61	166	17	6.2	23

1. Assumes G factor of 0.2 H_2 atom/100 eV
0.07 O_2 atom/100 eV

2. Assumes 18 Kg ^{238}Pu and 50 Kg ^{239}Pu.

Figure 13. Gas Volumes Generated by Alpha Radiolysis in a Concrete Matrix[1]

How can you keep that container intact for a century on the surface, or when there are wide swings in waste activity? There are several alternatives which can be investigated. If 70% of the regular production waste is combustible and 90% of the TRU activity is associated with that combustible, all you have to do is segregate the majority of your activity, encapsulate it in concrete and throw it into the ground. There are several other alternatives.

In summary, there has been a lot of talk about combustibles, but nobody has really talked about their relative impact. By just adopting an across-the-board exclusion of combustibles, you will put a terrific burden on the people that have the waste now, in the first place because of the dose that they will have to make their workers take, and secondly on any processing facility that we might design, because the shielding must be increased, and when shielding goes up, the cost of these facilities skyrockets.

In thermal power density you have a 10th of a watt per cubic foot. Pu 238 is half a watt per gram and we have 18 kilograms. That means that we would have to increase waste volume with Pu 238 if we were to conform with such a criterion. Supercriticality is dependent on the type of increments (???). I think that it should be up to the people who generate the waste to establish their own criticality limits and be responsible for them, rather than for someone to state how many grams per cubic foot are allowable, because it's more involved with the hydrogen plutonium content, or a matrix content, or whether you use a resinous absorber that might be associated with the plutonium. A related question is how high do you stack 10-ton containers?

We have been designing a process for these wastes; a process description and its costs will be released in September for this facility, which would operate for 10 years, using this conceptual container. One of the most difficult problems we've had to address in this area is how to get a container out of a TRU-contaminated area clean enough to transport. People who work with radioisotopic sources know how difficult that is even with very small sources, and we're talking about large containers and high levels of specific activity. We feel we have the methods and the technology to do it. But remember that radiation depends on the ratio of maximum to average.

Discussion

Q. Does your analysis say that with gas generation you couldn't get your container to withstand a pressure buildup over a period of time?

A. If we were to mix the with concrete, at that 7 T factor that I mentioned, I'd say you'd get less than a century of use out of it on the average. The maximum case would of course be shorter. The alternative is to isolate the highest specific activity materials, separate the combustibles from the noncombustibles and incinerate them, put the ash into a glass matrix, and put the glass in a grout; or you could put the glass in solidified HLW, or there may be a low-level matrix that you can fix the ash in. Or you could just put in heavy-walled containers and then put it in the grout.

Q. On p. 5 of the criteria, it says metal containers are preferred. Your container has a stainless steel exterior, and I believe that stainless steels are not compatible with chlorine environments in many cases. Can you comment?

A. Yes. We started this study in 1974, and we designed the process for surface storage. Stainless steels are ideal for certain storage conditions. We used a carbon steel inner container; we were sort of playing both ends against the middle. If you were to put these containers into salt, our carbon steel is a much better containment.

same title

CHARACTERIZE TRU WASTE INVENTORIES AND RELATE CHARACTERIZATION TO PROPOSED CRITERIA

H. Zweifel, ARHCO

I'll give a brief history of ARHCO's waste problems at Hanford. Until 1968, burial grounds existed in three main areas of the flats (Figure 1) the 100 areas, reactor separation, and fuel processing. In 1968 the fuel processing area started shipping its waste to ARHCO, and in December 1973, the reactor areas started shipping. We've now receive all wastes from the flats. There are 170 acres of burial grounds in the 200 areas, and about 65 acres in each of the other two spots. We have estimated that the 200 areas had something like 6,200,000 cubic feet of waste underground, up until 1976. We're not sure about the 100 areas and the fuel processing areas, but they have somewhat less.

I want to talk about our current objectives, the types of wastes we're getting now, and I'll forecast what we're likely to have.

In 1970, we started putting our waste into containers with the idea of retrievability, and in 1973 we standardized the use of the 19A box and the 17C drum (figure 2, a and b). In a 15-month period starting July 1, 1975, we received the following types of waste:

Noncombustible: We put this into plastic bags, as is our custom with drums. We received about 1872 cubic feet of this type during that period. We had readings of 1 to 2 mr on the sides of the drums; the grams of plutonium in almost all our waste are under 1 gram per cubic foot.

Combustible-noncumbustible: We put this on slabs to be buried later. Volume amounted to about 8690 cubic feet over the 15 months.

Defense TRU waste: This is generally of a classified nature, and is generally a little higher in its radiation level. By OWI definition, this might be called intermediate-level TRU. The volume of this amounted to 43,000-plus cubic feet.

We also have caissons, which are similar to DuPont's culverts, and in these we put higher-level or more toxic materials (Figure 3). These caissons are separated into TRU and non-TRU. The caissons are underground, mounted on skids, and are meant to be retrievable.

Right now we have some highly concentrated materials, partly from outside sources. The D9 cribs are also being dug up, and the material is being put into a lot of combustibles: we put it in a plastic bag, which goes into an 11-liter can, which goes into another bag of 2-mil polyethylene, and that is put into a 13-liter can. This entire assembly goes into a drum. So you can see that we've had a bad time trying to repackage that material.

JULY 1, 1976

LOCATION	NUMBER OF FACILITIES	ESTIMATED AREA OF FACILITIES
100 AREA	26	~65 ACRES
200 AREA	28	~170 ACRES
300 AREA	28	~65 ACRES

Figure 1. Burial Facilities

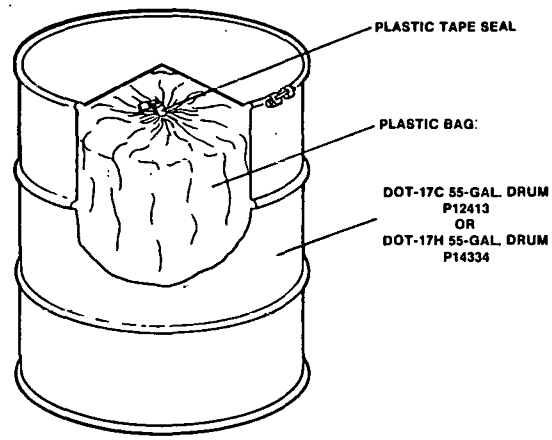

Figure 2b. 55 Gallon Drum

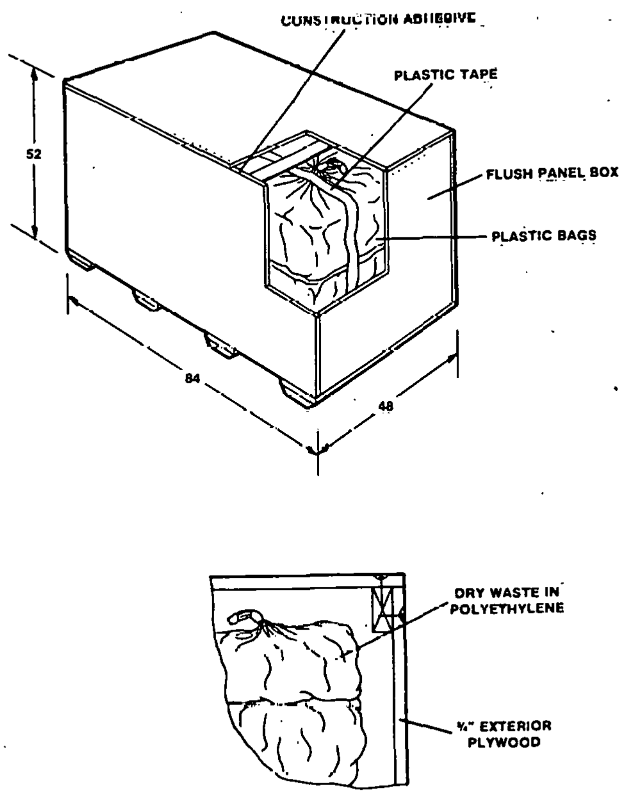

Figure 2a.

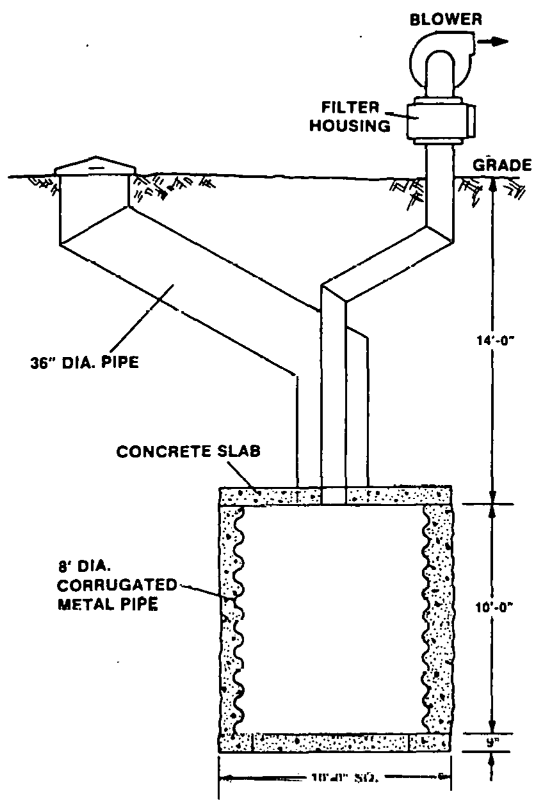

Figure 3. Solid Waste Burial Caissons

We also have a Purex tunnel into which we put large equipment; we put the material on railroad cars and roll them into the tunnel (Figure 4). There is approximately 2000 cubic feet of this material, all big equipment, involving heavy metals. All of this may be recoverable.

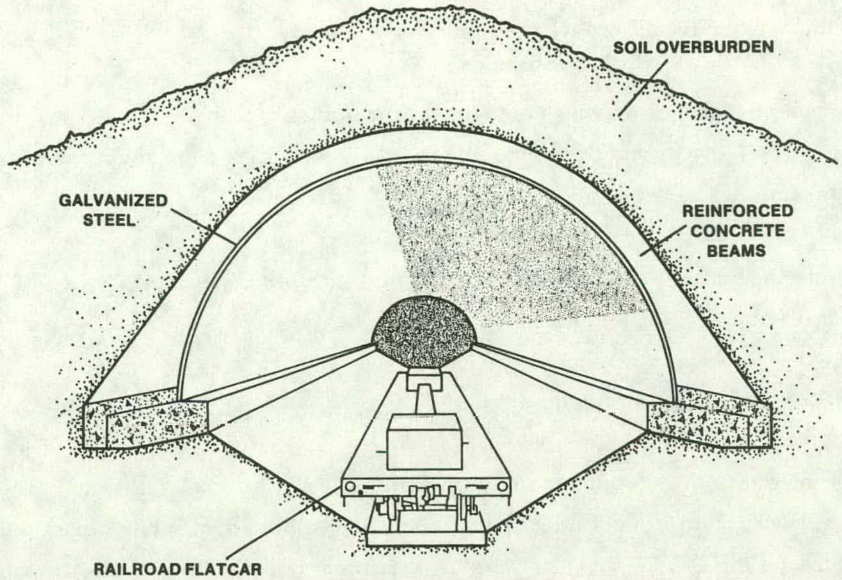

Figure 4. Tunnel for Storage of Contaminated Equipment

At present we don't have an incinerator, though we're talking about budgeting one in the 1980's. We have only a small compactor.

So at the end of 1976 we assumed that we had 6,200,000 cubic feet of waste. Because of the startup of several new operations, and the restart of Purex, we expect the quantities to go up substantially. So we're in the same position as INEL; every day the wastes continue to build; it is a severe problem to begin with, and can only get worse.

Most of our waste contains less than 1 gram per cubic foot of plutonium. On the basis of the WIPP criteria, we'd have to say that 80 to 90% of our waste would be considered combustible. Other reactor wastes vary, and we have little idea what these are. There is a plan to start characterizing all the wastes in the old trenches on government land.

We couldn't guarantee to meet your combustibility criteria without going into processing, which would be very expensive in manpower, radiation levels to people, and capital and operating costs. Your definition of combustibles gives as a problem. Your definitions are not clear, and we can see that we would have to do a lot of testing to determine where in your scheme of things our particular types of waste would have to go.

We feel we could meet 90% of your acceptability requirements on explosives. We never knowingly accept waste with explosives. If we did get some, we would probably process it before putting it underground. But the long-term effects of mixed ingredients would give us a great deal of difficulty in guaranteeing explosive safety, because we accept wastes from any other places, and can only take their word on the waste contents.

By the same token, we feel we can meet the pyrophorics criterion. We don't knowingly have pyrophorics in our waste, but again, when we get mixed wastes from the laboratories, we cannot guarantee what is in them.

The only thing that bothers us in the toxic materials criterion is the mixture of two or more compounds which in themselves are harmless.

We can meet the power density requirement.

In the matter of waste dimensions we have problems. Waste materials from the Purex process are big, and our practice has been to put our old equipment in large boxes before burial. Some of those boxes are 8 x 8 x 20 feet, or 12 x 12 x 8; they are of heavy concrete, and they would have to be processed, because we think weight would exceed your elevator limits, and certainly they couldn't be transferred as they are. We would also have the problem of size if we ever had to retrieve one of the underground caissons, because they weigh about 13 tons empty; they include a concrete slab cladding on a steel culvert.

There are also problems of contamination with the caissons; the material is put into them in one-gallon paint cans with various types of sealings, and when these are dropped into the delivery chute, we can't guarantee what will happen to them as they fall to the bottom.

In volume reduction, we are experimenting with an arc saw. The small pilot demonstrator has been very successful, but a full-size operation wouldn't be possible inside of a year and a half.

We see no problems on the handling criterion. Regarding materials and construction, we have wooden boxes that would have to be repacked to meet present standards; we also have a lot of plastic liners in those which we felt were all right, and to my knowledge none of them is Teflon.

As far as weight is concerned, the caissons and large pieces of equipment are the only ones that would give us a problem.

We feel we can meet your requirements on contamination, penetration, radiation, and labeling. These are chiefly matters of intensive work and a labor force, and if that is the way it has to be, it can be done. But for 6 million-plus cubic feet of waste, we'd need a lot of people, and it would be very expensive.

Identification for the records we feel we are meeting now in our various programs. Color coding is another manpower problem which we could handle.

DISCUSSION

Bradley: It has been said that the NRC will establish waste acceptance criteria in conjunction with OWI, although they themselves are also evaluating similar criteria. I don't remember your mentioning anything in regard to your facility about licensing. Do you have an interchange with NRC? How do you view their role in setting acceptance criteria?

A. We have talked with NRC about that, but the only hints we've got are that they will not accept liquids for transportation. They do not feel that a solid matrix or monolith is necessary; counts ( ) bigger than respirable or significantly smaller - these are the kinds of things they talk about, but that's as far as they will go at present. We must talk with NRC and try to understand their viewpoints, and if we see that these viewpoints are getting overly restrictive, we should try to influence them to back off. That has happened a couple of times.

Q. Do your see the probability of any substantive differences in acceptance criteria between OWI repositories and the WIPP?

A. No.

Q. You talk about aiming your criteria generally at future wastes, the kinds of things we might be generating that will require processing to meet your criteria, and this raises the possibility of two sets of criteria; one for existing wastes and one for future wastes. Is that in the context of proving out the WIPP on the basis of fairly conservative acceptance criteria, and the possible future chance of being able to backlog, on conservatism, so that it would simplify the job of handling the existing backlog?

A. We prefer one set of acceptance criteria, recognizing that some of the existing waste forms cannot meet them, and cannot be processed to meet them. For these items we must have special consideration. There probably will be another category of material that could be processed into that form if it were deemed necessary. I would think there would be experiments to establish how far you'd have to go in processing old existing wastes, and we're not likely to know that for several years. A lot of that experimentation would be in the laboratory.

Bradley: In your interactions with NRC, is there any understanding about a continuing dialog, or is that pretty much left to be initiated by either party?

A. There is no formal agreement or understanding. There is only an informal agreement to exchange information.

Q. Do you find any concern at NRC about a possible conflict of interest in these discussions, about licensing requirements or licensability of the facility?

A. I've not heard any such reaction. I get the feeling that as long as our interactions are informal, they'll continue to exchange information. Once any agreement with them becomes formal, and a license is applied for, that situation may change, but at least we will have had a useful exchange before that time.

Comment: We have asked NRC the question: when is our relationship going to start making you uncomfortable? I believe they have consulted their legal counsel on this, and don't have an opinion yet, but once they get some draft regulations or standards in the latter part of this year, they may slack off on such exchanges, or formalize them.

