UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD

FULL BOARD MEETING

July 8, 1992

Stouffer Concourse Hotel
3801 Quebec Street
Denver, Colorado

BOARD MEMBERS PRESENT

Dr. John E. Cantlon, Chairman

Dr. Clarence R. Allen

Dr. Garry D. Brewer

Dr. Edward J. Cording

Dr. Patrick A. Domenico

Dr. Donald Langmuir

Dr. John J. McKetta

Dr. D. Warner North

Dr. Dennis L. Price

Dr. Ellis D. Verink

ALSO PRESENT

Dr. William D. Barnard, Executive Director,
Nuclear Waste Technical Review Board

Mr. Dennis G. Condie, Deputy Executive Director,

Ms. Karen Severson, Congressional Liaison

Dr. Sidney J. S. Parry, Senior Professional Staff

Dr. Sherwood C. Chu, Senior Professional Staff

Dr. Leon Reiter, Senior Professional Staff

Dr. Carl Di Bella, Senior Professional Staff

Dr. Robert Luce, Senior Professional Staff

Mr. Russell McFarland, Senior Professional Staff

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P R O C E E D I N G S

8:30 a.m.

DR. CANTLON: Let's convene the Board, please.

The Board is reconvened. For those of you that weren't here yesterday, my name is John Cantlon. I am Chairman of the Board, and we are meeting to be brought up to date in the broad area of the systems approach to the Nuclear Waste Management System.

One minor change in the agenda for this morning, Wednesday, July 8, we are going to insert Carl Gertz in immediately after my remarks, to close out a number of the questions that came up from yesterday, but since we have a very tight schedule, we will defer any lengthy questions here and take maybe one or two brief questions and then we'll get right on to Dr. Lemeshewsky.

Carl.

MR. GERTZ: The first question I would like to address came from Dr. North yesterday about the study plans. Since we had several discussions on it, I asked my staff to prepare an answer to me which just came back. So, I have not edited. What you have in front of you is once again raw, draft data. But, it at least gave me some comfort that, in effect we were aware that that study plan that we submitted on 4/22 had not incorporated the changes to the ESF. And on 6/8 once we approved ramps instead of shafts by change board, we then sent documents and notices not only to that principal investigator but for 13 other study plans saying, you now must change your study plan and update it to reflect whatever. Change in testing strategy will occur because we are doing ramps and not shafts. So the process is following our procedures. It does work; but it is cumbersome sometimes. Of course, the question you might ask, why did it take that long to get our change board into effect to change from ramps to shafts and we waited for our Title I design so we had a better baseline was what I was told.

But, the key thing is the reason we put in the 422 in '92 changes, we wanted to add a couple of activities that were surface based, not underground. So, that is our process that is there for you. It may not be perfect, but it is fairly well documented. You will find 13 other study plans that have the same problem right now.

When we update those is going to depend upon lots of things. It will depend on funding for '93 relative priorities, and if we are not going to any tests we are probably not going to spend a lot of time.

But, I want to follow that up with one more thing. The exercise for 2001 that Bob Sandifer talked to you about, includes the principal investigator's best estimate of how they are going to do tests in ramps. And that includes, as I am told right now, continuous TBM operation. The PIs are not going to require the TBM to be stopped, unless there is a major anomaly. So, our philosophy in our cost estimate that is going into the 2001 estimate includes the latest thinking of the PI even though that is not reflected in a study plan at times. So, that closes that issue.

The other issue is one that John brought up and let me give you some handouts. What I am going to condense for you is either a three month exercise that we have gone through with independent cost estimators or a three day exercise that we have gone through with the utilities. And, I am going to do it in three minutes. And you can of course have an expanded briefing later on in the year, if you would like.

But, off the top of our head, $6.3 billion is our estimate that has been validated. It includes a couple of things. It is 20 years of activities; it is total cost required to determine suitability and to prepare an LA. Previous costs are about $1.3 billion. There is some escalation in the future, so that is in there. Excuse me, there escalation in here at $600 million; there is unescalated state payments at $800 million. There is a cost to complete of $3.6 billion for direct project activities. And, if you want to know what is in that $3.6 billion, that is in the next handout.

And very roughly top level just the way to think about it, $.8 billion for testing site investigations; $1 billion for facilities to test in; waste package design, systems engineering, technical data base, institutional and project management and training. That is a very broad break out.

I have provided for you, as I did I think in January, our official accounting system. It is a work breakdown structure. When the cost estimators were in, they looked at 710 planning and summary accounts that make up this $6.3 billion. This is by our traditional work break down structure at the top level: systems, waste package, site, repository, et cetera. Keep in mind project management includes lots more things. It includes QA; it includes project control system; it includes the rent; it includes all those kind of things. And in case you are wondering what our formula is for state support, it includes 5 percent for oversight, 3 percent to the universities, 2 percent for impact, and $50 million for benefits agreement. So that is how we came to the $6.3 billion.

I have provided for you another work break down structure down to the fourth level. Actually, we go to the sixth level. As I said the independent three month exercise by Gilbert Commonwealth looked at 710 planning summary accounts and probably over 2,000 summary accounts below that. That is our official way of keeping track.

In case you are wondering where we are going and another way to look at it, this was presented to you in one form or another, talks about the firm foundation and our required costs to do business and then other things that are going on. That is provided for you both in what was spent in '92 and what we would like to spend in '93, recognizing it is the "administration request", because the additional 75 million may not be an official administration request. So, I have another chart that I didn't give you to confuse you to show how we split out 240 if we get it. As you can see we do have a fairly good emphasis on ESF with that kind of an approach.

Once again, the theory behind this is that you need these kind of things in place before you can do other things, whether it is drilling, whether it is design activities, where it is monitoring, you have to have a sound foundation.

DR. CANTLON: Carl, before you take that off, did I understand that the 70 million addition is in the 318?

MR. GERTZ: Yes, sir. That is in there.

DR. CANTLON: That includes.

MR. GERTZ: When Dr. Deere, testified and the utilities testified in front of Senator Johnson's committee as well as when John and I were there, when we alluded to the additional $75 million, that is the number that we get when you add the $75 million. However, I am told that is not part of an official budget amendment at this time. So, we are really at the will of Congress, I guess, because that is the next chapter in the process as to what the appropriations might really be.

I need to caution you, as John pointed out, right now not this number, but John's entire number for the program is 275 on the house side. That includes MRS, transportation, federal salaries, and everything else. My share of that would be significantly less than 25.

DR. CANTLON: Roughly what percent?

DR. BARTLETT: 150.

DR. CANTLON. 150

MR. GERTZ: 150. That is 30 million less than we are spending this year.

So, John has a lot of tough decisions to make to come to allocate that. And then once we get 150 at the project, we have some tough decisions to make as to how we allocate it. As I say, that is one way to look at it and the other way is what blocks we spend money on in here.

These are just summary activities. So, you have to keep that in mind.

DR. CORDING: That 43 for support facilities and equipment, what principally would that be?

MR. GERTZ: That is getting the electrical system in place to support TBMs. That is additional pads and roads, I believe, for the drilling program. And that is our sample management facility our hydrological research labs, all the facilities, support facilities. But the big player in this is about 20 million, I believe is to get the electric line into the site. And of course, you could use stationary power, if you decide to that to temporary diesels if you wanted to too. That is a trade-off that we need to make.

DR. BARTLETT: Let me underline that this is just the Yucca Mountain portion of the budget. We are also trying to design an MRS and construct one, procure casks and do other things. So, this is only part of the activities.

MR. GERTZ: This is what we are spending this year. As John says, it is highly speculative of what the number will be next year. Which makes, as the M&O pointed out very aggressively makes it difficult to plan on whether I am going to have a 318 program come October or 150 million program come October.

You know as a project manager, I hear the same debate that goes around the table. Some people would like more engineered barriers. Maybe some would like more geochemistry. Maybe some would like more performance assessment. Some would like some more surface based testing. Some would like to get underground. Some would like a broader institutional outreach program. You can't have all those kind of things. And there is more and more and more.

We go through this debate fairly regularly in the program.

And just to clarify on paper schedules, and I know Ed this comes to answer your question, a 240 million budget, that is what our--and this is 318. Now of course we are going to be looking at whatever money we get to still try to do some things early, one TBM or whatever. But, that was our planning case and the dates for start TBM and for reach main test level with those type of budgets.

DR. CORDING: That would be TBMs from both portals?

MR. GERTZ: No. It's just the one portal at this time. The second one follows it by about eight months or a year.

DR. CORDING: But I mean the cost is for basically two TBMs being mobilized within that fiscal year or something?

MR. GERTZ: Ed, I don't know the answer for sure. I know it is probably buying two, I remember that. I think it is mobilizing one--getting ready to mobilize one. The other one would be in '94.

DR. CANTLON: Okay. Thank you, Carl.

Now, we are right on time. We will proceed now with Dr. Lemeshewsky looking at systems area.

DR. LEMESHEWSKY: Good morning. I would like to go over some introductions here. We have one change from the printed list although it is in the agenda. Larry Rickertsen will be replacing Frank Ridolphi in the listed presentation. He is in the agenda but not on the sheets that are either in my slides

or your books, probably for the papers.

Bill Bailey, Bill Hollaway and Peter Gottlieb, you will hear a lot and you will have a lot of questions today. I wanted to capture this change of pace of going into the systems studies area by giving a little background on our systems engineering work and some key activities.

Obviously, as I think you have heard from me and others before the systems and compliance generates requirements documents mainly. Part of this generation of requirements documents is the identification of decisions that need to be made in the program. Obviously, these have to be tied into the program schedules in some kind of a decision tree and scheduling network.

Two efforts that then trigger all this are then the identification of system studies that need to be performed, both at a system level and then those that affect the individual program elements.

Part of this is more than just identify the individual system study by a sentence, but is to identify the scopes, inputs, outputs, resources, form of the output, schedules, phases and the sequences by which these studies need to be done.

Hand-in-hand with this goes the evaluation and development of a series of models that have been developed over the last six or so years that the M&O is using to perform these studies. In being able to be flexible in doing new studies, we have to keep a continued enhancement going for these studies. And to the models that support them and also in the operational scenarios that we run in performing these studies and that triggers the interest in terms of human factors and approaches to the program that may be sometimes too detailed. But, we need to make scenarios regarding them in order to come up with cuts that perform in these studies.