Bradley: What is NRC doing in terms of research to form a data base for acceptance criteria?

A. I don't know of any interest expressed in the WIPP operation with regard to waste acceptance, but they do look at WIPP as a proving ground in other areas, particularly construction, facility design, and shaft sinking, and they have mentioned possibly using the facility for confirmatory research in situ.

Comment: We have the same feeling at ARHCO; they're interested in what we're doing, but I don't think they're interested in doing any R&D on their own. We had an interchange with them on HLW liquid; it was a straight information exchange, and when we asked them about a possible conflict of interest, their legal counsel said that while they're glad to exchange information with us, nothing should be interpreted as implying that anything we're doing will be licensed.

Comment: Right now, NRC has no responsibility to license a facility that's going to accept TRU waste. I talked with them yesterday about the status of the revision of 10 CFR 20, regarding the 10-nanocurie-per-gram level in the acceptance of TRU waste. The indication I got was that no action was being taken on that at present, and nobody was pressing for an answer. The position they laid out was that since they have no mandate in law at this time, they don't feel any legal responsibility to do anything. They do have to be concerned if they are called upon to license a facility for HLW which would also accept TRU waste. But right now they don't seem to have any responsibility for licensing a TRU facility for either commercial or ERDA waste. I don't see any legal problem about licensing the WIPP; but on the other hand I don't see, even if we asked them to, that they would have any jurisdiction to issue such a license, unless there's a major change in the regulations, or new legislation is introduced. Perhaps something will come of the S-63 bill that Matthias has proposed, regarding a government body that would manage all commercial and ERDA wastes.

Bradley: Under present rules, a repository dedicated to commercial TRU waste would not require a license?

A. That's right.

Bradley: How does that differ from the licensing of commercial burial grounds? If they license those, why wouldn't they be similarly concerned about a repository for commercial TRU wastes?

A. The proposal made in 1974 regarding that matter has never been acted on, so there is no legal basis by which they can license. I don't think they intend taking any action except in regard to that particular rulemaking.

Comment: We were told about two months ago that they were not considering that rulemaking; the problem is that there is no environmental statement. When there is one, it will cease being a proposed rulemaking.

Comment: NRC is in the process of changing their views on a lot of things; they are thinking things through, and they don't yet have all this worked out. You can get differing viewpoints from different people at this time because of that unsettled situation. But the feeling that seems to be coming through is that sometime in the future, the NRC will take a stand on TRU commercial waste, and that stand probably will be some sort of ruling regarding how bad it will be or what it will be; Liverman probably doesn't know either.

I also wonder whether we should even ask them, for fear of precipitating a decision. I got an NRC document yesterday indicating that they will probably become more involved with state governments to help them develop criteria for both safety and licensing. The idea seems to be that state governments don't have the resources to look into it, and ERDA has not spent much time or money in this area, so NRC is projecting more involvement here.

Comment: I'd like to get back to the criteria. There is a blank in the combustibility matter; one of the problems we might have relates to repository operation. I'd like to relate this to the container and not to the storage room; if the container has one noncombustible barrier, the combustible content should not exceed 15% of the total volume of the container. Under that kind of criterion, all the fiber-coated boxes we are now receiving with noncombustible material in them could go to the repository. I think the fiberglass is now listed as acceptable. The problem is with the fiber, if I'm not mistaken. If I am, we'll have to talk to Rocky Flats, because they define the content of their boxes as noncombustible.

Comment: It's not the contents of the boxes, but the quantity of organics that counts.

Comment: What I'm trying to say is that we define acceptability for noncombustible material inside the package, and we relate the percentage of that to the number of noncombustible barriers that the container holds. I have a second comment; we have a bin arrangement which has a steel barrel inside a steel bin. Here again, if you had a criterion stating that if the waste container had two noncombustible barriers, then the combustible content--the inner barrier--could not exceed 15%, we could shift all bins from C to D ( ). I'm just trying to establish some ground rules. The question that ERDA headquarters is asking is, how much of currently received wastes could be sent to the repository? I'm not talking about burials; I'm talking about from 1972 to the present, since we've been into upgrading, and I'm saying that these two types of criteria would allow us to ship everything we have in the noncombustible content category.

Comment: We worry about what happens when a container disintegrates, if it contains organics.

Q. Is there any quantitative measure of organic content?

A. We're not prepared right now to fill in this kind of figure. This is not based so much on short-term problems; I think some of these problems are solvable on a short-term basis, but on a long-term basis there are lots of questions that haven't been answered yet.

Comment: You sound as if you are thinking of adding a separate criterion on organics, on the basis of whether they're combustible.

IMPACT OF PROPOSED WASTE CRITERIA ON ROCKY FLATS AS A PRIME WASTE GENERATOR

E. Vejvoda, Rockwell International

Rocky Flats is one of the largest generators of TRU wastes; most of it is sent to the Idaho National Engineering Laboratory (INEL) in Idaho. Two shipping configurations are used for transferring the TRU waste: (1) 55-gallon drums and (2) 4' x 4' x 7' FRP coated boxes. The attached photographs illustrate these two shipping packages; Figure 1 is a diagrammatical cut-away view of the 55-gallon drum. Figure 2 shows the rigid poly liner used in the drum configuration. Figure 3 is a cross-sectional view of a 55-gallon drum containing cemented sludge. Figure 4 is a diagrammatical cut-away view of the FRP-coated box. Finally, Figure 5 shows a FRP-coated box ready for shipment.

That Rocky Flats has been deeply involved in programs and efforts (both administrative and operational) to reduce the volume of TRU wastes is indicated by Figure 6. The results of these programs (Figure 7) show that we have reduced the volume of our TRU waste by a factor of two since 1973.

Rocky Flats will also have on stream several new facilities which will process wastes that will be stored at WIPP. A Rotary Kiln incinerator will be used for the incineration of combustible wastes with recoverable amounts of plutonium, while a Vibrating Hearth will be employed for incinerating combustible wastes with non-recoverable amounts of plutonium. Experimental Fluid Bed Incinerators are located in an existing Pu processing building. These four items - nitric acid recycle, secondary Pu recovery, sludge drier and pelletizer - are in our new Recovery and Waste Treatment Facility.

Vitrification, Soils Decontamination, and Decontamination facilities - are waste development programs in progress. Our waste processing capability will be upgraded by the time WIPP commences to receive TRU waste.

The impact of the proposed waste criteria on Rocky Flats will be reviewed concerning present and anticipated future capabilities and practices. The first item of concern is combustibles. At Rocky Flats, combustibles are processed based upon being recoverable or not recoverable. Our concern here is with the non-recoverable category. Present processing involves compacting, tamping and shipping in drums and boxes. Future processing will include the vibrating hearth and fluid bed incinerators noted above. The impact involved is essentially concerned with the amounts of residual carbon and organics that will be acceptable.

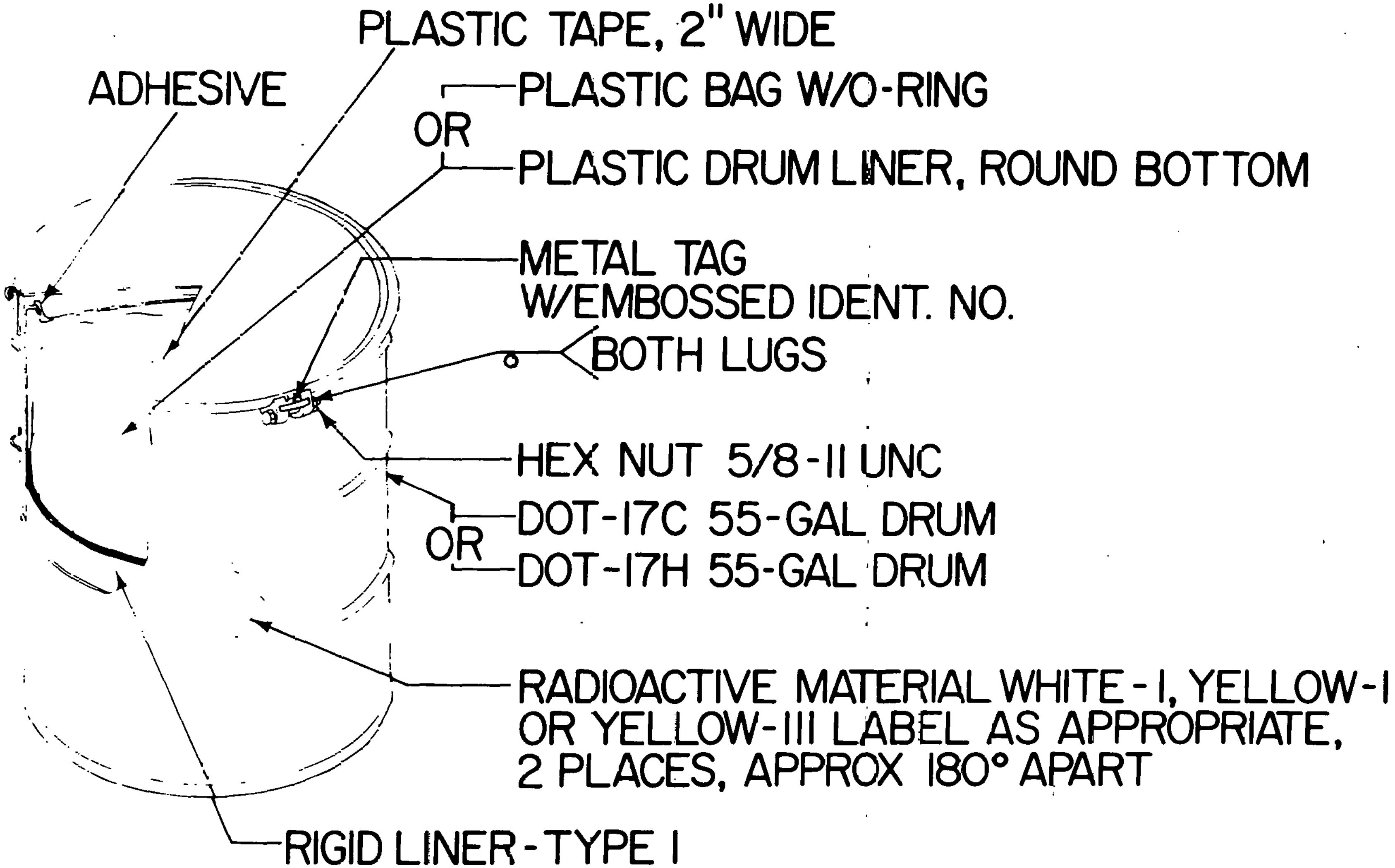
PLASTIC TAPE, 2" WIDE
ADHESIVE
PLASTIC BAG W/O-RING
OR
PLASTIC DRUM LINER, ROUND BOTTOM
METAL TAG
W/EMBOSSED IDENT. NO.
BOTH LUGS
HEX NUT 5/8-11 UNC
DOT-17C 55-GAL DRUM
OR
DOT-17H 55-GAL DRUM
RADIOACTIVE MATERIAL WHITE-I, YELLOW-II
OR YELLOW-III LABEL AS APPROPRIATE,
2 PLACES, APPROX 180° APART
RIGID LINER-TYPE I

Figure 1.

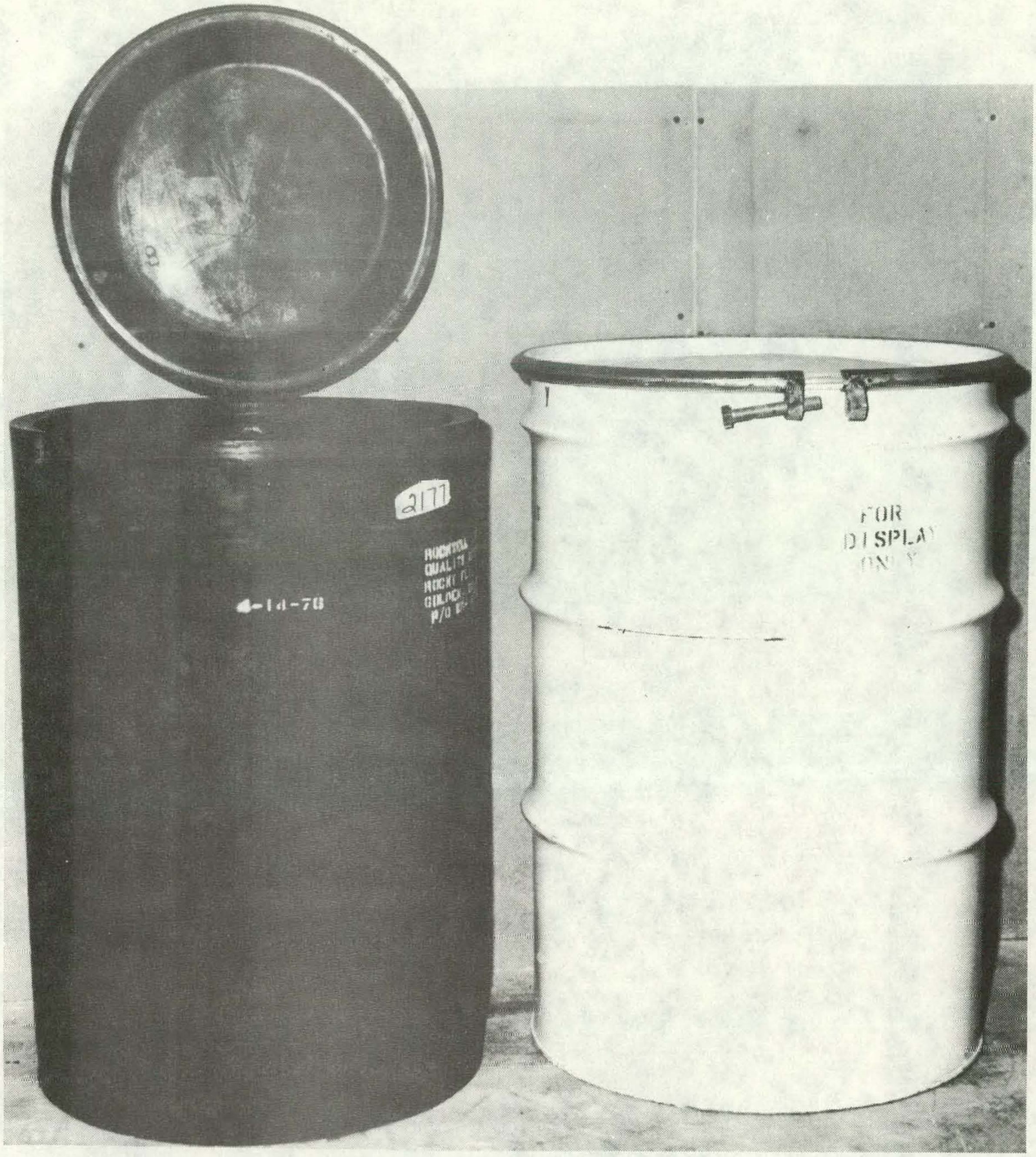

Figure 2.