The objectives of our studies, and these are not all, but certainly key, is we have to develop these requirements documents for the program. So, we not only define the requirements, we also have to develop records of these decisions using these studies, by which we will converge on the program. One other thing that is of paramount importance to us is a concept of evaluation of these studies; the criteria; the measures of effectiveness. It is not always cost. It is not always X, Y or Z. It is a family of parameters, measures of effectiveness of things like that that are a little bit different for each study. So that has been a uniform approach we have tried to put in all these studies, so that we don't have to go back as we have in the years past and redo the same study with a different measure of effectiveness because of time changes and other things affect it. So, we have to--when we identify these studies we look at the full suite of measures that we want to look for for impacts.

Hand-in-hand with this, these studies support decisions that are being made by the individual elements of the programs. With the M&O and the DOE people this is a kind of a hand-in-hand operation in that the M&O is able to work within their organization with their design agents as these studies are being done, so that the trade-offs can be occurring at the working level without undue delay and formality in terms of scenarios and things like that. We obviously don't want to evaluate a scenario that is not of interest to the designer and that type of thing.

A little history on where we have been on system studies. It is hard to believe we have been doing them since 1984 in this program. As early as, in my experience, in '86 and '87 time frame we identified that we could not complete our requirements documents without certain key system studies being done. With the M&O's arrival we feel that we have sufficient resources, integration and the ability to talk with the designers and interface with the right number of people to converge on these decisions and get this effort done.

One recent activity that we have done is just publish last month a digest of all the studies that were done since 1984 and their preliminary assessments. So, that is kind of an important--we want to converge on this. We don't just want to do the same studies and it is remarkable to see how some of the studies resemble the ones that we are doing today.

The last two are an ongoing activity. This isn't a static effort. We have to continually resolve the scope of these studies. The priorities change. The sequences. The near-term--the phasing activities. You'll hear a lot of that today.

In summary, what you hear today, I think with the M&O and Board, we are now in a position to accomplish and address these critical areas out of these studies. Although these studies will continue to raise significant interest, if they didn't raise this interest, they wouldn't be worth doing. I guarantee you that.

The decisions in these areas are needed now, not to hold up the program. We need to make some kind of established positions on these so that we cannot hold up activities that are going on. We don't want to go and converge on the wrong solution. But, we are at a time in this program where we need to make some firm decisions. They don't have to be detail design decisions, but we have to resolve certain approaches.

I am sure you will agree after you hear these presentations that one, you will be stimulated; two, I think you will be favorably impressed as, I am, about the information that these presenters will cover. And I think that this is, at least in some cases, maybe the first time you have heard some of the results of these studies that we have briefed you on previously about our scope and scenarios that we are going to perform. So, I think it will be very interesting.

Thank you.

I will introduce the next speaker as Larry Rickertsen.

DR. RICKERTSEN: As Bill said, I am not Frank Ridolphi.

Frank is the manager of Systems Analysis at the M&O. And in that role, he has had the responsibility for not only managing the analyses that are done, but the development of the overall approach to pull together the various studies to make sure that they will be timely, be able to provide support to the particular decisions that need to be made.

That development is one that we hope to conclude with about September of this year when we produce, what has become and has been called the roadmap or the frame work for the system studies that will be done to evaluate alternative concepts, design concepts and so on.

I recently have come on with the M&O. I have been with a program for I don't know how many years, but several years. And one of the initial assignments was to also work in this same area. The emphasis is a little bit different. Frank's role focuses on the design issues, the design concepts and mine is focused a little bit more on the strategy area. But, you can see that there is a blending of those. So, Frank and I have worked fairly closely in that development.

What I would like to do here is to provide you an overview of trying to do a lot of things at one time to get it to show and illustrate some of the studies that are ongoing and also to get at this overall picture of how these things fit together, both how we see it now and how we envision that will evolve with time.

This particular viewgraph just illustrates for you what we mean by system analysis. It is one that where effects in one area, one element of the system actually affects multiple elements. So the idea is to make sure that you take all that into account, so that as you begin to work on the system to improve it and to evaluate it in various ways, that you make sure that various measures of performance or measures of effectiveness are satisfied, such as safety in cost and how the thing fits together.

An important point in developing any overall framework is to recognize that in the phasing of the program that you will do actually different kinds of analyses. They are strongly related to one another, but the specifics of the analysis will have a different focus.

For example, in the early stages of the program which is what we are in now, will be called concept definition. Whereby concept, we mean the design concepts. Concept of operation. What generally facilities you will use and what functions they will have. That is one set of analyses.

During the requirements definition, once you have your concept and we set up the requirements of that, you will do another set of tradeoffs associated with identifying what parameters you are going to set requirements on and so on. Likewise in design, you will wind up refining the design to meet those requirements and there will be another set of tradeoffs that you will do trading off various aspects of the system one against another to optimize the design.

Then, finally in the close-out stage the compliance statement you will also do analyses. And as I said, they are related to one another. The work that you do during compliance verification is a lot like the work you do in development of the requirements. A very similar analyses but with a different focus.

However, it is important that to see two basic kinds of studies that you do. One is the development of information just to set up the cases you are going to look at. You need some basic raw numbers, data that help you understand what you can do. What kinds of alternatives you can set up just how to define the various cases that you are going to evaluate. And then there is a set of analyses to actually compare various options and various alternatives that you have in mind.

Those are also closely coupled. You don't really-- sometimes you are doing both things at the same time. So, it is important to know that sometimes you'll begin studies, even if you don't know where those studies are going to go because the studies help you set up before you are going to go.

DR. PRICE: Before you leave that slide, what phase is this program in right now?

DR. RICKERTSEN: We are clearly in the concept definition phase. We have a concept for the SCP. That concept has evolved and we are evaluating alternatives to that concept. You heard yesterday about the robust waste package. The SCP concept is a thin-walled package. So, that is an alternative concept that is being evaluated at the present time. Cask alternatives and so on are being evaluated. So, we are still in the concept definition phase. We are doing a lot of requirements definition with this phase also.

The program, for example the MGDS is at a stage, the MRS is at a stage, so we are going to begin license application for the MRS in the fall. So we will be at the design and development stage for the MRS soon. So, you have to take into account--the main point of this slide is that there are different kinds of analyses that you have to build a roadmap for. But we are at different stages. We are at a variety of stages. We are clearly not at compliance verification yet, so essentially in my opinion, most aspects--the thing I am worried about is the concept definition stage. The critical issues happen to be in that area right now. That is the one we get asked the hardest questions about.

DR. PRICE: The reason I asked the question is because as your answer indicated, I don't think that the phase of this program if you look at it as an overall program, is very clearly determinable. Some of the things blur at me as I look at it in trying to figure out what phase are we really in.

DR. RICKERTSEN: Well, in most large projects of this size there is always that blurring. It is hard to separate out things. There are people who might be made managers over various aspects now wind up working for one another at various times. But clearly the concept definition phase we are still in that. We haven't left that one yet. And there will be some--and I would imagine as you move into the latter stages of design that that will begin to diminish, although there will always be new ideas proposed by people; good ideas that ought to be looked at. And I will come back to--most of what I have to talk about is what you are doing in the concept definition phase.

DR. PRICE: It appears to me though, just a quick comment, that the design and development is kind of intermingled with this thing and tends to get confused with other concepts and Freeze's decisons along the way before all alternatives are carefully massaged.

DR. RICKERTSEN: Actually, it is a point I wanted to make and I am glad you made the point for me.

In the development of the roadmap, it is very important to us to emphasize the fact that there are people who--as I will talk about later, there are stages that you go through in this phase itself, and you will be looking at alternatives. Sometimes people feel we are not examining those alternatives. We have already sat on a particular pathway by the SCP. And we want to emphasize that there are in that roadmap that will be developed, you will see actually comparisons of various alternatives. I will talk a little bit more about that.

As I mentioned to you, there are some of the analyses that you do, system analyses that you do right up front to produce data. In addition, sometimes even though you don't know quite where you are headed in detail, you know that some decisions are going to have to be made early and so you will begin to do system evaluations, even though you don't have the roadmap completely mapped out. And that has already begun. We have already completed a number of study evaluations, some are also ongoing to feed particular near-term decisions.

One of the studies that was begun early, almost as soon as the M&O came on board was the Throughput Study. You are going to hear more about that Throughput Study. Bill Bailey will be talking about that. And that is providing information not only--well, basic information that you will need just to set up what the MRS will look like, what the throughput rates and what the capacity rates are and so on, that help you define the various options that you will look at in those cases.

In addition, there are some natural evaluations you do as you evaluate throughputs. You begin to do some optimizations right away. It is very natural to look at costs to the extent that you can incorporate them and so on and Bill will be talking a little bit more about that.

I want to talk about building a framework that you would do for system studies during the concept definition phase. And analogous framework or generalization to this will apply during other stages, but let me go on with this. The main point I want to emphasize on this viewgraph is that the framework needs to provide an integrating mechanism for all your studies. One of the things you will find right away is that people looking at the MRS will say what is the throughput for the MRS? What is the capacity for the MRS. And that question is not an MRS question. It is system question. You answer that one by knowing what throughput for the entire system is; what the interfaces are with the other aspects of the system.

Therefore, beginning an MRS study of throughputs doesn't quite answer--doesn't get at what you need to know. So, you would like to have a map of all the studies that you do to see how they tie together.

The real integrator is, I don't know how to emphasize this, maybe it is so obvious that I don't need to emphasize it. The studies that you do don't make decisions. There is some decision out there somewhere that you are going to resolve. Some higher level decisions and then lower level decision for that feedback. And that is what controls what you do. The system studies merely provide information that you need. If you decide up front that you are going to make a decision and you don't need any more analysis than that, automatically says for the purpose of that decision, you don't need a bunch of system analysis.

There is--I don't know if the decision has been formally made, but in the presentation on waste package, there is a fairly strong pressure to move toward robust waste packages. It is almost as if that decision has been made. I am not sure it has been formally made, but I suspect if whatever was discussed yesterday, that there will be an effort to change the baseline toward a robust package. There are some refinements as to exactly what you mean by that. But, system analyses to decide whether you are going to go to a robust waste package or stick with a thin-walled waste package are probably not necessary. The decision may have been made. I am not sure that that is really true. I don't look at the decision makers that say that. But, if that decision had been made then it wouldn't be worth a whole lot of money to do that analyses to see if the thin-walled waste package is a good idea.

Once the decision has been made, that determines how your studies go and that is the focus here. It doesn't show that in order, but basically third bullet on here essentially deals with that.