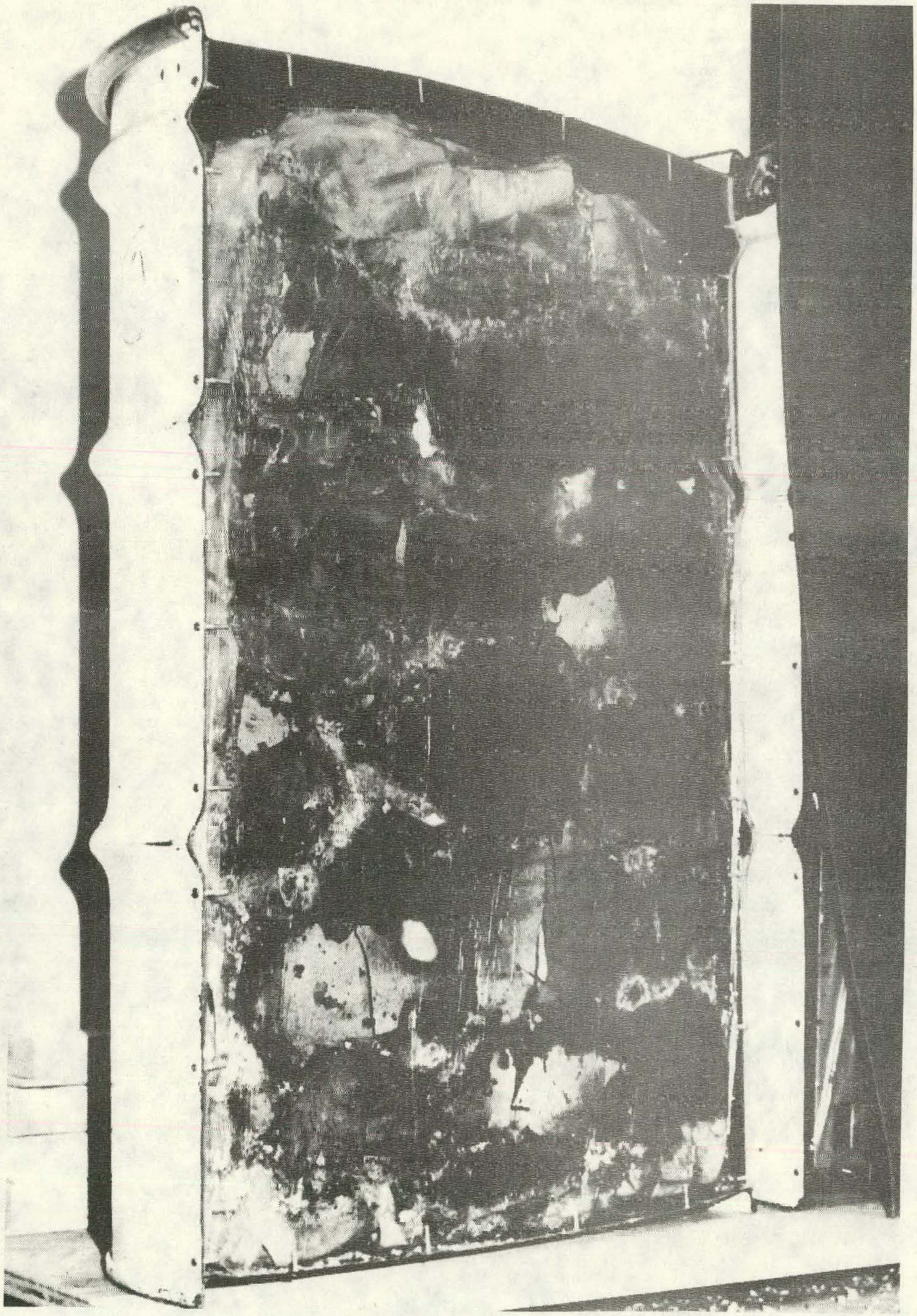

Figure 3.

IGURE 4

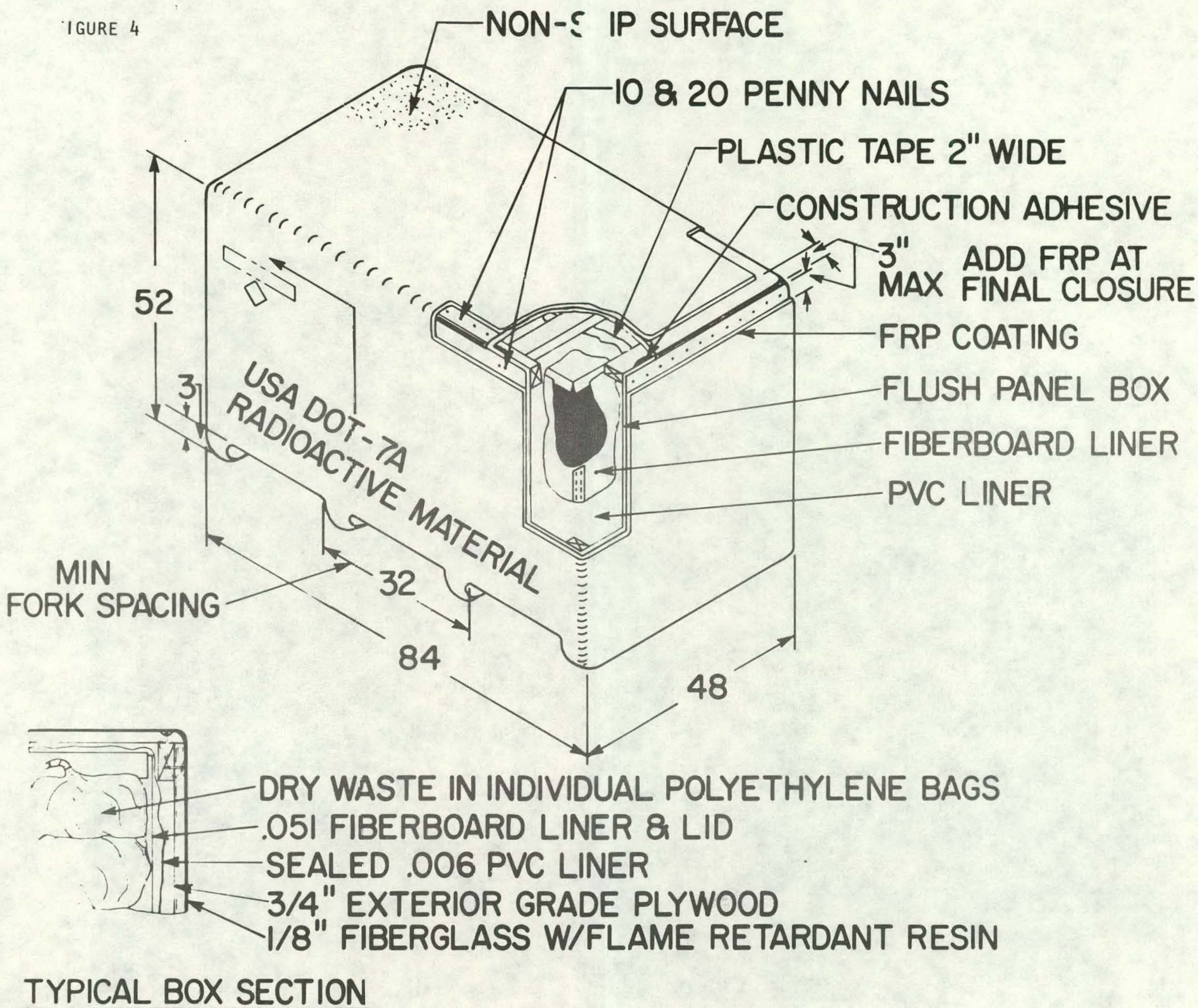

Figure 4.

Figure 5.

TRU Volume Reduction Programs

Administrative

- Bulk Purchases
- Control of Materials Entering Pu Processing Areas
- Reuse of Materials
- Formal Segregation
    - Non Retrievable
    - Retrievable
    - Combustible
    - Non-Combustible
- Personnel Education

Operational

- Compaction of Combustibles
- Size Reduction Facility
- Pressing Techniques
- Drums Versus Boxes
- Stainless Steel Tools

Figure 6.

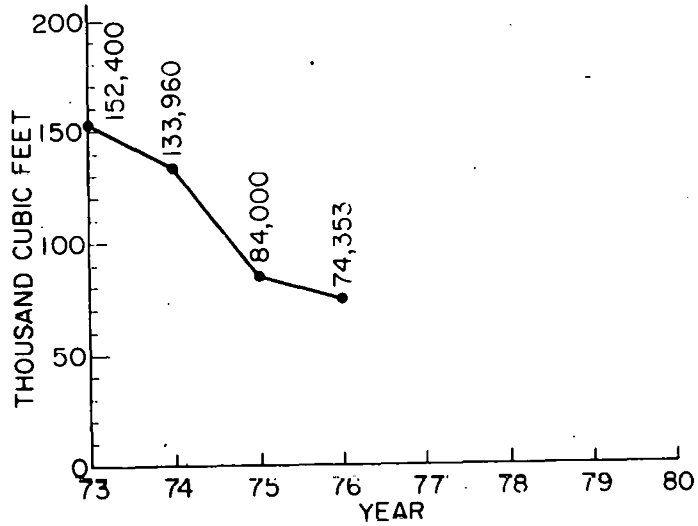

Figure 7. TRU Waste Generated At Rocky Flats

Rocky Flats does not ship any explosives nor any known pyrophoric materials. Consequently, the proposed criteria do not affect us.

It is possible that the materials used in our waste packaging could generate toxic fumes at 800°C. The potential reactions between the waste and packaging system will also require investigation. Rocky Flats also proposes using the NIOSH Toxic List as a starting point. The impact involved will also depend upon definitions and compound identifications required within the waste shipping system.

Our present waste is processed to preclude free liquids. However, our sludges may contain up to 60% water which is stabilized with Portland cement. Future processing in the new Waste Treatment Facility will reduce the water content to 5 - 10% and will also produce pellets. The main problem is dusting. We may have to develop and establish minimum and maximum water limits for each waste residue.

Thermal power density in our drums and boxes ranges from less than 0.002 watt to a maximum of 0.44 watt per drum, 0.77 watt per box, or 0.073 watt per cubic foot. Since SP 5948 is a Rocky Flats shipping permit, the proposed criticality limits indicated will not impact Rocky Flats.

Our present stabilization capability consists of cementing only. R&D is presently developing vitrification capability for the ash produced by the Fluid Bed Incinerator. The impact proposed by the Stabilization criteria would necessitate the addition of cementing capability in our new Recovery Facility. Obviously, vitrification facilities would also be required. Rocky Flats is suggesting that pelletizing and/or vitrification be considered over cementing to reduce the overall weight. The proposed stabilization criteria will require technological development for a variety of residues generated by operations at Rocky Flats.

We are concerned that our FRP-coated box may exceed the percent of allowable combustibles. The FRP-coated boxes presently cost us $350/box. Last year, Rocky Flats shipped 480 boxes. At a cost differential of $150/box between wood versus metal, an additional cost of $72,000 would have been incurred by Rocky Flats. The major impact for the waste container is additional costs.

We see no problems with the Waste Packaging System except for the proposed content of the records. We color-code combustibles with a green triangle and lead-lined drums with purple squares. No impact is anticipated if the color coding is kept reasonable.

The cost of laboratory work required to complete the suggested records may be prohibitive. The determination of all actinides present would be very difficult, expensive, and the accuracy in doubt. The waste processing history must be kept simple and limited to a sentence or two. Reconciliation of the requirements is in order to balance the laboratory expenditures.

To summarize the most significant items which will impact Rocky Flats -- we are concerned with the allowable organics and carbon content; the acceptability of our FRP-coated boxes and plastic liners; the addition of cementing and vitrification facilities and the development of the necessary technology to operate them; added cost of metal boxes; and the added laboratory costs for records.

These four items, processing of discarded equipment, assigning actinide values to discarded equipment, contaminated soils, and D/D considerations are not addressed in the criteria, but are very important to us. These items need to be included in any future criteria.

X

RADIOLYSIS

Al Zerwekh, LASL
Ned Bibler, SRL (p. 82)

To begin with, each of us sees a typical waste composition a little differently, but a reasonable approach seems to be to look at a cross-section of waste generated by various operations. Also, what you call organics I will sometimes refer to as hydrogenous wastes because that's the term we normally use.

Clearly, gas emission will occur when there's an outlet backed ( ) by hydrogenous materials. The gas mix will generally include hydrogen, carbon monoxide, carbon dioxide, and methane. There can be some longer-chain hydrocarbons up to mass 6 feet ( ), especially if the temperature has been elevated above room temperature, which is a nominal 20°C.

We've measured the greater ( ) gap on at various levels of Pu238 contamination in the laboratory, using 300-cubic-centimeter stainless-steel cylinders to contain the standard . Gas cannot escape from these cylinders unless we choose to remove it. Ordinarily we sample even if the pressure is 16 psig. We pressurized one cylinder repeatedly to 100 psig before sampling it, because we wanted to see what happened at higher pressures. We have no containers likely to contain 100 psig; 16 should be more than enough. Rates of pressurization have varied from about 500 to 5000 pascals, which is like 7/100ths to 7/10ths of the psi per day. The quantity of gas that will form depends on the identity, the quantity, the physical form, and the distribution of the contaminant on the high- matrix as well as the identity and quantity of the matrix itself. For example, cellulosics--polyethylene--will generate gas more rapidly than other waste components.

Let me give you some comparisons between total gas generation and hydrogen generation. Low-density polyethylene, such as you find in bags, is the bad actor of course. , , hydrocarbon, , CH_2 are all these, so you get a lot of hydrogen from it. Water-soaked cellulose will generate gas at about twice the rate of dry cellulosics. Also, the rate of gas formation increases with temperature. It is a little hard to understand why alpha radiation should be affected by temperature; I think it has something to do with recombination, but increased temperature clearly influences the rate. For solid materials, the rate gradually decreases with time because the effective contact between the TRU and the hydrolysis matrix decreases as the matrix decomposes. You can shake one of these cylinders thoroughly and increase the rate rather rapidly, whereas the rate decreases as the cylinder remains undisturbed. Obviously such disturbance is unlikely if the container is in storage, but it certainly could happen during transportation.

Our laboratory experiments used matrices contaminated far beyond what is expected in TRU waste. We were hoping to establish several points on a straight-line curve so we could extrapolate a direction from the end of that curve and therefore could predict gas formation in any contamination situation. The thing that we did not know was that the rate appears to be dose-rate dependent, so our extrapolations didn't work out as planned. We had to actually look at contamination in the levels where we expect to be working.

LASL has a special category of Pu238-contaminated waste which is stored in concrete casks. Each cask contains two 30-gallon mild steel drums, and each drum may contain up to 20 grams of Pu238. A four-inch copper tube is connected to one of the drums. There is also a thermocouple inside the drum, and another centered on the drum. There is a thermocouple under the cask, and then there are copper tubes that sample the air in both casks. We can also sample the in the cask.

We usually array 20 of these in a cell, then a dirt barrier, and another 20. We use crushed volcanic ash. Four of these casks have been sampled and we have pressure gages on them. We have never seen one of these drums pressurize. We also periodically sample the gas in the drums. There are about 300 of these drums in storage. I picked one that has a high Pu content of 10 to 30 grams. We can sample the gas from inside or outside the drum, inside the cask, and from the headspace around the drums. A sheet of corrugated metal is placed over them and the ditch is backfilled to a minimum of one meter of earth; the metal sheet is mounted so that any surface water will run off. Penetration is like 11 inches. Our average rainfall is quite low; perhaps 12 inches a year. Surface water penetrations can be as much as about 11 inches, but then it starts to transpire and as evaporation starts, water comes back up into the air. Our wintertime precipitation in particular is very low. We have an ideal situation here for storage because the average moisture in this tuff of volcanic ash is 3% or less, so there's pretty good isolation. These are all considered to be in interim storage; the casks can be recovered, and there is equipment to pick them up. They weigh about 2500 lbs.

We also monitor temperature inside and outside the drums and under the casks. We have data on some of the sampling. After 64 days one drum, which contains a multiple mixture, shows that the hydrogen is up 15%, while the oxygen is down to 70, so that the mix is no longer explodable. The rate varies according to the amount of TRU, how it is distributed, what the matrix is, etc. Another one took 200 days to get up to an explodable mixture of 9% hydrogen and 40% oxygen. We have not sampled this one lately, but I am sure that the hydrogen will continue to rise and the oxygen to come down so that the mixture will no longer be explodable. After completing % of the tests, we have proof that if hydrogen content is 6 mole percent or above in the mixture, it is not explodable, but if the mole percentages of hydrogen and oxygen are approximately equal, the mixtures are explodable. One contains 8.7% hydrogen and 10.7% oxygen, meaning that it was explodable. In solid trash we found that 9% hydrogen and 6% oxygen was not explodable. We tested the solid trash on several of these and found that 10.2 was explodable but 15.7 was not. About 27% hydrogen and only 8.8% oxygen was not explodable. If that 8.8% had been 10% or slightly higher, the mixture would be explodable. So you certainly can achieve an explosive mixture in these drums. It is not clear what will start this process in this way and in this sort of container. It is also not clear that you're going to get a serious explosion anyway, although it would certainly shake things around. The reason that we're not terribly concerned is that we've sampled many drums and I have yet to see it happening with gas. The gas comes out cold. In the lab, this gas is sampled through a filter, but then I opened up the line and checked the connection behind the filter, and did not find an explosive mixture. Our recommendations are that this kind of material in this kind of container is perfectly safe.

We've also studied synthesizing waste because there was some concern about whether concentrations would produce serious gram levels of contamination. We've let these go for 400 days before we checked the gaseous contents of a multi-contaminated cylinder. There was no gas pressure so we pumped the gas out of the cylinder so we could look inside with a mass spectrometer. There was .6% hydrogen; there was no measurable amount of methane -- we can't measure below .1 mole percent; there was still 14.8% oxygen, and essentially all the nitrogen from the air was still there. Clearly there was nothing here that could explode.