DR. PRICE: Could I just comment on that. If you turned that around a different way and say that the decision has been made for thin-walled container, therefore we are not going to do a systems engineering evaluation of it, because we have already decided we are going with a thin-walled container. The program may suffer a great deal unless you can support that with a system study, because later when demands are placed to justify this decision and show that the decision was in the best interest of the American public, you say well somebody made a decision, so we didn't do any system engineering. So, I would like to challenge what you said by turning it around the other way and indicate I think the systems engineering with all of the alternatives have to be on display as having had a reasonable and prudent evaluation.

MR. RICKERTSEN: Somehow, I knew you would say that.

I guess the point I wanted to make, and it is an important one, is that there is a time at which a decision is going to have to be made. There are some cases where decisions could have been made in the past and just weren't made. And one of the things we are afraid of is closing off options. And appropriately so.

At some point though decisions with more or less degree of information. We want to make sure that we have adequate information, but if we hold off on that forever there are decisions that will never be made. At some point we are going to have know the thermal loading for the repository. We may not have all the information that one can gather to do that. We need to do everything that is appropriate for that, but at some point the decision maker or whoever it is out there will have said, I am going to take the risk based on what I have. And all I am trying to get at is to look at that opposite side of the question that at some point you have to make a decision, and you may not have all the information that someone thinks you might have, and you are going to have to defend the case against Boards like this and the public and other people.

The main point I want to get out at this point, is that the studies that you do don't have a life of their own; should not have a life of their own, that we do studies just because we like doing studies. The purpose of the study is to support some decision out there. And, you would like to know what that decision is. You would also like to know when the decision has to be made, latest date, earliest date, whatever it is, so that you can say, do the evaluation and say, you know, to get the information to do that and make that decision, I am going to need ten years of information, but I need the information today, or I need it in two years.

Therefore, the studies that we are going to do we are going to be very limited and we are going to have to go with that. And the roadmap allows you to think that through and that is the idea. All of the kinds of risks that we need to take that will be taking and so on, you can get a heads up view of that by looking at this roadmap and seeing what is at stake.

You begin with something called a Reference System

Description. A little hard to get at that. We have begun on that process already. It is not clear to people what you mean by the reference system. Is it the baseline? Is it what we are currently doing? Is it what we would like to be doing five years from now? What is it?

Basically, the view that we have is the system studies are ways of comparing various alternatives. The reference is just one of those alternatives. So, out of the baseline, the current baseline may have several alternatives in it. The reference system would be one of those alternatives. There would be other alternatives that would also be described, maybe still within the baseline. I don't know if I made that very clear. There is a difference in the baseline and the reference system description.

Then you can also define what those alternatives are, and then based on what those alternatives are, you set up a decision, a hierarchy for getting at those alternatives, drawing it down to lower and lower level detail that you think is appropriate.

An important point about that is, this milestone, the timing, when you need decisions by. And so one of the things that we found very important was to include a reference and description of a list of milestones, when decisions have to be made in that reference system. You probably need the same thing in each of the alternatives.

You'll find out that there may be some information that just isn't timely and therefore that study may not be as necessary and we are lowering the system priorities.

Once you have that decision hierarchy, milestone schedule and so on, you can develop your roadmap of system studies, and the models needed and the data needed and so on.

An important point of this is that when you are completed with this, you have gone through the process of developing the roadmap, you have this top down approach to developing studies, an important point is it doesn't stay static. You find right off the bat, that as you proceed through the different phases you will be adding studies to that list, timing them according to what you need for those decisions.

In addition, you find that in some cases there will be decisions made along the way that will determine which direction you go with your studies. So you'll close out some studies and you will introduce new ones or you will clarify ones that you had stated fairly ambiguously before because you didn't want to go too far down the road until you had some more information.

So, the roadmap needs to be a dynamic thing. A very flexible thing, casting it in stone will be a disservice. And one of the interesting things since I have come on the M&O one of the things I have been interested to find out is how flexible the M&O is in dealing with the configuration management and change control that is automatically on our program on us, and at the same time handling this dynamic approach.

In talking with people, they don't seem to be afraid of this and they seem to be aware of the problem. It will be interesting to see how we are able to deal with the problem. It is one that has faced us in quality assurance and in other aspects. We get frozen into things that we feel we have to do although they are no longer timely.

Let me just say that where we are at. We have almost completed with the reference system description and with alternative descriptions. Not quite done; it hasn't gotten all the review that it needs to have. We have begun to flush out the decision hierarchy. We plan to have the decision hierarchy and the roadmap system studies and so on by September. So, that should be just about in time to help drive us through the rest of the program.

However, that doesn't mean that you can't be doing studies now. We have found already, we know from the preliminary work we have done in developing this decision hierarchy that there are some decisions that are near-term that need analyses right now. We need both information to set up cases that we are going compare and we need to have some analyses done already.

Two of those areas that we know are very--that we need information on very quickly, thermal loading study and alternative cask concepts. Work is already ongoing on those. We won't stop that work waiting for the roadmap to go. In fact, it doesn't make sense, because the roadmap will be constantly moving anyway. I have to be careful saying constantly moving. That scares a lot of people. But you need to make sure that it moves as the program moves.

Let me just give you a little brief introduction because Bill Hollaway is going to talk more about what has been done on the cask studies, some that have already been done and then one that is ongoing that is based in part on those studies.

I think what I hope is you will look at that in addition to all the things he wants you to look at, that you will kind of get a grasp of the scope and the approach that is used and look at that critically to help us.

Another one that we'll be discussing is the thermal loading analysis which apparently you have some interest in and I want to make sure that we are doing some work in there. You actually have been briefed on this already. Peter Gottlieb will be presenting something on this, basic problems of thermal loading as a question to help in some aspects of the repository either to help by condition the system so that it performs better, it is safer or it is easier to demonstrate compliance, or maybe you can put more waste in the repository and so on. At the same time there are system implications. And Peter will be talking not about the whole question, but the system implications, that is impacts on the MRS and the transportation system.

Now, what I want to do, having said all that, I would like to, hope if I can talk about an example of what I mean by the system roadmap, studies and models roadmap and use thermal loading strategy as an indication of how we are proceeding. I hope I don't steal much of Peter's thunder in doing this.

But, I will just give you a little brief notion of how we are proceeding and how we have chosen to do pieces of the work initially and so on.

The work is actually in two phases as was given in the briefing before. The first phase work is essentially completed. There needs to be a report written and the draft should be soon and the final will be out in September. And it will address some aspects that we consider important to get at in the very early stage.

I don't want to do too much with this slide, because Peter will do a much better job, but talk about the last thing that it is important to note this. The thermal loading study that he reports on would discuss does a couple of things. It gets at some aspects of the problem, but it doesn't get at the whole question. You won't find out from Peter's talk what the thermal loading should be, because we don't know yet. We don't have enough information. Peter's focus was on what the system provides. There was a little bit about what will happen in the MGDS but not enough to be able to make a decision yet. So, that is not in there. And that is not the focus of what he will be presenting.

Let me talk about what happens in the roadmap. Basically you have a couple of decisions as you aware. License application and design of MGDS starts in about the middle of 1996. So a decision on what the thermal loading strategy should be for the repository should come somewhere about that time frame. I don't know, maybe 1997, depending on how far along in that design process you could carry alternatives; but, somewhere in that time frame.

The MRS license application design begins in the fall of this year. Therefore, decisions about the MRS need to be made early. If there are any implications of thermal loading on the MRS. And for that reason, the phasing thing, that we needed to get some information just to set up what we are going to do for the whole question, but also, we need to get at what kind of a decision are we going to have to make with the MRS? Here is a couple of alternatives.

You can adopt a strategy in which, for example, you can pick a thermal loading strategy based on whatever considerations you want to make. For example, there may not be sufficient information from the testing program for the MGDS to influence your decision, you might as well make the decision now. There has to be an evaluation of whether that is true or not. That is part of the early phase of the thermal loading strategy.

Another approach is to adopt an MRS design that can handle any thermal loading strategy. It would obviously be more costly, so you would have to go through and figure out whether there is an effective trade off there.

One of the things that you have to do to prepare for that is to evaluate the range of possibilities for the MGDS. What kind of package loadings are possible? What kind of areal thermal loadings are possible? What kind of waste characteristics determined by cooling or other aspects of the system are possible so that you know what range you would have to be considering in evaluating this strategy. And another one is the minimum impact to say MGDS be damned, we are going to design the MRS this way and MGDS you will have to thermal loading strategy within that set of parameters. And that is a third case. You are going to have to provide information to decide which of these there is the case. And that is the focus of the early phases of the thermal loading strategy to decide early what kind of decision to make for the MRS.

And, early on you needed some information to set up those cases and also to do a preliminary screening. You might find out that it is not practical to even consider some thermal loading strategies, as I said and that is the subject of the Phase I study.

Well, what I would like to do here is just introduce the next three speakers who will give aspects of system studies that are currently ongoing and in some case Bill Hollaway will be talking about some past ones which are relevant to this and I will tell you the scope that they do and the kind of information that is being provided that will set you up and also tell you a little bit about what we think is in store the next stage. And then after that presentation, I would like to come back with one additional slide and try to draw one more point out of all of this.

DR. PRICE: Excuse me. Let me simply ask about the roadmap. What you have presented at this point is a concept of a roadmap. Now you are going to--the next time we hear from you going to present something more concrete about that roadmap, is that what we should be expecting?

DR. RICKERTSEN: Yes. We will be prepared to make a presentation in the early stage, I think I'm scheduled with a meeting with PMR to talk about the roadmap and where we are at with that. As I said, the development will be completed--the milestone in September, and I would certainly expect, I am not the decider on that, but I would expect at that time we could provide a fairly comprehensive view of what that roadmap is. I would expect.

MR. MCFARLAND: You made a couple of comments, very interesting that you would develop a baseline configuration and there would be alternative configurations that would be developed also. You mentioned that this Phase I would be to look at these alternative configurations, and at the completion of Phase I, like to identify a preferred configuration for which--although the first phase does not address the ability to achieve the desired effects.

DR. RICKERTSEN: Thermal loading you are talking about?

MR. MCFARLAND: Yeah.

How will you make the decision for thermal loading if you don't have the ability to achieve the desired results?

DR. RICKERTSEN: Well, here is what you need to do to do thermal loading.

First of all, you have to go through this evaluation to find out what your constraints are; what you are allowed to do. And that is actually a fairly difficult job, so you are going to have to speed through it in some way. We have a notion of how to do that. We are able to get at it, I think we have got good information with regard to the constraints that the MRS and the transportation will put on it. We don't know exactly yet how the MGDS will constrain it. There are some notions that you could, for example emplace the waste and then to get a higher density go back and emplace it again. We are not sure you can do that or if it is appropriate to do that. We don't know what the safety aspects are, there are a number of questions in that regard that still need to be answered. That is the first thing you need to know.