We took apart some of this waste that had been in storage for a while. We examined the contents of one cylinder at the beginning of the tests and found that rags and paper had deteriorated most, as is typical. The neoprene cellulosics had typically degraded to a low-density particulate that is highly contaminated and usually airborne, although some of it falls out in a kind of brown powder. This material is highly combustible; if you burn it, almost no ash is left. This is going to be important in handling or transporting waste because these cans have to be opened under very carefully controlled conditions.

We believe that hydrogen should be allowed to escape readily from waste storage drums by employing standard drum seals. Gases diffuse through them, but particulate matter stays in the container. We have shown that our escape gases are always uncontaminated. Other LASL data show that hydrogen diffuses through plastics or concrete gaps very quickly.

We've been surveying waste drums in interim storage for over a year, and we have found that the average Pu239 content is between 7 and 8 grams, with a high value of about 100 grams. From the data we've studied, that appears to be an average high. Savannah River figures made available to me indicate that their averages are about 15 to 18 grams, and their high is also around 100 grams. They usually mark their 100-gram drums with red bands. The one third and two thirds nitrogen in these drums when stacked side by side in array was well within safe parameters as far as nuclear safety is concerned.

You will not get significant gas generation when you're putting away drums with this sort of contents. Someone talked yesterday about a 15-gram drum developing 1.5 liters per year, and I think that figure is for 100 years, not one year. At these levels of contamination, hydrogen generation is not significant in interim storage nor in near-term ABC ( ) storage. Gas samples from closed storage cells at LASL have shown a composition which was essentially equal to or less than half a mole percent of C0, $C0_2$, and no detectable hydrogen. Samples taken at INEL from the closed ITSA pads also failed to show the presence of hydrogen. For longer-term storage considerations, we must test hydrogen diffusion through bedded salt. From salt experiments I have seen, I am convinced that you cannot hold hydrogen in salt, but whether it will diffuse through bedded salt that has never been disturbed, I don't know. If we determine that the hydrogen does not diffuse, or accumulates in pockets, then we must evaluate the risk of such accumulations several hundreds of feet below the surface, as well as the risk involved if some part of those accumulations should vent to the surface. Clearly you can plug the holes, but the plugs must be able to withstand the pressures that will develop. It is certainly conceivable that a quick venting could mechanically carry a particular pattern (   ) although we certainly would have difficulty venting it all the way to the surface. I think drilling into such a gas pocket is a definite risk; it has happened many times in the U. S. with methane in drilling for oil; it is something that is anticipated, and is not a problem that cannot be dealt with. I suspect that hydrogen accumulations would fall in the same category.

In the first cell that we closed up, we think we can sample it because it has leaks, but we can't look at it. In our second one we have a manhole we can look through. There are 64 drums there, and we have various ones under test for various coatings we've used. Because if you close up air underground, so that you have an air-filled cell, the air comes close to the saturation point. Our facility runs 80 to 90% relative humidity, so there is a real problem there. You can pump this down to less than 30%, but in a week or less, moisture from the soil saturates the air again and your are back up to 80 to 90% RH.

We think that in the near term, there is no problem at present contamination levels of TRU waste, but for the longer term, we don't know because we have no data on hydrogen diffusion in bedded undisturbed salt.

X

RADIOLYSIS

Same title as previous paper

Ned Bibler, Savannah River Laboratory

I'll summarize some radiolysis experiments and then talk about cellulosics, and close with what I've done with alpha waste in concrete.

The reason for my work was to report on and evaluate radiolytic gas production from our waste, and also to try to determine what to do with our HLW fission-product volumes.

Very little of what I am about to say has been published.

Using curium 244 as an alpha source and cobalt 60 as a gamma source, we have irradiated glass containing simulated fission product sources. This will be available soon, and I'll be glad to give it to anyone. The BP numbers are 1459, 1464, and a little of it is available in BPMS 7651.

I used curium 244 because it was available to me; its results would be identical to those obtained with Pu 238 or Pu 239. You have to use various levels of these isotopes to achieve the same doses, but the results would be identical unless there's a typical interaction with the alpha source, which would be the matrix you're involved with; however the Pu 238 level is so low that any interaction is going to be chemically negligible anyway.

A major factor in cellulosics work is the volumes produced at constant pressure simply with mercury phenomena. If it were done in the glove box I would take a curium 244 solution of known activity and put it on the cellulosic material and simple laboratory tissues. I'd allow it to dry overnight, and the next morning foam that material so that hopefully all the curium is within the cellulose, and then put it in little flasks and measure the pressure generated. The purpose is to measure volume related to constant pressure.

To add to the experiment, we have sampled the gas, removed the sampler from the glove box, and analyzed the gas in the cellulose. Figure 1 shows typical results; they have generated a constant pressure, time is in hours, and there is lots of curium 244: 2.3 milligrams in this experiment. All I did was to measure the gas produced initially, one day after I put it in the cellulose, and 17 days later I closed it up and measured it again. The G value was 1.9.82; I'll show how I calculated those numbers in the next slide. These are the numbers I used to estimated possible pressures in the drums. Gas composition was primarily hydrogen, a lesser amount of CO_2, and a still smaller amount of carbon monoxide. I calculated the G lines by multiplying the slope of the line times the factors in the ideal gas law, the dose strength; I know the amount of curium present; all the alpha was absorbed, possibly to G values. This shows that the G value does decrease with dose. Al Zerwekh said that if he didn't shake the container to cause the cellulosic material to get down to the bottom, the pressure ascension rate decreased. It looks as if it levels off; I haven't done enough experiments at larger doses to determine whether it really does.

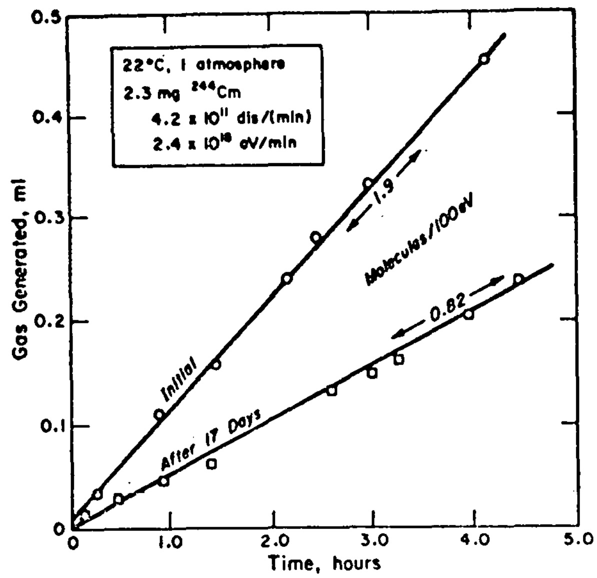

Figure 1. Gas Production from Alpha-Radiolysis of Cellulosic Material

So I took a G value of 1.9 or 2, and asked what pressure would be generated in the drum. But it's simply a rearrangement now of the ideal gas law. The dose rate used to calculate the amount of plutonium in the drum is specific activity (???) in this calculation, assuming that all alphas are in intimate contact with cellulosic material. In application of course this is probably not true.

In Figure 2 is the calculation of pressure in the drum as a function of time per curie of Pu 238, Pu 239, with two lines that I've referred to before because of the cans of Pu 238. Ten years, five pounds; we've never seen any drums with this type of pressure that leaked. In this calculation I assume that the G value does not decrease with time or dose. With explosives we have found that it does. In flasks I've given a slow burn to several cellulose with and without exposure to curium to show physical damage from alpha radiation. This emphasizes Zerwekh's point that if you open a drum, the material will fly everywhere, so great care must be used.

My research on concrete resulted from the fact that at Savannah River we were evaluating two matrices into which we could put our fission product sludges. This is HLW in concrete and glass, and we needed to know the pressure in both if we put them in stainless steel containers.

I used a high-alumina cement, not a typical Portland cement. Other studies have shown that high-alumina cement gives the lowest leach rate for Sr90 and Ce137. The sludges were the grout. The composition is about 60 grams of cement and 40 grams of sludge, with iron oxide, manganese oxide, or specially prepared hydrous oxide   to simulate our sludges. You mix this with the dry cement material and add enough water to get a paste with a lot of set. The setting occurs in a glovebox. The water solution contains curium. I placed the mix in a steel tube and allowed it to set about 20 hours. After a certain amount of time I took the tube out of the glovebox, sampled the gas, and analyzed it by gas chromatography. Figure 3 shows the pressure guides. The cement actually should be called concrete because it contains iron or manganese. The different slopes in the figure result from different levels of curium in the mix. The ones with the tubes have the same levels of curium, and slope differences result primarily from differences in volume in the two systems because I had to deal with the volume of the pressure gauge.

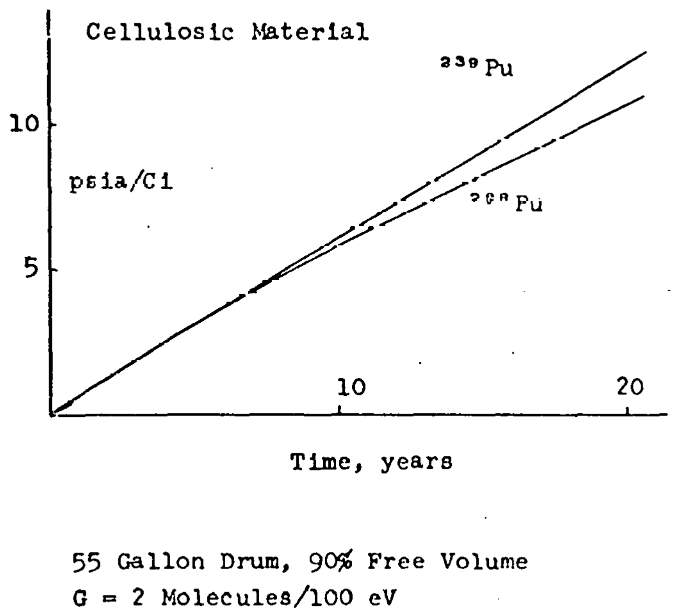

Figure 2. Pressure Increase from α-Radiolysis of Nuclear Waste

Figure 3. Alpha Radiolysis of Concrete and SRP Simulated Waste

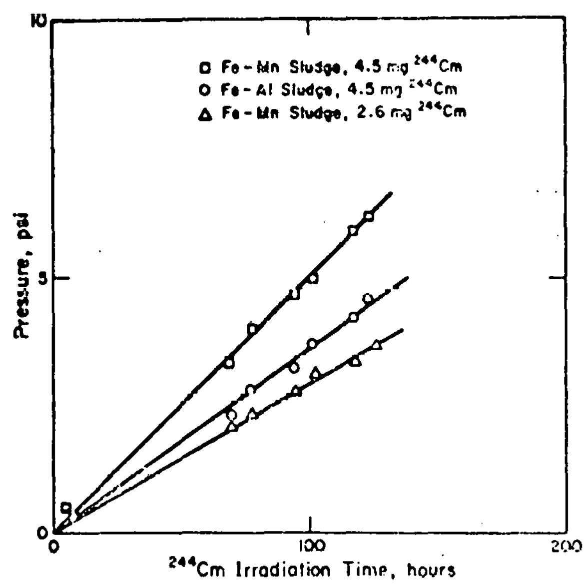

Figure 4 shows one that we allowed to go all the way to 200 pounds; that is as high as we have let any of them go. To do this of course you have to have special safety factors, but it can be done. This is a much higher dose rate. I can't compare this rate to the dose rate in drums containing plutonium. We've done one at a much lower dose rate where we followed it for something like 3000 hours and it got up to 100 pounds. It increased in linearity only by about 10% of 200 pounds. We vented that and analyzed the gas.

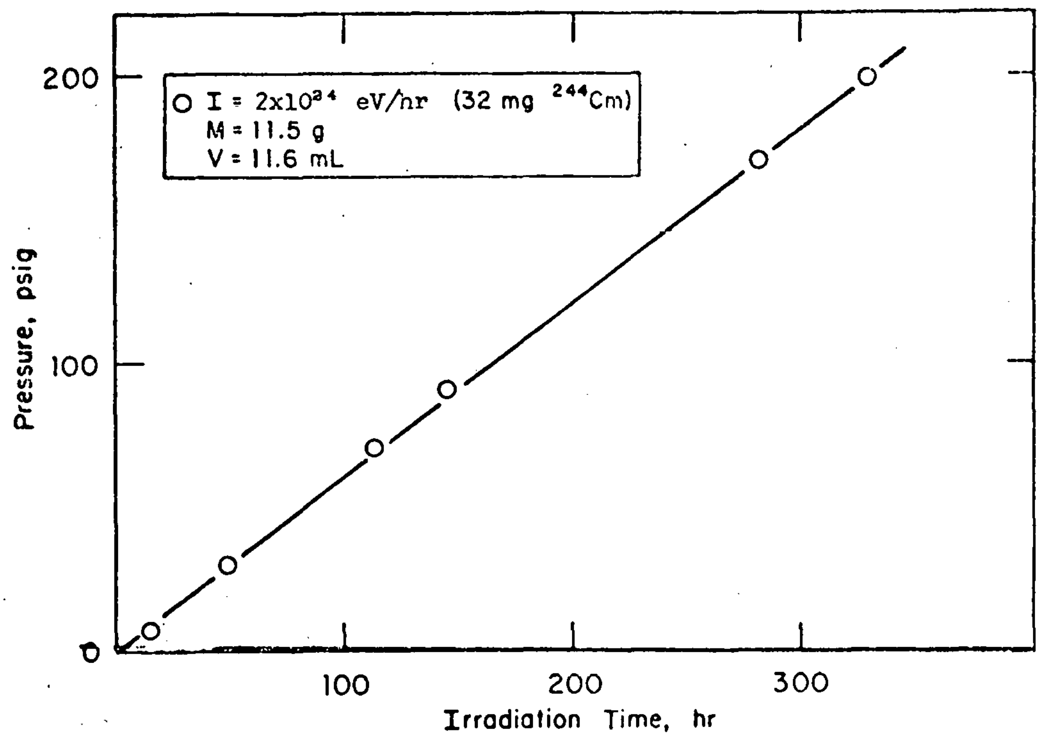

Figure 4. Gas From α-Radiolysis of Concrete

Gas composition in these experiments was stoichiometric amounts of hydrogen and oxygen. The ratio varied from 2 to 1, which would be the stoichiometric amounts of hydrogen and oxygen, and 2 to .5. In some cases we had less than stoichiometric amounts of oxygen. With the one that we allowed to go to 3000 hours we closed it back up and the pressure followed the same line, indicating no effective dose in that experiment.

Before I try to apply this to waste storage I want to give you some typical reactions. In the concrete matrix, which is calcium, aluminum, iron oxide and sodium in the outside framework, plus water, alpha particles interact with the electrons in the water plus ionized. The ionization gives you an electron, just as would happen in a mass spectrometer. In a mass spectrometer it has been observed that the H_2O+ reacts on every collision with H_2O that hydroxyl radical. Of course there is now an electron floating around in there, migrating onto that surface; it wants to become thermodynamically stable. So if the reaction yields the hydronium ion, it gives hydrogen and the net result will be the hydrogen atom and the hydroxyl radical. These are unstable and look for something to react to. I could envision them forming intermediates with the outside matrix; for example, the hydrogen atom latching onto the electrons in the oxygen in the matrix to satisfy itself, but that is still not thermodynamically stable. The two logical combination reactions if they happen to bump into each other will give hydrogen and hydrogen peroxide, plus H and O equals water. We have found evidence for an oxidizing species in our concrete with gamma radiolysis. We treated it with ferrocyanide solution and also with iodine and found that the were oxidized as species. We cannot conclusively say that it is hydrogen peroxide.

As pressure increases, the hydrogen peroxide concentration increases. They can interact with the radical to give you another radical in return. You can hypothesize that there will be a few hydrogen peroxide radicals to give you oxygen. These reactions are all based on many, many studies of radiolysis of liquid water. It looks as if we've solidified the water by putting in the hydration basis of the concrete. With gamma radiolysis the pressure increases, but reaches an equilibrium which is dependent on dose rate. The reason it reaches equilibrium is that reaction with the hydroxyl radical plus hydrogen. This is why very little hydrogen is given off in reactors. The hydrogen remains in the water and reacts to give an equilibrium pressure. With the alpha particles we ran a nice straight line all the way to 200 pounds. I don't know how time has to go, or even whether we ever would reach equilibrium. The difference of course is that with gamma radiolysis the intermediates would form much farther apart. With alpha radiolysis you can envision attracting , so that these would all fall very close together.