The second thing you need to know is then to define for yourself a set of scenarios if you like, that are true thermal, alternative thermal loading strategies. In our case, you will see in Peter's case that he will provide a set of scenarios. We think they give you--they bound the problem. They may not. We are not sure exactly what temperature conditions, thermal conditions and mechanical conditions and so you are going to get in the repository.

So, the next phase would then to be define real scenarios. And the work that you will see Peter report on helps you get a handle on that. There is another piece you need to do with regard to the MGDS. Then once you have done that, you need to get at what the impacts are. Those impacts are do you get a thermal loading strategy that you want? Do you dry it out for 10,000 years or can you put in the amount of waste you want? Whatever it is.

Then you need to look at system impacts in detail. You need to look at designing impacts on the casks and the canisters on the repository design. You can see how this question goes on and on.

You want to know about cost? And there are a number of associated costs. Those things go on down the line. You can't get at all those without--well I don't know how much information you can at all those. To do the full scale modeling that you need to determine what the--when you get the thermal loading strategy, I am not sure you can do that within the next five years, because you have to take into account boiling, evaporation, so on and so forth.

MR. MCFARLAND: If it is determined or that you come to position that says that testing is needed in order to make a definitive selection, will there still be an effort to make a decision prior to that testing?

DR. RICKERTSEN: What we will evaluate is, whether it is worth making--whether you really need to get all the test data. Whether you should get the test data. Whether the benefit is so high out of a particular strategy that it would really pay you to get the data, then at the same time you need to look at how long it would take you to get the data that you need. It may not come by 1996 or 1997 and then you have to evaluate just how much this particular strategy worth it for you. And that is a very important question.

In the 2001 exercise there are a number of efforts to look at that very question. To look at what information you get early out of the ESF and what information you can get later and whether you can get the information some other way. That hasn't--we haven't come to those conclusions yet, however, that should be done in the early phase of the thermal loading strategy. It hasn't been done yet.

We hope that--well, I don't know. If I had to guess what the answer is, having worked on the thermal loading problem in 1976 and 1979 and 1981, when the decisions were made there, the basic conclusion is that there are some intuitive feelings that you get. Of course, none of those really looked at the unsaturated zone, so there is some new impacts. But there are some intuitive feelings that you get about the value of a thermal loading strategy. One of the conclusions you can find is that it is hard to get a hot repository. And maybe going for a hot thermal loading strategy, may be a lot harder than you think. You may be impacting the system, I may be giving the answer ahead of the time, I don't know what the answer is, but that is what my intuition says, that you will really be impacting the system in a very significant way to get a hot repository. I think we all know that.

DR. CANTLON: Thank you.

DR. PRICE: Could I ask another question?

DR. CANTLON: Go ahead.

DR. PRICE: You indicated that the thermal loading impacts on the MRS had a priority because of the date in which the MRS considerations had to come by. Is it not relatively true that there are certain dates that are milestones in this program and which from your viewpoint are pristine. That is you can't contaminate these dates. Those dates are there. And these dates then force you in a systems engineering context into having to make, adjust your systems engineering program and having to make decisions also with respect to those dates that if you didn't have these dates dominating the scene, you would probably go about it differently?

DR. RICKERTSEN: The answer is yes. That particular one is driven by 1998, pure and simple.

DR. LUCE: In evaluating in a systems manner, the thermal loading, I didn't hear you mention, but I guess you are aware of the possibilities of increased uncertainty with the high thermal loading as far as permeability changes, chemical changes because you are dealing with a sort of a never-never or a very unresearched field by and large where you have both high and low temperatures and you are in a situation where kinetics are not known with as much certainty as lower temperatures or much higher temperatures.

Is this sort of thing, is this going to be factored in, the uncertainty that might come from a high thermal loading and also the perception that the public might have on something that is not as certain as one would like?

DR. RICKERTSEN: The answer to the first question is that it is one of the most important things that you have to consider. If what you are trying to do is to reduce the uncertainty and get through licensing or risk uncertainty in the program that occurs because of the flow system, what new uncertainties are introduced by a high thermal loading, and do you gain something by going to a low thermal loading. That is a very important consideration.

We have in, and you will see in Peter's slides, a statement that says that one of thing is public considerations. I don't know quite how you do that. I have looked at it, you know bring in decision analysts may be the answer. I don't know how you take care of that one. It is there. I don't know how you would address it. I don't know, some people are going to have lack of confidence no matter what we do. So, I don't know quite how you assess that.

DR. LUCE: We learned a little bit, I think, over in Finland and Switzerland as well as Sweden and they would like to present their information so that the average person could understand it without resorting to understanding stochastic processes.

DR. RICKERTSEN: There is part of our effort to develop a long term strategy and bring about additional confidence in using the Department of Energy and the way we present things.

Just what do you do? What are we doing wrong that we don't have the confidence? And one of the things is the robust waste package to my mind, is one way to get at that. That intuitively you are going to have a better system if you have a robust waste package. And maybe intuitively you will have a worse system if you have a high temperature regime. We need to get at that.

DR. PRICE: Is the existence of the MRS which is kind of a foundation of what some of these things are in the next presentations as a matter of fact. The existence of an MRS is that one of these things where a decision has sort of have been made and you feel that that is a given now that you work with? Or, do you feel that the systems engineering background and studies to support an MRS versus no MRS have indeed been made?

DR. RICKERTSEN: The two drivers in our development so far, as I said we are only part way through that development, the two drivers are the 1998 date and something like a 2010 date for putting waste in the repository are both drivers. Of course, one is not cast in stone type of driver. Like 1998 is one that is not cast in stone, but there are contracts out there and a regulation that says 1998. So, we will have to deal with that if that is not the case.

So, one of the alternatives that could be introduced is a different date, or no date for the MRS, or no MRS.

One of the recommendations made in our reference system description is to consider the alternative of no MRS. So far the development hasn't included that, but that is one of the alternatives that would need to be entertained.

DR. PRICE: So your answer is, at this point it is a given, but the necessary system engineering studies have not been made.

DR. RICKERTSEN: That is correct. So far.

DR. BARTLETT: Mr. Chairman?

MR. CANTLON: Yes, John. Dr. Bartlett.

DR. BARTLETT: I wonder if I might make some comments from the director's perspective on some of these issues and talk broadly about how and when the circumstances and decisions compel the studies and the studies and the inverse of when the studies might compel the decisions.

First of all, I would observe that for the technologies that we know of right now, and the alternative constructs for implementing this system, there are in fact over 2500 ways the system might be implemented. So, first of all there has to be some sort of scoping thing that brings us down to reasonableness. And that is one of the purposes of system studies to bound it into reason.

And then there are some other issues that do constrain the studies and also give focus to progress in the program. For example, what Dr. Price was just addressing, because the schedules for under contract to begin receipt of spent fuel call for doing that in 1998 and because we know that we can't begin disposal until 2010, in essence there has to be an MRS and that kind of function makes sense for the program as it stands.

Now you get into questions like have been raised of "what is the throughput?" Well you can do a sort of a generic or sterile system study, but the fact is the reactors in the United States discharge about 2200 metric tons per year. In order to eventually move the stuff at decent rate and empty the pools, the throughput rate simply has to be something on the order of 2500 or 3000 metric tons per year at steady state. Then you get into the questions of what ramp rates to achieve that and then all of the design issues to achieve that rate throughout the system. You also have the currently legislative constraint of a capacity limit of the MRS of 10,000 metric tons. That could be adjusted if it is acceptable to the host.

So, there are these factors that constrain it. One more other illustration I might mention is that some time ago there was a what we call a limited scope thermal loading study done, which indicated if you wanted to run a cold repository you could not begin loading until 2080. That is an unacceptable result. So, what that means is that question is how hot of a repository do you run and what are the factors that govern you decision concerning that? And you have factors such as the cost of a robust package against a less robust package and the defense in depth aspects of the issues encountered during regulatory reviews governing some of those decisions.

In general, one of the questions I ask is how much independent decision making can the system tolerate or to put it another way, how loosely coupled or tightly coupled can the system be? And to give you an illustration of why that is important is under the process that is being followed with the MRS, the host can have a lot to say about the design choice. That is independent decision making in effect. Can the system tolerate that? In fact in my judgment it can at this point. We have a range of design concepts from which the host can choose, and then we can work in the throughput rates and everything associated with that.

Similarly to give you an idea of the need for a loosely coupled system, we have built an inventory of specific data on every sub assembly at every reactor; 111 reactors; tens of thousands of sub assemblies, and let me say, there ain't no two alike.

We cannot ask the reactor to go pick a specific sub assembly to meet a heat tailored objective. The system has to be flexible at the detail level. When the reactor owner sits in the queue where he has opportunities to ship so many metric tons, he is going to ship what he wants to ship; not what we want him to ship. And we have to accept that as part of the requirement of flexibility in the system.

So, fundamentally the system has to be tolerant of flexibility which accommodates these kind of details. The system level study should recognize that. They should also recognize these compelling constraints which affect the scope of the work to bring it down to something doable in a publicly acceptable time frame.

DR. CANTLON: All right. Woody. Dr. Chu.

DR. CHU: I had a question which Dr. Bartlett almost completely thoroughly addressed, but I still have a little bit of a question left and that is, I mean I understand that you are operating under constraints, both under past legislative decisions as well as policy decisions that haven't been made. You have contracts that you have signed and therefore, you are operating under the constraint as to how the world may operate. Nonetheless, we have a physical world from which we can build these models, that is derive a paradigm from which we can gain understanding and a physical world is unconstrained by that and that is having these sites generating waste on a continuing basis and accumulating waste on a continuing basis, where now the decision is being made as to whether or not, some day in the future, some of this waste may or may not got to some centralized site to be stored and the rest would have to go to a repository. And my question was as to whether you thought there may be benefits gained from looking at the system as a paradigm that is derived from the physical world as opposed to the constrained world. As to--from the--as to the insights that you may gain. Because, the way that you may want to overcome these constraints having an MRS, for example, may not come out the way that you hope for. And so the unconstrained paradigm may give you insights which you may not otherwise gain through modeling of the desired state. That was my question.

It would have been different, had you not gone through your discourse, John.

DR. BARTLETT: Let me try and answer it this way, Woody, I think there is quite a difference between what you would think is the paradigm optimum system and an acceptable system. There may be a multiplicity of acceptable systems, which are being defined by not so much what is technically optimum but what is practical and accomplishable given the circumstances that really shaped the system.

I think within that field of 2500, there is a multiplicity of acceptable answers. There might be one that is technically or whatever optimum, but you don't necessarily have to achieve that one. What you have to do broadly for our program purposes is achieve the mission on behalf of society that has been set by Congress. And I think that gives us and requires us the opportunity to deal with the flexibility that is within that.

DR. CANTLON: Well, let's go to Mr. Bailey before the break.

MR. BAILEY: Last September I briefed a Nuclear Waste Technical Review Board on our plans for system studies. Today, as Larry has indicated we will discuss the status of these studies.

The Throughput Study is one of the major studies that is currently underway. It was started almost exactly a year ago and is scheduled for completion at the end of this fiscal year. We expect that there will be future updates and we will probably, we'll assuredly being using the throughput methodology to support other studies in the future.

The primary objective and purpose of this study is to establish the preferred rate in which to move spent nuclear fuel and high level waste through the CRWMS. As you know for quite some time a 3000 MTU per year in received rate for both the MRS and the repository has been used as a reference. But there is no clearly documented rationale for that. Evidently it originated based on logistics calculations some time ago when the ground rules were different from what they are today.

Also there was a study conducted for DOE about a year and a half ago which recommended consideration of much higher throughputs. This study was based using life cycle costs exclusively as a measure of effectiveness and it also assumed no inventory constraints on the MRS. So, we will also update these previous throughput rate studies by incorporating current updated cost and other data. And we will also evaluate non-cost measures of effectiveness as well as cost.

Now, I might mention that I think one of our accomplishments to date is that we have significantly improved the methodology that has been used before for evaluation of CRWMS scenarios which allows us to evaluate them must faster. This was accomplished by recosting one of our primary models on a much faster computer and by automating the interfaces between our waste stream analysis model and our cost model.

Specifically, also we are developing data to establish the throughput rate designed bases for each of the CRWMS system elements and to provide sensitivities and trade offs to guide design decisions and performance criteria for inclusion in specifications. And we will also determine sensitivities, identify constraints and cost drivers.

This chart shows the assumptions and guidelines for our study. We first determined the preferred throughput rate for a reference case. And then we considered impacts of variations on this reference case on the determination of this preferred throughput. Now let me point out at the start that our reference state is the starting point for our analysis. It is not necessarily at this point in time intended to be a baseline, any sort of program baseline. And also the variations to the reference case assumptions that we use are not intended to be thought of as a program alternative strategies. Rather they are--the impacts or changes that might occur and contingencies.

Scanning down the list, for example, at this point in time we are now looking at the western generic MRS location. Initially we were considering only the eastern generic location. We are assuming that the repository has its NWPAA limit of 70,000 tons inventory of which we assume 63,000 tons is allocated to spend nuclear fuel.

And looking at the last bullet on the chart, at-reactor post shut down storage costs turn out to be a major cost driver. These costs are on the order of $3 million to $4 million per year per a shut down reactor.

Now these costs are not part of the CRWMS at least until such time as DOE takes title of the fuel. But they are related costs that are borne by the utilities, so we present the data both ways. We show the data including these costs which we call total systems costs and without the costs which we call CRWMS cost.

DR. PRICE: What does oldest fuel first or acceptance rights and selection means since in fact the utility can deliver any fuel to you when they are in the queue?

MR. BAILEY: Okay.

The allocation rights are determined by oldest fuel first. The utilities do not necessarily have to give us oldest fuel first, but we go to them in that order. If they choose to give us fuel other than the oldest fuel first, there will be some sort of negotiation between DOE and the utilities as to exactly what that should be. At this point in time we don't know exactly what their intentions are, and we are looking at alternatives there.

DR. PRICE: You say there will be negotiation--I thought that the utility had the privilege of delivering to you when they came in the oldest fuel first to the top of the queue that they delivered to you what they wanted they wanted to get rid of.

MR. BAILEY: My understanding is there is a provision for DOE to negotiate this, although that is the initial interpretation that they do not have to provide the oldest fuel first. I think there is latitude though for DOE to negotiate.

DR. PRICE: On your slide for acceptance rights makes it sound as if DOE has the acceptance rights based on oldest fuel first. And that isn't right.

MR. BAILEY: That's correct. That is correct. We meant the acceptance rights for the utilities. That is what this line was intended to convey.

Our methodology begins with the generation of realistic loading scenarios for spent nuclear fuel and high level waste for the reference case and alternative variations to it. We use the characteristics data base to provide projections of spent fuel discharges. We use a model called a waste stream analysis program to characterize the nuclear waste streams and to sequence fuel shipments according to allocation rights and it can support various acceptance strategies.

We also use a series of interface programs to aggregate the data by year, to compute cask purchase requirements and to add the high level waste stream. This also reformulates the WSA output into a form that can be input to our cost model which is the System Engineering Cost Analysis Model, SECAM developed by Pacific Northwest Laboratories. Now, as Art Greenberg mentioned yesterday, the M&O is developing a total system model which will when completed and operational will provide still more efficiencies and more flexibility in particular to when we make changes and modifications.

And the final step is to use these models to evaluate measures of effectiveness. We do consider, as I said life cycle cost and other measures of effectiveness which I will show on the next chart.

These are the non-cost MOEs that we have considered. Several of them may be thought of as surrogates for risk or public concerns such as waste handlings. Some of them really only come into play when we make changes such as having a western strategy or not having a western strategy or if we alter cask capacities, or if we have MESCs or not have MESCs.

Now this chart shows our principal results to date. For our reference case we have determined the preferred range of system throughput rates and it turns out to be a range and not a single value as I will show on the next charts. And that range is 3,000 - 5,000 MTU per year.

We identified the corresponding MRS operational concept which is consistent with the MRS CDR reference design concept which uses dry vertical concrete storage casks as the storage technology.

We have provided MRS inspected receipt rates and shipping rates for spent nuclear fuel as well as spent nuclear fuel and high level waste receipt rates for the MGDS. And we are continuing to analyze impacts of selected variations. We are also continuing to develop cask requirements data to support the Phase I transportation cost procurement that Ray Godman talked about yesterday.

This chart provides a schematic of our reference scenario. The bars refer to rates and are measured on the scale to the left. The lines are inventories and are measured on the scale to the right. So, for example, notice that for the MRS, we initially ramp up to 900 MTU a year. Then in 2010 when the repository starts to accept fuel and at which the MRS inventory has reached its capacity of 10,000 MTU which is the most it can have, according to the NWPAA until the repository starts accepting fuel. At that time, we then ramp up to 3,000 MTU per year.

Now, after the MRS inventory reaches its statutory maximum of 15,000, we continue to ship spent fuel to the MRS but we switch to a pass through, flow through mode of operation. And I will describe that on the next chart.

Notice also the line which represents the spent nuclear fuel inventory at the reactors. In 1998, that inventory will be almost 30,000 MTU. Notice that during the 900 MTU per year range, we still do not accept fuel as fast as it is being discharged. But then once we switch to our steady state 3,000 MTU per year we are bringing the inventory in the reactors down. It never gets to zero, and that is because as I mentioned before under assumptions, we have a 70,000 ton limit on the inventory of the repository of which 63,000 is allocated to spent nuclear fuel and the EIA projection with no new orders and no lifetime extensions beyond 40 years, is for 86,000 tons. So that leaves 23,000 tons unaccounted for and presumably we would either have to have a second repository or have to lift the limit on the first repository to eventually accommodate that fuel.

And by the way, I might mention that when we talk about a throughput rate in this case 3,000 MTU per year, we are referring to the steady state operation. And that is for convenience, we define that as being the rate at which fuel is received at the repository. In this particular case that is also the same as the rate at which fuel is taken from the reactors.

Now this chart may be out of order in your books, but it is there (p. 10). And this shows the same information focusing on operations at the MRS. And notice that again that when we are in steady state operation, we go to pass through and flow through. And what I mean by that is in pass through, if a truck comes into the MRS carrying spent nuclear fuel, the fuel is off loaded and then loaded onto a rail cask for a transfer to the repository. If a rail cask comes in, then that rail cask is loaded directly onto a dedicated train and we call that flow through. A dedicated train for a shipment to the repository. So, no fuel in the case of flow through, there are not waste handlings at all at the MRS, and in neither case is any fuel stored at the MRS. It is either passed through or flowed through.

Now, the reason why we continue to ship fuel to the

MRS in the pass through and flow through mode is in order to consolidate shipments at the MRS, and reduce total shipment miles for the CRWMS. Now, obviously, this particular advantage of the MRS diminishes the closer the MRS is located to the repository. And in fact if they turned out for example to be in adjacent states, we would probably dispense with a concept of pass through and flow through and ship directly to the repository.

I might also mention that this particular concept, which is consistent with the dry vertical storage, concrete cask storage technology, doesn't especially well support selective withdrawal from the MRS according to age and burn up which might be used to support a thermal loading strategy as we talked about before. And we will say more about that in Peter's talk on thermal loading strategy. If we wanted to have an MRS oriented that way, there are other alternatives which would be considered.

This chart (p. 7) shows the annual costs for our reference case, in this case using the western strategy. Notice the costs are broken out according to the operating element of the CRWMS. The lowest set of costs there are the MRS costs and the next layer is transportation and then the repository surface facility and then the repository underground and then lastly on top are the waste generator costs which are almost entirely the post shut down storage costs at the reactors.

Notice the spikes in the MRS and the repository surface facility costs early on are the facility construction costs. These data by the way are based on the Parsons Sandia data which are incorporated into SECAM. We are currently in the process of updating the data for the MRS based on costs which are currently being generated by our MRS design team.

Notice also the relative magnitude of the waste generator costs, those that are in green. And by the way, they are cut off at the year 2041 just to have a constant basis of comparison between each of our throughputs that we looked at. 2041 happens to be the last year of emplacement for slowest throughput rate that we looked at, which is 2,000 MTU per year.

But, you can see from the size of these costs, why the utilities would have an interest in high throughput rates that would move the fuel away from the reactors quickly. But, from our point of view we have to look at it from the total costs which includes the cost of building the facilities at the MRS and the repository.

Now this chart shows the total system costs as a function of the throughput rate at which we take the fuel. And this does include the post shut down storage cost, the waste generator costs that I referred to.

So, notice that with the exception of the 2,000 case, which is clearly higher, the curve is fairly flat, almost all the way out to 6,000.

The range that we selected was 3,000 to 5,000 and the reasons for not including 6,000 had to do more with logistical considerations than cost considerations. It turns out at the 6,000 MTU level there are years in which later in the program in which we simply would not be able to take 6,000 because it wouldn't be available. And also earlier in the program when it is available there are some difficulties of actually taking the fuel at that faster rate and those are being explored in more detail at this point in time.