Let's see now what happens when we put it in the drum. Again I used the G value. This is just a review of the calculations, calculated to be attained by the number of moles in the ideal gas law and the pressure change, and of course dose rate times the amount of curium, times specific activity, times the energy of the alpha. The alpha has a range of the order of 10 microns in this concrete material. Figure 5 shows the results: the dose rate range and the highest dose. If you are talking about 10^4 or 10^5 years of storage, you get pretty high dosage from the decay of Pu 239; the reason I put the highest dose on here is because I see no effect up to that dose. The G value for the high alumina cement is .2 and .1.

I have also looked at Portland cement containing perlite, with a higher G value, so it obviously depends on the composition of the cement.

Figure 6 shows pressure as a function of time in a 55-gallon drum containing 200 grams of Pu 239. I don't know of anybody who has drums containing 200 grams of Pu 239 in concrete. This is calculated; the assumption is a G value for total gas production of .3, I put 5% free board in here, and I assume the concrete was 10% porous, so that gave me the volume in the drum. If you want to get 100 grams out of this, you divide by 2. I have assumed no pressure or dose dependence, but after 30 years you can tell that you had 200 grams with a pressure of 100 lbs.

Dose Rate Range (eV/hr) $5.3 \times 10^{19} - 2.0 \times 10^{21}$

Highest Dose (eV) 2.3×10^{24} (244 Days Irradiation)

Concrete	$G(H_2)$	$G(O_2)$
High Alumina	0.2	0.1
Portland-Perlite	0.6	-

Figure 5. G-Value for Gas From α-Radiolysis of Concrete

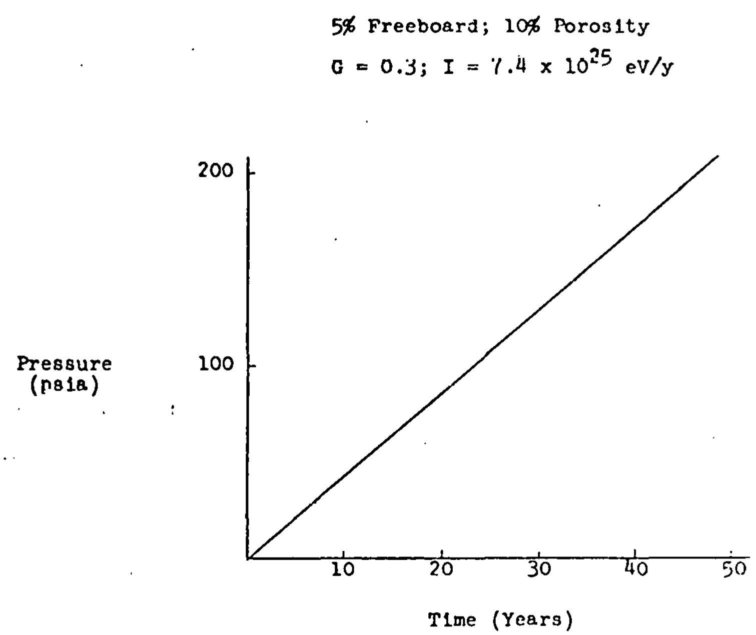

Figure 6. Pressurization in Drum Containing 200 g ^{239}Pu in Concrete

If you want to calculate the pressure you have to know the volume of the cell or the volume of the cabinet. Let me stress that I've assumed no effect of pressure on that G value, nor any effect of dose or amount of water. If there are no other sources of water, with this dose how many moles of gas and how much water is available? The calculation indicates you will run out of water. I don't know what happens if you run out of water. This is how I did the calculation: there's about 6000 moles of water available in the 55-gallon drum. The concrete is 1.7 grams per cubic centimeter; that can vary, of course. The water-to-cement ratio is .3; I assume that this matrix is 30% water, which is a reasonable number; it may be as low as 20 or as high as 50. So if you multiply 6 times 10^3, you run out of water after about 50,000 years. I haven't gone to doses that high. My highest dose was 10^{23} E.D. or something like that. One year is 10^{27} in this instance.

So what happens to concrete when you run out of water; do you go back to the cement as dust again, or what? In all of this I assume that the G value is constant. Other factors affect it also; the composition of the concrete, the gas pressure, etc. I've seen no gas pressure so far except in the experiment where I went to 200 pounds and the pressure decreased linearly by 10%. I don't know whether that was due to pressure or to volume change in the gauge, or what; this has to be studied further if you want to be able to say that in the 10^4 or 10^5 year, hydrogen pressure in that cavern will be such and such.

Also remember that, as Zerwekh said in regard to cellulosics, there is a dose-rate effect, but at the levels of plutonium in present-day drums, the hydrogen generation range is very much lower than it would be if it were based solely on energy; it implies that the efficiency of gas production decreases as dose rate decreases. This will have to be proven. I haven't seen it yet with concrete, but if you want to use these numbers you will have to do this, and the dose.

All right, what happens when you run out of water? We haven't gone to such high doses. Certainly there is a dose effect in cellulose. I haven't seen it yet in concrete, but on a much longer scale, doses are negligible compared to 10^3 or 10^4 years. I haven't seen any effect caused by the amount of water available in the concretes that I have made. I have seen the effect of organics on vermiculite; the less organics, the less gas; but I haven't seen that in concrete.

If hydrogen generation is the problem, what can be done about it? Is there any way to stop it? I have done no experiments to attempt to lower the hydrogen yield in my alpha radiolysis. Remember that my concretes were sealed in steel. We did the same thing with the gamma. If you heat that concrete in an oven at 100° overnight, you'll lose a little water, and you'll still get hydrogen, but the yield is much lower. The same may be true without alpha, but I haven't tried it. With a high-alumina cement, which is refractory, you would think that it was a much more terminally stable cement, with probably less water, and less hydrogen. Of course if you really want to assure yourself that you will never get hydrogen, take the water out.

Discussion

Q. Some of your results on concrete are disturbing. What kind of work do you think is necessary before you would recommend whether or not concrete should be used as a waste form?

A. I don't want to make any recommendation at all. There's probably a matrix you can put in that's more stable than the concrete and the form that I used. I don't think you can create a getter or anything, and I don't think you will ever get to the point that the radiology of the air or the hydrogen won't re-form water and decrease the pressure, simply because all the alpha will radiate the air.

Q. At Savannah River are you going to the glass or the concrete for high level waste?

A. I don't know whether a formal decision has been made or not.

Comment. No formal decision has been made but we are aiming at some R&D. We feel that work is necessary in glass for HLW.

Speaker: There's not enough data right now for somebody to recommend that you don't use concrete. One of the important experiments will involve what happens to the hydrogen.

Q. What happens to the hydrogen in the moderator or the reactor liquid water?

A. I have irradiated water in out cobalt-60 facility. When you radiate distilled water or water containing inert chemicals what happens to hydrogen? You generate intermediates which diligently search for something to react with. If hydrogen is there it can react with the intermediates. You reach a point where the concentration of hydrogen in the liquid water may be 10^{-4} or more, but the reason that it reacts more than anything else is because there's nothing else in the water than can react. I've put water in our cobalt-60 source at 10^{7} rads per hour and got an equilibrium pressure no higher than two pounds. The same with concrete under gamma radiology.

Q. Are there other chemical reactants--physical sorts of mechanisms--that you envision as a means of keeping the pressure down in an impure vault?

Comment: There are two kinds of water in concrete, free water and water of hydration. Hydration waters have less hydrogen than free water. This is the primary reason for the heating of concrete under gamma radiology.

Comment: There has been some work done at Oak Ridge checking out calcium oxide as a gas getter, and it did reduce the pressurization from thermal degradation. There is some potential that some chemical compound may be able to react to gases, but more work needs to be done.

Speaker: The back reaction is the one you want to cause to occur as rapidly as you can. The appropriate multi oxidation-state metals like nickel, iron cobalt, etc. were pinned (???) to cause the back reaction, (hydrogen going to water) to be enhanced drastically. If you put in the right catalyst you can cause the back reaction to be so much faster than the polar direction that you probably won't generate much hydrogen. You just recycle your water.

Discussion

Q. I guess your work, or at least some element of it, if carried to the conclusions you'd like, somewhat depends upon having clarification about what happens within 1978 on how many transportation issues arise?

A. (inaudible)

Q. Inaudible

Speaker: In the course of a fairly decent program budget review of several of the major sites, invariably the question came up about D&D activities. In the first instance, there is a lot of confusion about where the responsibility within the agency resided. It's clarified at the moment, but in a way that I can't believe will stand up for very long. ECP currently has the responsibility on D&D R&D work. There is a general understanding on how one would proceed in terms of any actual D&D projects associated with major facilities, but is a little unclear just where responsibility resides in terms of the implementation of authorized projects when funding is obtained. I think a number of things could influence the time table on which you could see the agency moving out on some major D&D effort. I don't want to leave the impression that there is anything specific that provides insight, but we know the climate and it wouldn't be any surprise to see some current events that would push us into a rather concerted effort on the D&D areas. So I think it is an expansion in our plan that we have to take into account, and hopefully before too long some better specificity of clarification would be brought to bear on how that plan could proceed. We will be getting major clarification at such time as the future of the agency shakes down and as management of these activities firms up a little more clearly. I wouldn't think that those there today are prepared to take any major decisions about commitment of major resources for D&D in the prevailing climate.

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STATUS OF ERDA TRU WASTE PACKAGING STUDY

Jay W. Doty, Jr., Mound Laboratory

I would like to present to you the Status of the ERDA TRU WASTE PACKAGING STUDY, currently being conducted at Mound Laboratory.

Beginning in FY-1977, MRC initiated an ERDA Waste Program entitled, "TRU WASTE CYCLONE DRUM INCINERATOR AND TREATMENT SYSTEM," that combines three distinct tasks:

TASK No. 1 - Cyclone Incinerator Development

TASK No. 2 - Immobilization Methods and the Determination of Criteria for Judging Acceptability of Solidified TRU Waste.

TASK No. 3 - Acceptable TRU Packaging for Interim Storage and Terminal Isolation, the status of which we will discuss today.

The key objective of ERDA Manual Chapter 0511 is the responsible technical management of its radioactive wastes. However, the pressures exerted by negative public opinion; the lack of cooperation from elected officals; the imposition of constraints by both federal and local protection agencies; the requirements imposed by DOT; and the impediments imposed by railroads and truckers, definitely place TRU Waste Packaging near the top of an effective waste management priority list.

To begin activity on TASK 3 a data collection and review phase was initiated to insure that the Project Team got all available information. An immediate review of appropriate ERDAM's and DOT regulations was made. Concurrent with this effort, MRC reviewed the ERDA FY-1976 contractor site plans at Mound Laboratory and at ERDA Headquarters. A complete literature search was also made, utilizing computer techniques at the University of Dayton and Mound Laboratory. Over 2000 references were found in the survey; however, only about 250 references were found to be useful in this particular task project. To gather still additional information, a contractor questionnaire was prepared, reviewed, and revised by the Project Team, and then transmitted to appropriate operation offices and contractors by the ERDA/ALO operations office.

In any information gathering effort, not all the information provided is completely usable; therefore, site visits are planned to investigate the questionnaire data and significant contractor concerns so that a unified contractor consensus on waste packaging can be achieved.

At the time of preparation for this presentation, the following contractors had returned their questionnaires to MRC: Atlantic Richfield Hanford, Atomics International, EG&G, LBL, LLL, LASL, Mound, and Rockwell International. During the last few weeks, information has been received at MRC from the Chicago Operations Office and Oak Ridge Operations Office; however, due to the timing of this meeting, the data could not be abstracted and incorporated into the information that will be presented today.

This list of contractors represents approximately 60% of the contractors solicited, and the data which will follow in the presentation is for the FY-1976 and 1976A waste generation period.

The TRU WASTE volume varies significantly between contractor sites as illustrated in Figure 1. Plotting the waste volume generated in 1000 cubic feet versus the site generators we can see that Rocky Flats has generated approximately 89,000 cu. ft. during FY-1976 and FY-1976A, while ARCHO generated approximately 54,000 cu. ft., Mound 13,000 cu. ft., LASL 12,000 cu. ft., LLL 2,500 cu. ft. and the other sites (LBL, AI and EG&G) approximately 600 cu. ft.

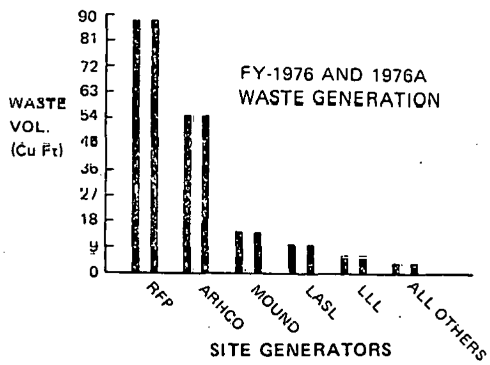

Figure 1. TRU Waste Volume Varies Significantly Between Contractor Sites

The major isotope being generated in the ERDA TRU Waste is plutonium-239, with heat source plutonium-238 the second major contributor. The other isotopes (in trace quantities), that must be reported as required per ERDAM 0511, include Plutonium 240, 241, and 242, Curium 244, Californium 252, Berkelium 249, Uranium 233, and Americium 241.

Also of importance to note at this time is that to date in the low level TRU waste, no explosive materials and pyrotechnics were reported. One contractor did however report some toxic material contained in their TRU waste.

Of the total TRU waste generated, only 20% represents combustible waste (22,600 cu. ft. out of the 169,000 cu. ft. generated by the eight reporting contractors.) Also, of the total TRU waste generated, only 0.5% requires shielding--only 880 cu. ft. of the total volume generated. This indicates that the data to date supports the fact that the intermediate level TRU waste generated during FY-1976 and 1976A is extremely small in volume.

The transportation of low-level TRU waste is heavily dependent on the ATMX railcar; 104,000 cubic feet of waste generated during FY-1976, 1976A was shipped by that means. Waste shipment by supertiger during the same period amounted to only 3000 cubic feet.

Of the total TRU waste generated during FY-1976, 1976A by the eight reporting contractors, 62% of the waste was stored at INEL. About 104,000 cubic feet was stored at INEL, approximately 3000 cubic feet was stored after shipping at the Nevada Test Site, and approximately 62,000 cubic feet was stored onsite. One interesting but very important observation from the data was the large amount of waste stored on site. An immediate question becomes quite apparent. "If this on site stored waste had to be shipped during the FY-1976, 1976A period, could the present transport systems accommodate the increase in volume?" The answer to this question will be discussed with you later in the presentation.

Seventy-seven percent of the TRU waste is currently packaged in a box geometry. It is interesting to note that of the total 55-gallon drums (37,600 cubic feet) approximately 50% of that volume (18,500 cubic feet) represents a DOT 17C with a High Density Polyethylene (HDPE) liner, while approximately 9,000 cubic feet represent a DOT 17C drum without a liner. The remaining 55-gallon drums are only DOT 17H type drums.

The FRP box contains a large quantity of TRU waste by volume (126,800 cu. ft.) and if this package (the FRP box) does not meet the WIPP criteria, then a costly repackaging operation at storage sites (such as INEL) is a certain reality. Steel boxes, such as the 4' x 5' x 6' Argonne box are also used in the packaging of TRU waste. Other waste containment systems contain, for example, corrugated metal pipes containing cemented wastes. These CMP's are 2-1/2 feet in diameter and 20 feet in length.

The FY76-76A TRU Waste Breakdown looks like this: Equipment 79,000 cubic feet, Glovebox/Laboratory 54,000 cubic feet, Combustibles (or hydrogeneous) 17,000 cubic feet, Dry Sludges 8,000 cubic feet, Absorbed Liquids 6000 cubic feet, Cemented wastes 4,500 cubic feet, and Others (such as contaminated Soil and miscellaneous waste types) less than 500 cubic feet. The waste type categories as shown were developed by consolidation of definitions supplied by the participating contractors. For examples of the Waste Types:

Equipment - decommissioned gloveboxes, process tanks, building rubble, metal piping.

Glovebox/Laboratory Waste - process hardware, metal, glass, asbestos, and tools.

Combustibles - paper, rags, wood, rubber gloves and tubing, plastics, etc.

The surface radiation dose rates of the TRU containers shipped as reported by the contractors to date (Figure 2), do meet the WIPP criteria in the area of Penetrating Radiation.

	MR/HR	
WASTE TYPE	AVG.	HIGHEST
EQUIPMENT	1-5	1 86
GLOVEBOX/LABORATORY	1-5	10-85
COMBUSTIBLES	1-70	10-200
DRY SLUDGES	0.5	2
ABSORBED LIQUIDS	0.5-5	1-10
CEMENTED WASTES	0.3-1	0.5-10
SHIELDED	1-10	10-2000

Figure 2. Surface Radiation Dose Rates of TRU Containers Shipped

A cursory analysis of these data suggests that both drum and box systems are desirable due to the following reasons:

Material Handling Systems in each facility

Waste Processing Systems in each facility

Present Radioactive Material Assay Systems, and Present Modes of Available Transportation Systems.