I might also mention that these costs do not include discounting of future costs. If we do include discounting, which we have looked at, it tends to favor the lower throughputs, because the lower throughputs push the cost further out into the future.

This chart shows the reason for the relative flatness of the cost versus throughput trend. Notice as we increase throughput capital costs increase, and this is because we are having to build larger facilities. On the other hand operating costs decrease with increase in throughput because we operate for fewer years of operation. So, the net effect is they tend to balance out which causes the flatness in the curve that was shown on the previous chart.

Now in addition to evaluating the throughput scenarios per se, we used the throughput methodology to investigate special cases and to support the other studies we are doing. I am including two graphs here to show examples of special case analyses. In this case we were looking at the optimization of the size of the trains to carry the fuel from the MRS to the repository. And it clearly has an optimum somewhere around ten to twelve cars per train case.

This is another special case that we looked at and this is the variation of the oldest fuel first acceptance at this time. What this does is give priority to shut down reactors. It says we would go to the reactors first that are shut down. And the two bars to the far right are the totals of the others. Notice that there is a savings in total system costs if we operate in this mode, and it is entirely due to the reduction in costs in costs incurred at the reactor. But notice also in the reactor costs that dry storage costs actually increase. That is the white bars there at the top of those.

And this is because by not following the oldest fuel first allocation, some of the very oldest reactors would lose their position in the queue and have to use more dry storage instead.

This chart summarizes most of the activities that we are working on now and will be completing between now and the end of the fiscal year. I also want to emphasize that besides the things that are done specifically for the throughput study, that we are using the throughput methodology to support each of the other studies that you will hear about in a few minutes, and we will continue to do that.

The first bullet that refers to analyses ongoing regarding the transportation cask, I mentioned the work that we are doing now in determining number of casks required for the Phase I procurement. We are doing similar analyses for Initiative I, and also we are looking at some of the logistical issues associated with high throughputs that I referred to before.

We are looking at alternative acceptance strategies. I just showed one. We are also looking at youngest fuel first and other strategies that we anticipate or changes that we anticipate that the utilities might request.

We are analyzing alternatives MRS operation concepts. We are also looking at if we did have lift or removal of the constraint on MRS inventory, then what would be the optimum MRS inventory? So, we are looking into that.

In our nominal case there are no new reactors, but it is assumed that all existing reactors have their lifetimes extended to 40 years if they are not already 40 years.

So in this next bullet we look at extending a certain number of these reactor lifetimes to 60 years and in the no extension case, none of the reactors have their lifetimes extended at all.

We are looking at the affects of delays in the start in the MGDS as well as the MRS. As I mentioned before we are including updated cost data for the MRS in other parts of the system as it becomes available. We are also looking at some methodological changes and impacts such as the sensitivity of our cost data to uncertainties in those numbers and the incorporation of D&E costs.

That is all my slides. I'll be happy to answer questions.

DR. CANTLON: Questions?

Before we take questions, let me just announce that there are copies of Carl Gertz's overhead on the back table for anybody who would like copies.

Questions from the Board?

MR. BAILEY: Thank you.

The next speaker will be Bill Hollaway who will talk about some work that we have done on looking at using--

MR. SHAW: I'm Bob Shaw.

I had two questions. One, you have the non-cost measures of effectiveness and yet everything you talk about in terms of costs, have you done any indications of those other measures of effectiveness?

MR. BAILEY: Yes. We have. And in our next talk when we talk about minimization of waste handlings, we will show how waste handlings do change with changes in operating procedures and with technology changes. It turns out that when we just looked at throughput for the most part, those other non-cost MOEs did not have a significant effect. They come into play most importantly when we change procedures or when we change technologies. Not so much when we change throughput.

MR. SHAW: Your answer leads me into another question I had also. That is that it seems to me that one of the principal effects of the number of handlings that you have is the actual personal dose that is acquired.

MR. BAILEY: I'm sorry, I didn't hear the number--

MR. SHAW: As a result of the waste handlings, I would think that the measure of effectiveness might be more accurately the amount of dose that people receive. And as a matter of fact to a certain extent, shipment miles and cask miles can also be related to that. Do you have any plans to use does as one of your non-cost measures of effectiveness?

MR. BAILEY: We will talk about in our next talk about taking--just going the next step. At this point we just haven't had time to do that. We have used waste handling as a surrogate for risk, and dosage considerations.

MR. SHAW: I think that would really be an important conditional factor.

MR. BAILEY: We agree.

MR. SHAW: I had one other question, too.

MR. BAILEY: Sure.

MR. SHAW: In recent months the magical figure of $6.3 billion has been bandied around a lot with regard to the total system costs. And yet yours here on the order of $18 billion, and I wonder if you can tell me--

MR. BAILEY: No, I think that $6.3 billion you heard was referred to site characterization costs at the repository, not the total system. And in fact, this $18 billion is not--does not include D&E costs which are significant in themselves. We are looking at the cost of the MRS, the transportation system, the surface facility of the repository and the underground facility.

MR. GERTZ: I think that is a very important point for clarification. Site characterization costs and development are not in the total system cost that he has presented.

MR. BAILEY: That is correct.

MR. GERTZ: $6.3 billion is our current cost including the -- cost since 1982 for studying the site and applying for a license application.

MR. DUFFY: I have a question, Mike Duffy from Battelle. Is "first in, first out" a policy that could be applied to the MRS so that all of the fuel had to basically go through all of the processing steps?

MR. BAILEY: Yes, as an alternative. It is not the one that we have used in our reference case. We have assumed, and whether or not we wanted to use "first in, first out," or any other withdrawal strategy would really depend on what we are going to do at the repository and the order in which we want to bring fuel in in order to meet a thermal loading goal.

MR. DUFFY: Now, if you had to implement a "first in, first out" policy, I suspect you are going to have an MRS at least with the hot cell part of it double, probably twice the size of what you currently have which is going to add quite a bit to the MRS cost that you estimated there. How might that change some of the conclusions? Have you looked at that?

MR. BAILEY: Well, I don't think I would want to guess at it.

MR. DUFFY: Well, I guess the point is, in the purpose you said that the throughput was basically the throughput through the entire CRW on that system. And in reality you are not pushing all of the 3,000 metric tons of fuel through the entire MRS. Wouldn't you go to this--

MR. BAILEY: That is correct. And that is why I was careful to define throughput as being a steady state throughput I received at the repository. And in this particular case, our reference case, it is also the rate at which we take it from the reactors. But that is not necessarily also the case. We could be taking less than 3,000 from the reactors and then also withdrawing some portion from the MRS and then using that as a total of 3,000 which goes to the repository. So, there are a number of combinations like that that we could use and we are looking at several variations of that type.

DR. CANTLON: Other questions?

MR. GERTZ: Could I just clarify one thing now that we have the handout.

I just wanted to clarify one thing since there is now a handout. To put things in perspective the reason that we are doing the 2001 mission study, is that in our baseline we did not get that number for 1992. So, as a result we have to determine the funding profile. Less money this year; more money the next year. And you still get the scope worked on and in addition to that we brought the M&O on board to -- to one, look it all over and make sure it meets their needs. So, that is why we reached the Mission 2001, recognizing that this is being restructured. But it has been independently estimated in a new funding profile and -- that was about three months after.

DR. CANTLON: Thank you.

Okay. We are going to take a 15 minute break.

(Whereupon, a recess was had off the record.)

DR. CANTLON: All right. The Board is reconvened. Let's proceed with the presentations.

Mr. Hollaway.

DR. HOLLAWAY: My name is Bill Hollaway. I am with the M&O in Systems Analysis. I am going to talk to you and present a few of the initiatives we have going on. A few of the different system studies that we are doing related to alternative cask and canister concepts.

In other words, right now we are looking at transport only, storage only, emplacement only. But our study, we are looking at alternatives to that, things that would integrate, storage, transportation and/or emplacement.

The approach that we are taking is a broad one to look at everything. Perform system studies on all the alternative cask and canister concepts including universal casks that would be used for storage, transportation, and eventually emplacement. Dual purpose casks that would be used for storage and transportation at which time they would be taken out and put into a disposal container. Universal canisters which would be used for storage, transportation and then emplacement, difference between universal casks and universal canisters being that the canister is not shielded. So, it is always inside some other type of overpack for shielding. Overpack for storage and overpack for transportation. But the canister is not shielded itself.

And MESCs, that is multiple element sealed canisters. And what that is is a subset of universal canisters. It is a specific application of the canister concept for specific technologies. The MESCs technology has been used with new home storage technology, with the ventilated storage cask, storage technology. Basically any technology where you have concrete acting as the shielding material and you want to use natural convection air cooling inside. You have to have a sealed canister inside. So that is what the MESCs are made for.

System studies that are identified and underway. Ones that have been done and ones that we are working on now. The first one is an assessment of multiple element sealed canisters for storage and transportation focused on the MRS. This particular study was motivated by issues raised by potential MRS hosts regarding this type of technology, and we wanted to step back and say, okay, before we consider that, what would it mean to the system and I will talk about that. And that represents an assessment of a limited MESC scenario, a specific MESC scenario and I'll talk about that.

That work has been completed and a report on that was issued to DOE in May of this year. So it has just been around for about a month and a half.

In the second one, work that is going on right now is a broad cut. Cask and canister concept assessments looking at all of them, stepping back, looking at all of them, what are they? What do they mean? What order might we want to look at them in more detail and how might we look at them in more detail. And I'll talk a little bit about both of these.

The first one since it is done, I'll give you a little feel for the type of work we do, how we go about doing the work we do. And the second one I'll touch on what we are going to do, where we are going with that.

So the first on is this assessment of MESCs, multiple element sealed canisters for transportation and storage of spent fuel at the MRS. Background, as I said MESCs, multiple element sealed canisters are sealed metal canisters, not just canisters but hermetically sealed canisters containing one or more spent fuel assemblies. This issue was raised again by potential hosts, could we use this at the MRS? Could we just have these at the MRS. So, we wanted to do a system study to find out what impacts that would have on the rest of the system. Not just the MRS, but the rest of the system elements. Waste acceptance. Transportation. The MRS itself. The MGDS. What does that mean to the rest of the system?

Visualization of the MESC itself. One thing that I want you to get out of this is that the MESC technology, it is more than just a piece of steel wrapped around some assemblies, actually an engineered structured. Sealed, load bearing. This thing is pushed and pulled so it has got to be an engineered structure capable of having those things done to it. So it is fairly big, robust structure. It is made up of square tubes that hold each one of the assemblies. Discs that space these things out. You have tubes running in for backfilling for taking water out of it. You have end shield plugs here and that is used when they slide these things into the storage technology, then they leave and go back and put a cap on it. So, you have to have some shielding there. So you have all these things that make it bigger than just the assemblies. If we just took seven assemblies it would be smaller than this. So that is one of the things we have to look at.

It is actually an engineered structure, welded and sealed. And the welding, it is not bolted, it is welded. That is one of the issues that will come up as far as impacts on the rest of the system.

DR. PRICE: This is put together at the utility, I take it.

DR. HOLLAWAY: Well, basically it comes with the lid off of it and the rest of it there. It is built before it gets to the utility and then it is shipped to the utility.

DR. PRICE: But the assembly is--the spent fuel is put in there at the utilities and sealed.

DR. HOLLAWAY: At the utilities in this scenario. It could also be done at the MRS, but for this scenario we looked at it being done at the utilities.

DR. PRICE: And sealed.

DR. HOLLAWAY: And sealed, and welded and backfilled and sealed and verified.

DR. BREWER: Excuse me, could you give us rough ideas of dimension and weight?

DR. HOLLAWAY: Now dimension--if an assembly is 180 inches here, these end caps, inside a cask you might have 180 inches to get the assemblies in, these end seal caps add about a foot or maybe a foot and a half onto that. So that is one thing to think about when you put this into a transportation cask, you have got an extra foot and a half that you have to get in there and that costs you something weight wise.

No shielding here. Shielding on the ends, but outside here is just stainless steel wrapper, so there is no shielding there. So weight wise, this thing could weigh ten to 20 tons, big robust. That is without the fuel in it, but not as big as a storage cask. We are not talking about 70 tons or whatever, but still big.

DR. BREWER: All right. The thing is what, 15 or 16 feet long. What is the diameter and roughly how much does it weigh empty and full?

DR. HOLLAWAY: Empty let's say approximately 20 tons. Now it depends how many assemblies are in it. Seven assemblies, about half for an assembly, it is about 3.5 so you maybe have 4 tons of fuel, maybe 20 tons of canister. It is about 25 tons for this. Now this one holds 7 PWR assemblies. Some of the ones used specifically at the Oconee site holds 24 assemblies. So you are looking at a much bigger, actually 70 tons for that.

The difference between this and a storage or transportation cask is the shielding on outside of it. That is the extra weight.

DR. BREWER: How long and what diameter?

DR. HOLLAWAY: 180 inches which is 15 feet, add a foot to a foot and a half and you are looking at 16.5 to 17 feet long. Diameter you are looking at something on the order of about two feet for this up to about five or six feet for the big ones.

DR. BREWER: So the gross weight of this thing fully loaded could be as much as 80 tons?

DR. HOLLAWAY; Yes, sir.

DR. BREWER: Thank you.

DR. HOLLAWAY: Motivation of this particular study was that a MESC system where these were loaded at the reactors and then shipped sealed to the MRS could avoid the routine handling of individual and canister and spent fuel at the MRS. That is the motivation for this.

So the system that we are evaluating here was one where the MESCs were loaded and sealed at the reactors before going to the MRS. Only sealed MESCs would be accepted at the MRS and they would not be opened at the MRS. So, we wanted to perform a system study, whole system, all system elements to look at what that would mean.

Now status, this work is completed and this report has been issued. As I said, this was a limited assessment. Other ways of looking at this, we are looking at that in the cask and canister concepts assessment I'll talk about after this.

Methodology to give you a feel of the way we go about doing these things, first and almost foremost is to identify and lay out what the ground rules are so that if you see the results you understand what it is you are looking at and where it came from.

The second one is to define what the scenarios would look like. How would this actually look like from a system perspective.

Third, this gets back to your question, one of the pieces we were missing was if we wanted to look at a small MESC or large MESC, how big is big, how small is small, how much does it weigh and how big is it. So, we did a lot of work, because that was one of the missing pieces of input we needed.

Identify and evaluate measures of effectiveness. This came up. Things other than costs. What else is there? Handlings, radiation exposure, et cetera.

DR. PRICE: Safety.

DR. HOLLAWAY: Safety. Okay. We are using surrogates for safety right now. Things like handling, things like shipment miles. Those things. Measures of effectiveness.

Next, to go through and look at what the impacts are on each and every one of the system elements all the way from beginning. Waste acceptance and the waste generators, looking at the reactors themselves, transportation, MRS, MGDS, whole picture.

And last after we have looked at that and said, okay here are the impacts, we want to step back and say, is there anything that might impeded implementing this system? Any of what we have called critical issues, you can really thing of it as potential obstacles to implementing this system. What is out there.

We'll run through the ground rules. First was to use existing MESC technology. We did not attempt to redesign the MESC technology. We used what was there. Scaled it up and down as we needed it. The MESC would be loaded and sealed at the reactor sites. And this would come in later as one of the major impacts.

System must be able to accommodate all the sites. We did not want to build a system where we could only take some of the sites and tell the rest, sorry we will have to get to you later. We wanted to make that one of our ground rules. Every site has got to be able to be in this.

Only MESCS are accepted and stored at the MRS. MESCs are not opened at the MRS. So, no routine handling. But, I will point out that one of our ground rules was and this will get in later when we talk about costs and other impacts you still need a recovery cell. You still need some way if one of these things turned out to be leaking, some way that you could demonstrate an ability to recover. It wouldn't be in routine use, but you would the ability to recover. Mandated probably by the NRC and more likely by the host site itself, so you could say if anything happened, we can take care of it.

DR. CANTLON: This is some sort of a sleeve that it fits into if it were leaking? Or overpack or something?

DR. HOLLAWAY: No, the recovery cell which you would actually take the leaking canister in open it up, put it in another--

DR. CANTLON: So a hot cell.

DR. HOLLAWAY: Basically, yeah. The reason we didn't use the hot cell or transfer cell terminology is that it is not something routinely used. It is something you would set up and hopefully never have to use. But you would have it there in case you needed to defend some depth.

Waste generators who are required to load and seal these would have the option once the repository is opened to ship directly and avoid continuing these sealing operations. For the purposes of this analysis, we only looked at putting the first 10,000 MTU which is a fuel up until 2010 in our scenario when the repository opens. Only that fuel went to the MRS in these canisters. After that it was shipped direct.

Now that is an assumption that does really change the conclusions of this work and it is something that we will look at sensitivity wise later. And at the repository what happens with these, is you can either integrate it into the engineered barrier system, that is one possibility, or if you can't do that, if it is not the right size and it is not the right mix of fuel, cut it open and unload it. We looked at both because it is too early for us to make a call on what would happen with that. So, we looked at both alternatives.

DR. PRICE: If you added as low as reasonably attainable as one of your ground rules you could call it a mescalero.

DR. HOLLAWAY: We tried to steer clear of the humor here.

Scenarios that we looked at, the first one we looked at was there are a few designs out there that are in use today, 7-PWR that is in use at the Robinson site and the newer 24-PWR MESC design that is in use at Oconee. Now these are designed and licensed for storage, not for transportation. That is another issue I'll talk about.

But these things are out there. Designs exist. NRC has seen them. Could we do it with that? The problem is that 7-PWR goes in a 70 ton rail cask. Actually it was designed around the IF-300, 70 ton rail cask. 24-PWR MESC would go in a 125 ton rail cask. Now those violated one of our ground rules of being able to pick up from all the reactor sites. So what we did was look at a version of that with saying let's have small and large.

Okay, small, 25 tons loaded in the cask or less so we could pick up from all the sites but also large where it could be used to get some advantages from being able to ship more in each one, less operations, less sealing, et cetera.

When we looked at that, the small ones are awful small, about 1-PWR, 4-BWR. Pretty small. So we looked at as a perturbation what about overweight truck taking you from 25 tons fully loaded to 35 tons moves you up from about 1.4 to 3.7. Advantage there but clearly the disadvantage of everything being by overweight truck. But, we wanted to look at what would that do.

The next scenario we looked at, the last one was what if we didn't want to address two types of canisters, we only wanted one. Well, if we only had one and we had to service all the sites, it would be small. So, we looked at that. Obviously it means a lot more canisters, a lot more shipment miles. I'll talk about that. But only one thing to look at.

And we included a reference scenario. We had to have some baseline to be able to compare what we are doing here. So we are not just comparing MESC scenarios. Do we have a scenario with no MESC, which is essentially the scenario we have right now. Transport only casks, storage only casks, look at that and have some reference to compare it to.

MOEs, we looked at several MOEs. These are the quantitative ones that were actually quantified using the codes that Bill Bailey talked about with respect to the Throughput Study, the WSA code, the interface program for logistic models. And I'll get into what you are supposed to get out of this.

First, quantitative MOEs that we looked at. Number of transportation casks you would need. Number of MESCs within the MESC scenarios. Number of shipments to be made. Cask miles and shipment miles. The difference here is one is a radiation exposure surrogate; one is an ordinary transportation risk surrogate. So we looked at both of those. Obviously, they are closely related. Then a number of handlings. What does this mean for number of handlings.

And when you look at this, the reference scenario is on top. Scenario 2 using small and large here overweight truck and large and just small. Now I have pointed out here that scenario 1, since it would service all the sites, we didn't go through with a numerical analysis of that because it violated one of the ground rules. So this is essentially the reference MESC scenario compared to this. What do you get out of this?

Advantages of MESCs. Lower number of handlings. You are handling canisters and not individual assemblies, so you have a lower number of handlings. What do you pay? Get a larger number of transportation casks, have a larger number of shipments; larger number of cask miles, larger number of shipment miles. My next slide will address what some of that means. But effectively you are getting an advantage here in handlings and you are giving up something to get that. Now we didn't put any weighting on these MOEs. We just went through and quantified them, pointed out where the differences were. But depending on the individual and how you weight those you might feel differently about them.

Now, shipment miles and cask mile shipments, what does that mean? Those are number surrogates for other things. I have this listed as qualitative MOEs and the reason is you could actually quantify these. We didn't use codes to quantify these numbers. We used surrogates to lead into these. These are radiation exposure. We felt this was very important to get some handle, not to leave this out.

Radiation exposure at all the venues, waste acceptance, transportation, MRS, repository, and also the public. What does this mean to the public? For instance, for the waste generators we looked at how many shipments come from there, and what type of operations they do. More intensive means more exposure.