Looking at these points realistically, contractors today cannot afford the cost to revise and/or re-engineer their present facilities without sufficient budget increases.

Still to be evaluated are the trade offs among several waste management aspects:

1. Interim storage versus terminal isolation. One big question which has been previously discussed is whether the packaging containment system now utilized for surface storage environment is suitable for salt storage environment.

2. The dimensions of the packaging containers used by the referenced contractors generally meet the size limitations as specified in the present WIPP criteria. However, a very small percentage of boxes will not meet the WIPP 8' x 9' x 12' requirement, such as a 5' x 10' x 30' box which has been generated at LASL.

3. Cost of any containment system is of prime importance to waste generators. With funding and economic problems all contractors are continually faced with, cost certainly ranks high as a contractor concern.

4. The WIPP criteria - not much to comment about since that is the purpose of this working session.

5. Interim storage criteria are established at this time, but if conservative changes in criteria would be imposed, these would definitely affect the TRU packaging program.

6. The Retrievable Surface Storage Facility - Again, although no definite guidelines on this type of storage have been clarified, if this alternative becomes a realistic mode of storage, then changes in packaging criteria would be warranted.

7. And lastly, the NRC immobilization criteria. These may or may not have a bearing on the low level and intermediate level TRU wastes; however, with the Nuclear Regulatory Commission becoming more actively concerned in waste handling and storage, their ideas and feelings must be addressed and formulated regulations followed.

Evaluation of data against constraints will define an acceptable package.

Follow-up site visits will continue with the generators to completely clarify questionnaire responses and to discuss significant program concerns. Following completion of the application checklists, formulation of a basic criteria checklist, which will be used to judge the acceptability of TRU packages for both interim storage and terminal isolation, is planned. Resource material for the basic criteria checklist will include, for example: (1) ERDA Manual Chapter 0511; (2) Title 10 and Title 49 of the Federal Code of Regulations; and (3) Graziano's Tariff.

Evaluation of the application data against clearly identified constraints will provide important data leading to an acceptable TRU package. The acceptance criteria will be developed during May and June, 1977. June and July of 1977 will be devoted to identifying potential problems which may be related to specifications, transportability, retrievability, or suitable terminal storage. This effort is followed by identification of candidate packages falling within the basic application checklist and the basic criteria checklist. The data will be compiled, and a mid-program report is planned for completion by the end of FY 1977.

From information collected in our packaging studies, the immediate requirements for a safe TRU transport system compatible with the TRU package configuration were realized. Therefore, activity was also directed to investigate acceptable transportation mechanisms for shipment of the finalized TRU packaging system. A survey will be performed to determine the transportation needs of ERDA waste-generating contractors and also to determine and collect information regarding generation by waste types. Basic transport criteria will be prepared to enhance a preliminary conceptual design of new transport systems for TRU waste shipments to either interim storage or terminal isolation.

Discussion

Q. I guess your work, or at least some element of it, if carried to the conclusions you'd like, somewhat depends upon having clarification about what happens within 1978 on how many transportation issues arise?

A. (inaudible)

Q. Inaudible

Speaker: In the course of a fairly decent program budget review of several of the major sites, invariably the question came up about D&D activities. In the first instance, there is a lot of confusion about where the responsibility within the agency resided. It's clarified at the moment, but in a way that I can't believe will stand up for very long. ECP currently has the responsibility on D&D R&D work. There is a general undertstanding on how one would proceed in terms of actual D&D projects associated with major facilities, but it is a little unclear just where responsibility resides in terms of the implementation of authorized projects when funding is obtained. I think a number of things could influence the time table on which you could see the agency moving out on some major D&D effort. I don't want to leave the impression that there is anything specific that provides insight, but we know the climate and it wouldn't be any surprise to see some current events that would push us into a rather concerted effort on the D&D areas. So I think it is an expansion in our plan that we have to take into account, and hopefully before too long some better specificity or clarification would be brought to bear on how that plan could proceed. We will be getting major clarification at such time as the future of the agency shakes down and as management of these activities firms up a little more clearly. I wouldn't think that those there today are prepared to take any major decisions about commitment of major resources for D&D in the prevailing climate.

Colon

TRANSPORTATION OF TRANSURANIC WASTES: THE NEED FOR UPGRADING

Bob Lowrey, ERDA/ALO

In November 1971, a meeting was held at Oak Ridge to discuss alternatives for transporting alpha-contaminated wastes, considering the various transport methods available and the interface at the Lyons, Kansas, salt mine. The fact that acquisition and construction of the salt mine had been delayed gave additional time to study handling and transportation methods. First I will address the need for a study to identify the optimum system for transporting TRU wastes, and than I will summarize historical events.

Simply stated, a transport system study considering handling, packaging, overpacks, and transport schemes is necessary so that we can evaluate the adequacy of existing methods; identify the optimum system based on safety, efficiency, and economics; assure compatibility with the storage and disposal criteria; and assure compliance with regulatory requirements. To support the need for such a study, I will review some of the questions, concerns, and problem areas in the transportation of transuranic wastes; review previous and current efforts; then outline a generic approach.

For the various WIPP operating modes considered for accepting TRU wastes, my calculations indicate that since there is not enough hardware in service today to handle the volumes expected, a significant capital outlay will be required. Therefore, it makes a lot of sense to carefully determine the optimum system before committing the expenditures.

Factors Indicating the Need for a Study

The current operational mode at the WIPP is to work off the backlog of TRU waste in storage, and concurrently accept newly packaged waste from waste generators. ERDA estimates a generation rate of TRU waste of 250,000 $ft.^3$/year. ERDA now has 1,750,000 $ft.^3$ of TRU waste in retrievable storage. Based on acceptance of ERDA TRU waste at the WIPP, the current design basis assumes accepting 380,000 $ft.^3$ per year, based on a one-shift per day, five-day week. Even assuming all newly generated TRU wastes would be shipped directly to the repository beginning in 1983, it would take close to 27 years to work off the 3.5 million cubic feet backlog which will be in retrievable storage by 1983. Most TRU waste would require shipment in unshielded Type B overpacks. Most waste generators don't segregate out the LSA TRU waste (10nCi/gm to 100nCi/gm) which would qualify for the less-expensive transportation with exclusive-use vehicles. Of significance regarding very low activity levels is LASL's experience using the Multiple Energy Gamma Assay System (MEGAS) to segregate waste below and above 10nCi/gm. There is a positive indication that a significant volume of the so-called non-lined generated waste normally packaged as TRU waste is actually below the 10nCi/gm level. MEGAS is designed for waste suspected of alpha contamination near the 10nCi/gm level. It will measure low-density waste packaged in low-density containers down to the 1nCi/gm level.

MD and RF have used the ATMX railcar to make shipments of transuranic wastes under a DOT Special Permit initially obtained in 1969. The ATMX rail car has not been qualified as a Type B package, which is why we requested DOT approval to operate under the special permit. There are only ten ATMX rail cars modified for use as Type B waste transporters; six cars at RF and four at MD. There are a total of 14 600-series railcars and 48 500-series railcars. Most of these are in weapons related service and some aren't even in a Gondola configuration. Regarding ATMX railcars:

a. The limit is 101,300 pounds. 216 55-gallon drums can be loaded into an ATMX railcar, or 140 drums can be preloaded into two standard cargo containers which are then placed into the railcar. Twenty-four fibre-glass-coated boxes (4'X4'X7') can be loaded into the railcar.

b. AGNS conducted a study of the ATMX car system and abandoned the concept as too difficult to license.

c. On July 1, 1978, NRC will assume responsibility for regulatory approval of packages for the shipment of radioactive materials. At that time, all ERDA packages shipped via for-hire carriers by any mode must be covered by NRC certificate of approval.

d. A SARP covering 600 series ATMX railcars has recently been submitted to HQ for transmittal to the NRC for review and comment. Additional copies have been sent to the DOT for information and as backup for the existing special permit. A SARP for 500 series railcars will be submitted in June.

e. AL experience has been that ATMX railcars have proven to be an effective, economical, and safe means of transporting large quantities of waste compared with existing alternatives.

f. The cost of an ATMX railcar is estimated to be $150,000 to $200,000.

g. The limited life of a railcar is 40 years, as dictated by the AAR. We have about 20 years left on the AAR restriction.

To qualify an ATMX railcar as a Type-B equivalent container, we will try to obtain NRC approval for continued use under special permit, based on the combination of the railcar, overpacks, drums, or boxes, and liners. A problem with this approach is the reduced flexibility ERDA would have with changes in retrievable package design since there would be an interface with the NRC.

Each of the seven supertigers in service will allow shipment of 42 55-gallon drums, at a load limit of 30, 000 pounds. It would take 8 to 10 months to fabricate a supertiger at today's costs of about $70, 000. I understand the feeling in the commerical sector is that the licensing expense is so high that Type B containers are not now considered a fruitful business venture in minimal quantities, but that an order for 20 or more might provide the incentive for commercial interest.

One recurring theme in considering packaging and transportation systems for long-term storage or disposal of transuranic wastes is the economic incentive to package waste in containers for shipment in a Type B overpack that can be reused.

There is a tendency to assume that modular waste packages are preferred over the drums now used. However, for high density wastes, the volumes shipped by public carriers are weight-limited. (I mentioned earlier weight limits for supertigers and ATMX railcars.) There are several factors to consider before arriving at the desired package shape, including waste density, packaging costs, handling, transportation vehicle size, and utilization of space at the mine.

Regarding the 250, 000 ft.^{3}/year of TRU waste currently generated, a false assumption would be that existing transportation systems hardware can handle the annual volume generated. About 250, 000 (? ? ?) ft.^{3} of the waste now in storage was transported on-site to the storage facility and did not require Type B containers for shipment. Examples are transport of TRU wastes to the storage facility at LASL, RL, OR, and SR. By 1983 there will be an estimated one million cubic feet of waste transported on site to storage facilities without the use of Type B containers.

Past and Present Efforts

Frank Pittman stated in a September 1971 memo, that the systems to be used for shipment of alpha waste to the Lyon, Kansas mine would be based in part on the economics of the available alternatives. Also, the magnitude and character of the various tradeoffs that can be made force a look beyond the costs of transportation itself. Each of the alternatives will have varying impact on the economics of waste collection, segregation, storage, packaging, and handling by both the shipper and the repository staff.

The purpose of Dr. Pittman's 1971 memo was to establish an alpha waste economics study group. ORNL, MD, and HQ Transportation Branch had examined some of the economic factors; however, no one had made a synthesis. The group was established with representatives from RFP, MD, AL, INC, ID, OR, ORNL, and HQ-WMT. A meeting was held, which I referred to in my opening remarks, and an economics study compiled by Dow Chemical Co., RFP, was distributed in January 1972, by Bill Brobst, Chief, Transportation Branch, DWMT. An optimum transportation system was not identified because the proposed repository in Kansas was abandoned.

The Transportation Branch, HQ, while under DWMT, was to be the source of funding for the type of transportation study now envisioned. On August 1, 1975, Transportation Branch personnel prepared a short paper on TRU waste transportation in which they stated:

> "We need a system for alpha waste shipments, one derived from a detailed and synergistic study of all of the functional goals and constraints. Modular concept studies should be included. Rail should not be a preconceived solution. Time is very short--only a few months to have any impact on the salt mine design. The overall economics that need to be factored in are: (1) the costs of various packaging systems; (2) the costs of various transport systems; (3) the cost of safety approvals; (4) the cost of constraint charges; (5) operating costs vs. capital costs; and (6) the need of small shippers, not just large ones."

Funding was provided Rockwell International, RFP, in FY-76 and TQ to initiate a transportation study, and much of the time and effort in 1976 was spent in drafting and redrafting the 189c to the Transportation Branch's satisfaction. During the HQ reorganization of 1976, the Transportation Branch was transferred to HQ's ECT Division, the RFP study was discontinued since the Transportation Branch was no longer responsible for planning transportation systems or developing transportation hardware. Under ECT, the Transportation Branch function is an overview function, responsible primarily for evaluating the safety aspects of existing systems. ECT recommended that DMA fund the transportation work; however, DMA concluded that the TRU waste transportation question should be addressed on an ERDA-wide basis, and that some other office or division in ERDA, such as ECT or the recently established WPR, would provide more meaningful direction to an analysis of the transportation problem.

Excluding WPR funded work, numerous transportation projects are under way, most funded by ECT with a few funded by NRC, RRD, SSD, DMA, DOT, and Fossil Energy. Of the total of about 25 to 30 projects, only three appear to have some application to areas which would be covered in a TRU waste transportation study. These are ECT-funded: (1) Transportation Safety Studies, (2) A Safety and Economic Study of Special Trains, and (3) Study of Radioactive Material Transport Problems, 1976-2000, (all by BNWL.)

Transportation-related projects funded by WPR include a packaging study being conducted at MD, which Jay Doty has described earlier this morning, and two OWI studies. One is an ARHCO study to develop criteria for compliance with proposed governmental packaging regulations. Waste packaging criteria will be developed for TRU wastes categorized as nuclear-fuel-cycle low-level, intermediate-level, and cladding hulls. Functional requirements of packaging will be determined for the entire life cycle of each package. The other OWI study is to be conducted by ORNL. ORNL has recently entered into a work agreement with OWI to perform a comprehensive study on the transportation industry's ability to transport nuclear fuel cycle waste material to federal repositories when they start operation in 1985. The problems which are identified will form the basis for a program plan aimed at solving them in a timely and efficient manner.

Scope of Transportation Study

A transportation study probably should be oriented towards three TRU waste relocation situations: (1) interim retrievable storage, (2) pilot plant implacement (WIPP), and (3) permanent repository. The scope of the transportation should be defined in a program management document outlining objectives, milestones, and reporting requirements.

Various matrices identifying major elements and subtasks for a study are possible; however, I would recommend a generic approach such as the following:

<u>Interim Storage/WIPP/Repository</u>

Program Management Documentation
Acceptance Criteria
Regulations & Licensing Requirements
(State Highway Depts. regulate gross vehicle weights and vehicular dimensions)
Waste Characterization
Waste Locations/Rates/Volumes
Logistic Studies

<u>Packaging Study/Container Study/Transportation Vehicle Study</u>

Safety
Economics
User Interfaces
Public Relations
Security
Transportation Modes
Conceptual Designs
Support Facilities
Prototype Designs
Fabrication
Evaluation Tests
PSAR
NRC/DOT Approval
FPU's

You will note that two assumptions made for this generic approach are that licensing will be required and there will not be a significant safeguards problem.

There are several areas I have not dealt with regarding transportation of TRU wastes: intermediate-level TRU wastes; regulations which apply to shipments of plutonium in excess of 2-kilograms, in recognition of the potential for diversion; the proposed licensing criteria that are considerably more stringent than the current certification tests; the 13,000,000 cubic feet of TRU waste buried, some of which may have to be exhumed for repackaging and trans-shipment to the repository; the potential for large volumes of TRU wastes resulting from decontamination and decommissioning of facilities; TRU nuclide content limits for hydrogenous wastes due to radiolysis concerns; the current study to reevaluate the 10nCi/gm limit, which could result in a lower or higher threshold level; the potential for state or city restrictions on shipments such as the New York ban; qualify assurance and safeguards considerations--I am sure you can think of other factors which could impact transportation operations. Figure 1 shows possible milestones in a development of a rail and highway transportation unit.

At the time of the proposed repository in Kansas, the common denominator for evaluating transportation systems seemed to be economics. A more complicated approach is called for today. Safety, economics, WIPP criteria, new regulatory requirements, licensing procedure, public relations, the special train rule, (if adopted), the waste form in transit as determined by on-site or off-site processing, and even political forces will each have an impact on future packaging and transportation of transuranics to interim storage, to the WIPP, and to the final implacement at a repository.

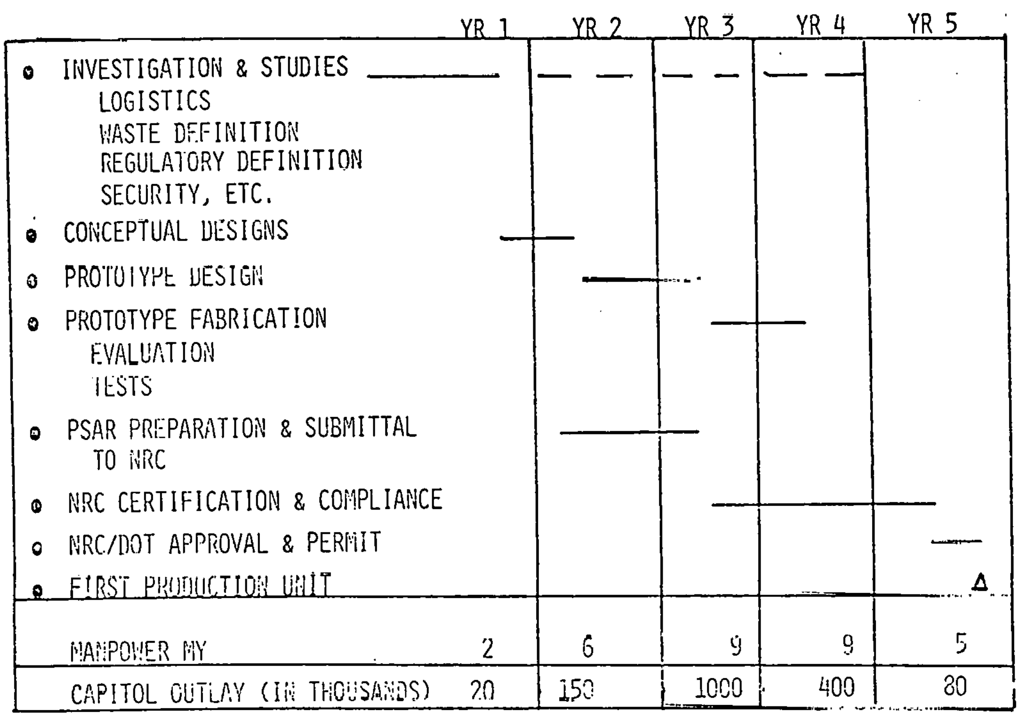

Figure 1. Schedule Based on Development and Licensing of One Rail Unit and One Highway Unit

Discussion

Q. (Inaudible)

A. We now use these cars on special trains, using one car at a time, per agreement with the railroad, based on a special train rule. It is more economical to ship by special train than by supertiger, so until we can develop new packaging designs and make comparisons we will keep using the ATMX railcar.

Q. How do you go about integrating your studies?

A. What we need is an integrated coherent system, and this program management document that outlines goals, objectives, considerations, etc., sets up the system for interchange of information. I don't know whether one contractor should do that, or five, or whether it should all be in-house, or outside...there are many possibilities.

Comment: We deliberately made this presentation as a kind of strawman, as Bob sees the scope and need, with the recognition that we were going to have to do something... perhaps talk very briefly at each site and organize an integrated approach. We have to take advantage of what has been done at each location and try to approach uniformity in transportation, packaging, etc.

Q. What is the status--will you go out on an RFP?

A. No. We are trying to get people sensitized, by a strawman approach, to the needs, to get the reactions of the various sites, and to identify areas that we'll have to follow up on very shortly after this meeting. There is no status of the study at the moment. We've talked earlier about it, I guess, about the February time frame. We thought that this kind of meeting, which cuts across a whole family of participants, would be a desirable way to get reactions and comments, to raise questions, and to find out what you thought about the time frame.

Q. I'm interested in knowing how the time frame you presented in Figure 1 interacts with the timing you were talking about at Mound. I guess you are carrying it through to prototype fabrication and evaluation?

A. The kind of information Mound needs is an investigation of . According to the schedule, manpower, etc., it will take 1 1/2 to 2 years to get useful inputs.

Comment: I would like to make a strong appear for getting the American Association of Railroads, the Association of State Highway Engineers, and the DOT involved in whatever we do. Such a simple thing as a problem with rights of way could negate out plans.

Speaker: All these organizations have to be touched, and it gets complicated. We were reluctant to begin any definitive study until after we had held this meeting. Studies seem to be proliferating and we must combine out knowledge as a guide for additional work. Let us each identify what work is going on and spread the word. I assume that one area that is not in question is that we decide upon some of the uncertainties associated with packaging criteria constraints we've talked about. I assume that design will be pretty well frozen in those areas in a timely fashion.

Q. What is the dependence of the design on the waste packaging criteria? It is a tight or loose relationship? My impression is that it's not so tight a concern as to drive the design.

A There is no real constraint so far as size, shape, weight, etc., are concerned. We are trying to design a facility with maximum flexibility and not box ourselves in. Transportation may present more problems, since about 75% of the shipments are planned for rail, 25% for truck.

COMPARATIVE STUDY OF WASTE PROCESSING

Hank Shefelbine - Sandia Laboratories

I am not going to present the results of a systems study of the TRU waste processing problem. What I hope to do is give a broad-brush outline of what such a study might entail. And since I am not presenting results, I can afford to be rather sweeping in stating the intended objective: What fraction of the TRU waste inventory should be processed, and what is the best method? Implicit in this objective are all the good "buzz" words of systems studies--costs, risks, environmental impacts...

Figure 1 shows some of the important elements of a TRU waste processing system. You start with a waste source. If you have new production waste and an off-site processing plant, that waste will have to be packaged, transported. Backlog waste already packaged by on-site processing can be shipped directly to a processing plant. In the processing plant, the waste will have to be prepared by incineration and some form of fixation. There may be other processes than those shown. We also have to think about eventual decommissioning and what that involves.

It is evident that many of the presentations and discussion in this meeting have addressed specific elements in this total system. We have heard about packaging, transport, risks of combustibles in the mine, etc.

Next, I would like to indicate what I think some of the options for the system might be (Figure 2). If we consider each waste type, we have to decide how much of it we are going to process--new production, backlog, all of it. Note on the right-hand column the differences in the kind of options possible. These centainly are not all the options. For instance, the quantities which need to be considered are likely to range almost continuously from processing none of the combustibles to processing all of them.

Figure 3 is a very general outline of the scope or method of attack for the proposed study. I want to save discussion of the data collection aspects until last. The cost analysis will include capital, operating, and decommissioning costs for the processing plants. However, since much of the transportation system, packaging, and terminal disposal facility will be needed irrespective of the decision to process, only the costs of above elements which are directly affected by processing would be included. For instance, the costs of "beefing up" the fire-fighting capability in the WIPP, to meet any increased fire hazard of accepting large quantities of combustibles would be included.

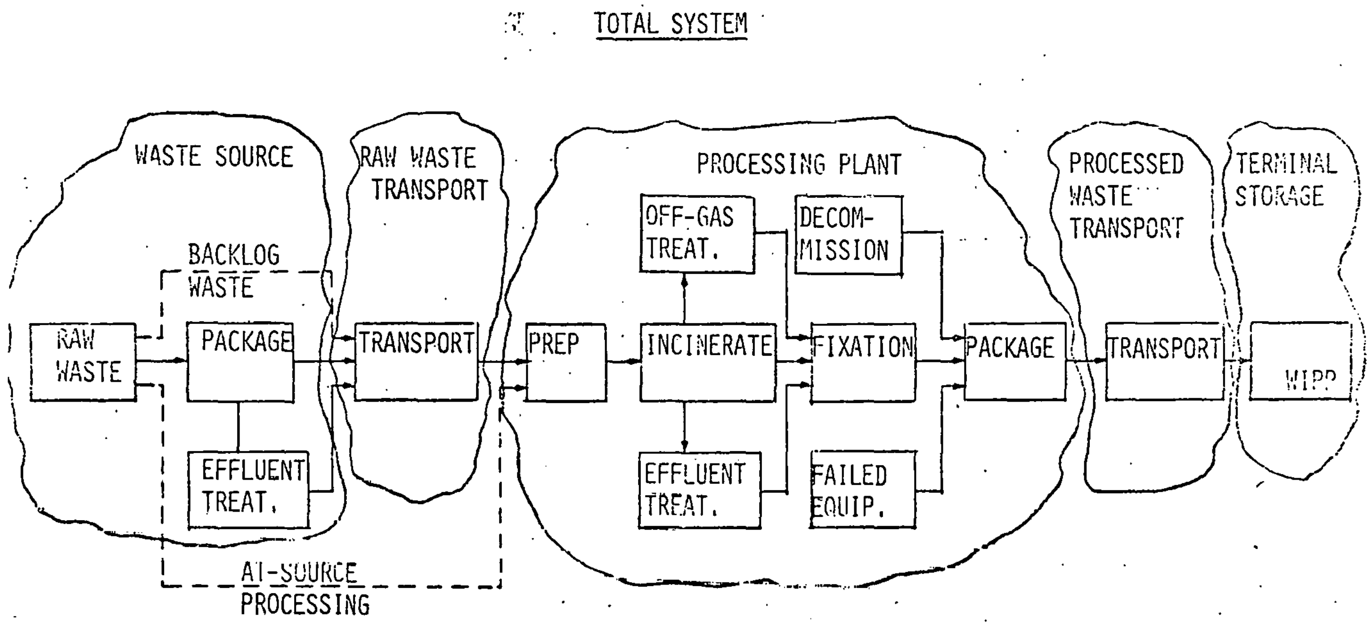

Figure 1

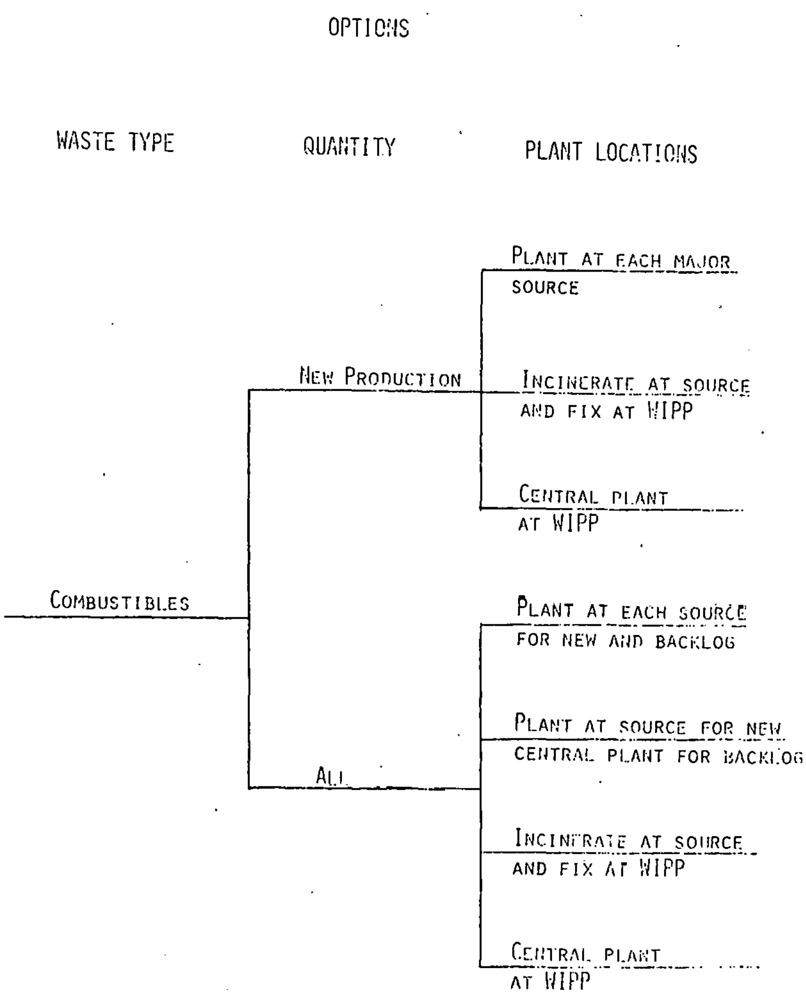

Figure 2

STUDY OUTLINE

DATA COLLECTION

DEVELOP CANDIDATE SYSTEMS

COST ANALYSIS OF CANDIDATES

SAFETY/RISK ANALYSIS

RECOMMENDATIONS:

BEST SYSTEM

AREAS OF GREATEST UNCERTAINTY

Figure 3

During these two days of meetings, I've heard many discussions of risks. Unfortunately, these discussions have tended toward either horror stories or certifications of purity. What is needed is a careful, objective risk analysis of all the elements--waste source, transportation system, processing plants, and the terminal disposal facility. Analysis of the risks during the operational phase is in my opinion a tractable problem. We can make use of considerable bodies of past experience and of risk studies on similar systems. Also, the operational risks of the elements are measured in the same time frame, and hopefully with comparable precision, so that any increased risks associated with processing the waste can be traded off with any decreased risks during transportation and terminal disposal.

The catch comes when we try to include the long-term risks of terminal disposal in the equation of operational risks. At the very least, the time scales differ by orders of magnitude. Analysis of the long-term risks is a much more difficult problem, and the confidence we will have in any such analysis will be considerably less that the confidence we will have in the operational risk analysis. This lack of confidence will probably require that we adopt conservative measures.

As far as the time scales, level of effort, and how the study might be handled are concerned, I'd like to make these comments:

1. The longer the study objective remains undefined, the more waste will be accumulating which have to be reprocessed.

2. But, as many presentations have stressed, many of the needed inputs are not available, and are not likely to be for some time.

3. The major efforts of the study will be:

   a. Coordination of all the on-going studies.

b. Identification of areas which are not being addressed.

c. Combination of all information.

4. I have no illusions that this is an easy task, but I think it has to be done.

I deliberately left data input discussion to the last. Figure 4 lists inputs which are necessary to the total system study. In the area of waste characterization, we have an excellent data base, and one that is easy to manipulate to get the answers we need. In regard to processing plants, one particular question occurs to me: Is there an incinerator which will process all types of combustibles? If there isn't, the idea of a central processing plant may not make much sense. I have talked about costs above. Characterization of processed waste is very important in defining what a unit package/shipping container should be like. On this subject, another point bothers me. If we decide that we have to process the backlog waste, what are we going to do with all that stuff? Any questions?

INPUTS TO THE TOTAL SYSTEM STUDY

WASTE CHARACTERIZATION

- BACKLOG QUANTITIES AND PRODUCTION RATES BY LOCATION AND WASTE TYPE
- CHEMICAL ANALYSES
- WASTE FORM DEFINITION

PROCESSING PLANTS

- APPLICABILITY OF PROCESSES TO WASTE TYPES
- COSTS
- RISK ANALYSES (SITE AND PROCESS SPECIFIC)
- PLANT OPERATING CHARACTERISTICS
- PLANT EFFLUENTS
- CHARACTERISTICS OF PROCESSED WASTE

UNIT PACKAGE/SHIPPING CONTAINER

- PROCUREMENT COSTS
- HANDLING COSTS
- BACKLOG PACKAGES

TRANSPORTATION

- APPLICABLE TARIFFS
- MAXIMUM LOADS (SIZE AND WEIGHT)
- RISK ANALYSES (MODE, ROUTE AND WASTE TYPE SPECIFIC)

TERMINAL DISPOSAL FACILITY

- RISK ANALYSES (OPERATIONAL AND LONG-TERM)
- COST IMPLICATIONS

Figure 4

Discussion

Q. You propose this as a total system?

A. Yes, I can't see that you can really separate out the individual components of the system. I think they are all valid. . .processing, backlog, etc. and if we process the backlog we will increase risk. I don't think we'll get an answer until all the data and items are in and we've developed a uniform matrix.

Comment: I don't think there is any question but what all the dimensions you identify will have to be addressed. In earlier thinking about it, I had not seen it as one integrated process quite to the degree you lay it out, but rather, for example, a given set of criteria for waste form and packaging against which WIPP, for example, would be doing its risk assessment, both operational short-term and long-term. What we might be talking about here is, with those assumed criteria, you are looking at what needs to be done by way of processing either one or both (backlog or new generation) into a form or into packages that again will meet the requirements, then there would be risk assessment associated with that, and then you get into the added dimension of centralized versus multiplicity of sites which brings the added transportation dimension to bear as well as the point you were making about the risk associated with processing to a point, a sort of intermediate approach, where you fix, incinerate, ship to a central point--and that has another risk assessment associated with it. But I sense that what you were proposing was a total system analysis, all the way from point of what you have in the way of retrievable storage clear through to where you are dropping it into. . .

A. Yes, all these factors have be to gathered together, but I am not so much saying that we have to form a team, or somebody has to do the whole systems analysis. What I am saying is, this is really what is needed, these factors are now being addressed, but are they all being integrated in a meaningful way so somebody can arrive at a final decision? You can't make a decision from a look at just one part.

Comment: We have to make sure that essentially the same data base and the same assumptions are going into each of the individual studies.

Speaker: That's right. That is the principal consideration that led me to touch on that subject here. Certainly before we undertook any trade-off study of centralized versus multiplicity of processing sites, that those doing such analyses must be approaching it from the same set of assumptions, so that you have some comparative basis that is realistic. I guess as a first-cut interest in this I felt it would be useful to gain not only a range of dollar cost but also some appreciation for the comparative risks, and that at a very early time, we should start talking with management and others so that they had some appreciation of what we are being driven to in the total system by the level of conservativism we are cranking in at various points. I certainly do not quarrel at all with the need to do these kinds of things, but I think it is a little bit broader in context than I saw at the first cut approach... and it seems to me that the issue is one of bringing the pieces together. I am sure, for purposes of this first assessment, that so long as we have some assumptions that are reasonably consistent, we could undertake this centralized versus decentralized approach as well as bring the added dimensions to bear on what those assumptions mean in terms of the resources that have to be enlisted. And that will tend to give you a pretty strong driving force working back on the system. My inclination on this is that it would not be too difficult, for a comparative study, to rather readily agree on a set of reasonable assumptions about where we are today as a basis for undertaking these analyses. I dare say there would be some interest in looking at some sensitivity studies associated with that--perhaps some variation on the criteria or assumptions that seem reasonable in order to get some better handle on what those may imply in terms of cost figures or degree of processing. Parallel with this, as another item I wanted to bring up later, I'm sure that what we are going to have to do very promptly is get you where you might want to be, in terms of waste quantity or whatever criteria or assumptions you are talking about. One of the efforts we have to undertake very shortly is to assess the ongoing process and programs (what they buy for you in terms of criteria as they are now constituted) and see whether that in itself provides a reasonable assumption in that operation or analysis that you want to undertake. Do any of you see any significant stumbling blocks? This may not be a rigorous undertaking, but a somewhat more systematic approach than I expect has been undertaken to date about the pros and cons of centralized versus decentralized processing. What is the reaction to the idea that such a study is needed? I know that several levels of effort have been undertaken at several of the sites at recent times addressing this, but undoubtedly under different assumptions than would probably prevail today. Savannah River and Idaho have done some work, for example, contemplating that they may be driven to exhumation of some significant part of their burial.

Comment: What you have proposed is exactly what I've envisioned we are going to have to have, because this whole business is predicated very heavily on WIPP--that's why we are doing it. But I'm really not sure that you can get anything meaningful if you do something less than that.

Speaker: Don't misunderstand. I think these are elements that have to be addressed. Some group or groups looking at an assessment of trade-off studies, of central versus multiplicity of processing capabilities, would essentially be using the same set of assumptions and therefore I do not feel that it is incumbent upon us as an approach to charge an organization or any assigned group to be making such an analysis to cover that little spectrum as well as the complete risk assessment on WIPP. I think we have to address all the parts in your total analysis; and I don't know if there are any shortcuts.

Comments: I think you have to sit down and plan a risk assessment kind of thing that you are talking about here. Somehow you have to do the over-all risk assessment that shows you your pay-off risks in terms of acceptability and operations.....

Speaker: I would think that on safe-security studies, with some variation in what appeared to be some two or three criteria most questionable at the moment that you could do a reasonably good job in this kind of exercise with such assumptions, without being too concerned that you are off base whenever these criteria become more fixed after additional work. What do you understand is the risk assessment dimension? Is that important in the context of the trade-off study, if your target is predominantly looking at centralized versus multiple-site approaches on processing? Except to the extent that you may say it is an element in deciding on one approach versus the other. And then if you get "half pregnant" in trying to do that, I don't see how you can avoid going the whole way to a full-blown risk assessment. I am not looking for a quality product right now--perhaps as in-depth in the risk assessment dimension as we all feel is necessary at some point for any one of these operations in the total TRU Waste program, but rather trying to delineate pro's and con's of centralized versus multiple-site processing approaches. I'm trying to get some handle on a reasonable range of cost considerations, among other things.

Q. On the question of centralized versus decentralized processing, the driving factor is what are the......... after processing? You have to look at your site and say we have x barrels or boxes here and x barrels or boxes here, and I'm sure you have a number of options. You may say, let's process everything that has over 5% combustible...the experience with Rocky Flats boxes. Or you may say let's leave these boxes alone. If we could set up to start with a range of options in processing that we want to exercise, what is it? I would start with getting everyone to agree with these things that make sense--what is the amount of combustible we want to process. Given that, then we could go into you centralized versus decentralized considerations. Incinerating at one place and fixing it at another presents too many risk consequences.

A. Processing at the point of generation versus some centralized off-site location and the dimension of risk of transporting that material without first doing something to it. to a central process point, in principle should not be such a major point of concern. Idaho offers a different order of consideration contrasted to Savannah River, for example. I have heard enough over these past two days that I thought it would be meaningful to talk about on-site processing versus centralized processing without going into an assessment of transportation risks.

Comment: Right. We just don't know what that risk is without looking at what we intended to do. What is the risk of shipping crates that have been in the storage path for five years, ten years? What is going on inside that drum?

Speaker: What we are probably going to have to do is convene a small group and try to see if we cannot develop some assumptions against which a study might proceed. We may find, in the course of doing this, that it's a much more difficult problem than perhaps I've felt might be the case to identify the pros and cons and range of costs and to identify the alternatives against the criteria that now exist--or some variation or sensitivities. I think there is something we can do--but maybe we will be put to the test to sit down and try to get some assumptions set up and see whether or not they will be the basis for any sort of analysis.

Comment: You should be able to get a range of costs under different options, but without the risk assessment you won't really have a good idea about how to pick which option, will you? If you look at the cost of centralized processing as opposed to distributed processing--you can establish those two costs in dollars--but you won't know which option to pick to minimize the hazards until you go through that risk assessment.

Comment: We all seem to be saying the same thing. We are saying we ought to be able to go through and outline a systems study like this at several different levels of complexity. And I agree that we need to go through that analysis crudely, quickly, to get the ballpark. And then you'll have to redo it again later for more accurate, more complete sets of details before we can make a final decision.

Speaker: We must satisfy ourselves that the product has real meaning. It may turn out that without going to a complex approach you may not have a worthwhile product. So we have to get down an outline, and our assumptions, and what we can achieve by it in contrast to some of the big gaps you would have in such an approach.

Q. At least 60% of the first cut I think has already been done in the approach at Battelle Northwest. At least the flow diagrams have been worked out to address this specific problem of waste processing.

Speaker: I am not that familiar with the details of their approach, but I would assume that their approach is largely if not exclusively predicated on processing at the source of generation.

Comment: They have all the options that I think any of us would have considered using in that flow diagram. You can process at the point of generation, you can process in the fluffy (?) mode, you can transport to another location and process--which may or may not be at the site where it will be disposed of, or you can put it into a sub-fixation matrix, like concrete or epoxy, and then put in the repository. In the interim between any one of these steps you can store either in the fluff mode or in any stabilized mode. All this flow diagram has been worked out for us already, so I think it's a good idea that we do this, but we have a leg up on part of the problem right there.

Speaker: I agree that we need to look at it and see how far it does go in approaching the problem.

Comment: I think that there are a lot of studies that have addressed specific parts of this--particularly in the transportation area a lot of work has been done on safety that can be applied pretty much directly--if we can figure out what the character of the stuff is that we are transporting.

Speaker: I've been rather hopeful that in posing a set of assumptions on the repository criteria and knowing that there is some conceptual work that has gone on in several places predicated on a given process, that in a matter of six or eight months I could have something that could give me a first cut on a range of costs and at least some rather definitive delineation of pros and cons of one approach versus the other. Obviously, that doesn't envisage any quality of product that you normally have to have. It's more of getting some kind of better feel, much as we've done on the HLW relative range of costs. Some of those analyses haven't been predicated on a very sophistcated quality of product, but nonetheless they've been quite helpful.

Comment: It seems to me that in six to eight months we can assemble something on the data base now available. In some areas we don't have any knowledge (hydrogen percolation through salt, for example), but if we admit that there are those gaps, we can at least identify the options that need to be processed, the costs of transportating. how much has to be transported, what the weights are, what locations we have. I don't know if we can get good cost numbers regarding our processing plants.

Comment: You know that by 1980-1981 we will be incinerating all of our waste--we are already committed to that.

Speaker: We may very well be drawing an extension, in the final analysis, about the backlog as contrasted to the approach which you would probably take for future generation of major quantities of waste. Better, very likely, you would probably pursue incineration or some volume-reduction processing at the point of generation.

Comment: I believe that the operators (I know we feel this way) would like to do the whole job and give central WIPP the resulting product. We'd like to incinerate, fix, ship in high-integrity packages.

Speaker: I understand what you are saying. There are probably also some people who worry about the Savannah resources being brought to bear in this program, and when you start talking about multiplicity of new processing capabilities to work off a large backlog of waste in some 3-5 sites, they may feel that it is worth looking at the possibility of establishing one such capability. I don't think that necessarily puts in jeopardy a capability at sites where you're generating large volumes of waste.

Comment: Just continuing. . .when you have been incinerating for a period of weeks be it high level and low, and you operate a plant the size that we do inevitably you will get cross-over--you are going to get a high package into a low waste. You have to have facilities for leaching, washing, processing. . .you almost have to have a plutonium processing plant to make sure that you can do the whole cycle. I can't see that going on at WIPP. Even with deep storage, I'd think you'd get human error.

Speaker: If you assume that you're not confronted with the problem of exhumation & processing at Idaho, how do you contrast the difference between Idaho and the WIPP? They are not generating anything--I think Weart said a drum a year or some such amount. They've got large inventories. By your line of reasoning would you think it would sense to make a case for a difference between establishing a processing capability at Idaho because you've got a large retrievable inventory there, as contrasted perhaps to WIPP or a repository? I can see that it irritates you in the context of the Rocky Flats operation but I am not sure I fully appreciate it in the context of a place like Idaho. Maybe the same consideration in your case might apply to some of the other sites. As for the cross-over problem, to what extent is that a greater risk of getting product out of the high-level side off to Idaho or some place for low level storage?

Comment: As for the material that exists at Idaho, whether you put a centralized system at WIPP or one at Idaho, I imagine you will have a much more difficult time. At Idaho you could build a plant or anything you'd like to take care of it.

Speaker: We can't get into the pros and cons of one versus the other, and the valid points you are making have to be considered. But the very reason that we are raising them leads me to the conclusion that some more systematic approach delineating the pros and cons is something we need to undertake. And whatever level of quantitative effort we feel is necessary to get us a product that we can take advantage of, I'd like to think that may not have to be that comprehensive or sophisticated in terms of gaining some reasonable feel of whether you've got gross differences in the trade-offs, advantages in one approach over another.

I think that LASL people, in view of the fact that we have some time, have indicated a willingness and interest to give a few comments on the status of their incinerator work.

CONTROLLED AIR INCINERATION

Louis Borduin, LASL

Since the terms "combustible" and "incineration" have appeared as many times as any of usual buzz words, we thought it might be of immediate interest to this group to hear a review of the controlled air incineration process under development at LASL. This is being considered near-term technology. We are about a month away from controlled start-ups with the system, and possibly six to nine months away from operation with transuranic waste. The original LASL charter regarding ERDA TRU waste was to assemble, develop, and demonstrate a production-scale system for reducing combustible waste. We were to look at alternate systems; the first one selected was controlled air incineration because it represented near-term technology. We went with as thoroughly a demonstrated technology as we could find for incineration, preparation, and off-gas cleaning. The system throughput was targeted at 100 pounds per hour. Doing some "back of the envelope" calculations, based on Lowrey's information, (about 50,000 cu ft per year at 100 pounds/hour, 24-hours-per-day operation) a unit with a 100-pound/hr throughput would have to operate about 166 days per year to reduce that volume incinerated transuranic waste to ash. Very briefly, in a controlled-air incinerator, waste packages are charged through a ramp and heated. A horizontal piston forces the waste into a lower chamber where it is ignited by natural gas burners in this particular case (but fuel oil or electric heat could be used). The waste, while it burns, and as an ash, remains in this lower chamber. The upper chamber is used as an afterburner, and excess air and heat are added to assure complete combustion in the unit. The lower-chamber operating temperature is about 1500° F; the upper-chamber temperature operates at 2200° F. This is adequate to handle the usual range of combustible waste that's generated within ERDA, which includes polyvinychloride, neoprene, latex rubber, paper, rags, etc. The unit which we purchased is commercially available. Outside of the chamber are the gas-controlled forced-air blowers, etc. We operated this unit with simulated radioactive waste, putting a total of 3000 pounds through it. I have some of the bags from those runs if you care to examine it. The ash is a very fine white powder, extremely dispersable, and completely inert except for about .3% carbon.

One of the strong points of the controlled air incinerator, is its design which minimizes particulate loading on the off-gas system. It is a very non-turbulent combustion phenomenon. Basically it is divided into three subsystems: feed preparation, consisting of several elements; incineration, including feeders and ash removal capability; and the off-gas conditioning equipment.

One of the unique features of the feed preparation subsystem is that we use a low-energy x-ray system to inspect the end-generated waste to avoid the necessity of re-opening waste packages as they're brought to us for processing.

We are using a building specifically dedicated to waste development efforts. We have special ventilation equipment, glove boxes, an assay system for incoming waste analysis, X-ray equipment to identify items that are incompabible for incineration, modified ramps, incinerator with expendable fire boxes, and associated facilities. We designed this for maximum flexibility of feed rate--from 0 to 100% at the 100 pounds-per-hour throughput rate. We have a limitation of 100 grams of transuranics. We expect a primary volume reduction in the range of 50 to 1. And then if you add secondary waste such as HEPA filters, etc., we expect a more conservative 35-to-1 volume reduction. The system could be used for higher-level transuranics.

CLOSING REMARKS

R. Glenn Bradley:

It has been very useful for the ERDA offices and the contractor organizations to meet and discuss facets of the TRU waste management program. We hope that the meeting has led to a better understanding of the status of work under way at the various sites, as well as of ambitions and plans for the future.

I have noted a few areas where we at Headquarters felt a need for near-term assessments that would better insure effective interaction and smoother interfaces between program elements. This list is not intended to cover all the areas in which we have been working, nor to show what studies or assessments should center upon.

1. We need to review the draft criteria to identify the qualitative requirements that now exist, and to translate these into quantitative terms on the basis of which operators and waste generators can evaluate necessary plans and modifications, which should lead to both near-term and long-term implications for the sites and the program. We need to do this for many reasons, not the least of which is to be sure that we are able to get these requirements factored into budgets, and to get everything done in a timely fashion so the program interacts well enough to prevent constipation in any one area.

2. We need to evaluate ongoing R&D programs against the total spectrum of R&D issues, and to try to identify gaps or areas in the program where redirection or additional considerations should be brought to bear. In doing that we should end up with conclusions in which are identified a scope of work, the types of end-products needed, and the timing and resources required for generating the end-product.

3. We need to reach a decision fairly promptly on the need for additional transportation studies, or perhaps an elaboration of efforts either made in the past or presently under way.

4. We need to reach conclusions about undertaking an assessment of centralized versus multiple processing capabilities. In relation to that, we need to assess the ongoing waste processing program, to try to match up the waste forms with the criteria, and to relate these efforts to the current program and to the end dates for having the necessary technology at hand.

5. We need to determine to what extent packaging redesign may be necessary.

When we get back to Washington, we hope rather promptly to scope the amount of work that is facing us. In the process of doing that, we will be in touch with many of you to review the considerations.

Similarly, we want to address what we feel are the most appropriate mechanisms by which to focus our studies, evaluations, and assessments. The subject matter and the type and nature of work that is now going on will have a very important bearing on optimum mechanisms. In cases where the subject to be studied cuts across a number of program areas and contractors, then a possible mechanism might be to draw on representative small groupings, and perhaps five or six , to undertake these studies, but drawing on the elements of the program that interact with or are dependent upon the subject matter of the studies. We will be in contact with you to discuss these mechanisms and to obtain your viewpoints on what makes the most sense.

A very important consideration that we recognize in Washington is that you are spread rather thin these days, with demands being placed on you from numerous directions, and we recognize that the heavy drain this places upon you may itself influence what might be the best mechanisms by which to assess the work to be done.

If you did not have time or opportunity to study appropriate parts of the criteria in preparation for this meeting, or if subjects have come up during the meeting that you would like to comment upon, please send those comments to Sandia, with a copy to Headquarters. We would be very interested.

In light of the meeting here, and the resulting identification of points about which there is uncertainty, it would be well to lay these out, if they are not already on your time-lines, over and above what we have already talked about. This layout would show where we are today and when certain points in time need to be reached in order to establish WIPP criteria and get the WIPP program underway. It would be useful for the entire contractor family to have an appreciation of what that time schedule looks like with respect primarily to questions critical to the whole program, especially regarding processing and issues of that nature. The more each of us understands the problems, hopes, and expectations of all the others, the better we can solve the problems in timely fashion.

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