Transportation, number of shipment miles that have to be made. That was our surrogate. At the MRS, the types of operations, the simplification of operations with the MESC system, handling just canisters, less handlings also.

At the repository these double stars and what this note means is since I said that we could either cut them open and unload them or integrate them into the engineered barrier system. Since it was not clear, we couldn't make a call. One would go one way and one would go the other way. So, we did address that.

Public radiation exposure linked to the number of cask miles each cask having a set 10 MR at two meters from the surface. The more casks you have with that the more exposure to the public that you have there.

What do you get out of this? The same type of picture. Occupational radiation exposure at the MRS goes down for the MESC system. What do you give up? You have more complicated operations, more of them and hands on sealing operations going on at the waste generator sites, so that goes up. Transportation, more shipment miles. More shipments. That goes up. And to the public, more cask miles. That goes up.

Now, the magnitude or how you weigh one of these against each other, we didn't go into that. We were not in a position to make a conclusion on that, only to point that out and that is a very important issue, is how do you distribute these things and I'll talk about that.

Looking at all those things, we came up with some advantages, disadvantages and critical issues. We actually went through each system element one by one and said what are the impacts, good and bad? Positive and negative? If there were none we wrote down there were none to make sure if we could, we left no stone unturned. A big long 20 to 30 pages on this but I condensed it down to a few points. What are the primary ones?

Primary advantages, no routine handling of uncanistered fuel at the MRS. Reduce number of waste handlings in the system, particularly at the MRS. Decreased occupational radiation exposure at the MRS coming out of these. And the potential to integrate this canister into the engineered barrier system. If you could do it that would be advantageous. If you couldn't it wouldn't. And, I'll mention that.

Primary disadvantage. The big one is, the burden on the waste generators to do all these loading and sealing operations. Right now there is nothing in the contract saying that they have to do this. That is certainly a major impact.

Increase number of casks, cask miles and shipment miles. Increases occupational radiation exposure resulting from the things. At the waste generators and during transportation and to the public. Now the magnitude of this I didn't go into, but it is increased. How important that is, again, is how you weight these things.

Now, I talked about advantage, potential to integrate it in it is an advantage. But if you can't and you get these out to the repository and you have to cut all them open, and then you have to dispose of the canisters themselves, you have a low level waste problem, that is a disadvantage if you have to cut them open and unload. So it cuts both ways depending on what you do with it once you get to the repository.

And this issue that Bill Bailey sort of got out with the casks was restricted flexibility to support repository thermal loading, specifically at the MRS. Once you have loaded it in these canisters, that is what you have. If you are doing it at the reactors, what goes in there is what you've got. At the MRS, the only support for thermal loading that you can do is basically buy a canister, which is some which is valuable, but you cannot buy assembly blending or selection at the MRS with this system.

Now critical issues, depending on how you feel about the advantages and disadvantages, you may favor this, you may not favor this. But what are the things that might keep you from doing it at all? What might impeded implementing such a system?

The first one is licensing of MESCs. I said there are MESC technologies around. They are for storage, not for transportation. No MESC has ever been licensed by the NRC for off site transportation of spent fuel. That is a hurdle to be gotten over. Not that it couldn't be done, but it hasn't been done and the NRC hasn't really seen this canister inside a cask idea, so that is something that would have to be dealt with. You would have to design, license and fabricate in order for the system to become operational.

Now what is the impact of that? The ability to meet scheduled milestones would certainly be impacted by that. Utility contracts, I have renegotiation of utility contracts. It could be simpler than that, but basically you would have to get consensus among the utilities to do these operations. It might require renegotiating the contract and it might just require negotiations with the utilities, but nonetheless you would have to have consensus and that is a fairly important issue.

The other one is this issue that kept coming up of radiological risk partitioning. It goes down at the MRS, goes up at the other site. How do you weight that. It goes down at the MRS, which is a CRWMS venue, but goes up slightly for public radiation exposure. How do you weight that? That is an issue that would have to be looked at.

Conclusions that came out of this is that first the system appears to be feasible. No technological reason you couldn't do it. But, the merits of it depend on how you weight these positive and negative impacts. And as a more specific conclusion, adopting this MESC based system loaded at the reactors all shipped to the MRS sealed already, to avoid handling individual uncanistered spent fuel at the MRS, give you positive effects at the MRS, if that was what you were shooting for. But it costs you something at the other parts of the system. It costs you something in waste acceptance. Costs you something in transportation. Costs you something at the repository. That is what effectively falls out of this.

Now as I stated up front, this study represented a limited scenario. In other words, we didn't look at what if you loaded big MESCs at the reactors and ones that were only truck capable and would ship spent fuel to the MRS and then canister it there. We didn't look at here. And we are going to look at that in the study that is now underway. So this is not the final story on MESCs, it is the final story on this particular way to look at it.

The rest of the picture, cask and canister concept assessment, general look. Objective: Perform a systematic assessment encompassing all of the alternative concepts. Let's look at them all. Using this to provide a basis for program decision making and program direction related to should we potentially put research money into things like this. How should we study them from a systems study? Should we study this first, or this first or this first? How intense should we study it? Are there outstanding issues that we could go ahead and start looking at now, for instance with the NRC? Start addressing now. Let's get those issues out and get them on the paper so we know where we are going and we are going there in orderly fashion.

Things that we are going to look at here again, universal casks, dual purpose casks, universal canisters and the subset of that MESCs. Look at all of those.

Methodology, now this will be a non-quantitative assessment at first because we are trying to trying to drive at what are those issues? Where should we go? Determine and describe what those concepts will be. Define scenario for that. What does that really look like for a system? What are alternative ways to look at that from a system standpoint. Perform a comparative assessment so we know what falls out of this, particularly relative to what we are looking at now.

Determine positive and negative impacts so decision makers can get their arms around this and know, hey, what are the issues related to that? What are the issues related to universal casks. Before we start thinking about should we study it, how do we study it? Should we put research money into it. How do we do it? When? You have an arm around these issues.

And the follow up from this will be recommendations relative to which ones look promising to do system studies on, research, et cetera to be passed on to the DOE. To be passed on to the decision maker. They have some way to get their arms around this issue and decide where to go next. And that work is underway. Now this is an initial assessment to get us on the road. This should be done this month, at least in a draft sense.

I am going to switch gears a little bit to a related issue that I have alluded to and that is minimizing waste handlings. This issue has come up again and again. The Board has raised this issue on many times, may reports.

Others have raised this issue. We want to have a look at this issue, top down, the whole thing. Let's look at the issue, figure out what the issues are related to that. How are we looking at that.

Our approach is to perform a three-part system study on minimizing waste handlings. Why three parts? Let's keep it clean. You see a lot of studies that are this thick and they go through the whole thing and by the time you get down to the bottom, if you didn't agree with everything that was done somewhere in the middle, you may not agree with the conclusions and the whole study might have to be redone, reshaded and in a different light. So, we are going to break this into the three natural things that it falls into.

The first one is just identifying what technologies are available and what operating strategies are available to minimize handlings in the system. What are they? Now we have done an initial cut at that work and a draft report was issued in May. So that is in draft in comment stage with the DOE. I am going to talk a little bit about our initial observations from that. But that is the first step. What are the ways you can do that.

The second step, potential limitations on adopting the technologies, are there things regulatory otherwise that might restrict you from adopting those things, let's get those on the table. The second part.

The third part is minimizing handlings. That is one parameter. There are other parameters out there. Radiation exposure, obviously related. Operational flexibility, cost and other things. We have to take all those into account when we decide what are the risk in cost tradeoffs involved with adopting any one of these technologies or operating strategies. In other words, we might find a strategy that this is a good way to minimize the number of waste handlings, but we would only carry it to a certain point because beyond a certain point you may get the system in trouble from an operational flexibility standpoint. You want to do it as best you can, but you have got to keep in mind those other parameters.

That is future work that we are going to be doing. I don't have a date for when that will be done. But these are the three parts of study. We know where we are going and we know what we want to do with this. This part is--the first cut is done.

This part, potential limitations, that is being addressed in this cask and canister concept. What will fall out of that is what potential things could impede implementing these things. And this very important third step, what are the tradeoffs.

I am going to talk about the first part, just the first part because we have some work on that. Technologies and operating strategies identified to minimize the waste handlings. The objective of this part of the study was to identify the technologies and operating strategies available. For the purposes of this first assessment, we define a waste handling as a transfer of a waste type where waste type was unshielded spent fuel assembly or an unshielded canister. We also counted canisters if they were not shielded.

Now we only considered spent fuel. We did not look at high level waste, just so you know what the assumptions were, and where we stand.

Waste handlings is going to occur at the waste generators, reactor pool sites, MRS repository. We looked at all of them. We had a reference case so we had a yardstick so we knew what we were looking at. And this is a clean reference case. The assumptions for it just from a numbers standpoint was 63,000 MTU of spent fuel, we just moved this number up. But we targeted it on 63,000 which represented about 220,000 assemblies in there.

We looked at individual fuel assembly handlings for the reference case and individual assemblies. All the spent fuel goes through MRS storage. Now we looked at that. Every assembly goes to the MRS. Everyone goes into storage at the MRS. Everyone comes out of storage at the MRS. No pass through, no flow through for this reference case.

We didn't look at consolidation. That was a perturbation that would add some complexity. We did not look at that. What would it mean to handle each one of the rods. That was not looked at here.

And the other one is lag storage handlings were not counted for the reference case and I'll talk about what that means later. So, you go out of the transportation cask into the storage cask at the MRS, not in the lag storage. I'll talk about what lag storage means later on. So that is the reference case. And basically what that means, is from a CRWMS perspective, each assembly is handled four times. Once into the transportation cask at the waste generators, go to the MRS. Once into the storage cask. Once out of the storage cask and then at the repository once into the disposal container giving four.

Now for the purpose of the reference case, we didn't step back and say what if the reactors use technology X, Y or Z, how many handlings does that mean for them, because that is out of our jurisdiction to determine exactly what technologies reactors will use. But, we did look at it. We mapped out flow charts with the different technologies available, what would it mean? But we didn't count them for the CRW on that.

The methodology we used was to go through and put a flow sheet down for all these handlings and the questions related to them, throughout the system. This is one example, handlings at the reactor. And I will point out that this says, first box says DOE to accept fuel. That is when we start looking at this.

Now there is one behind it that is not in your package but it is in the report and actually I have an overhead of it if you would like to see it that goes all the way back to the fuel coming out of the core, and we step through each part. This is for the reactor when it gets put into the transportation casks. There is also one at the MRS which is obviously very complicated and at the repository. We have all of these. So, this is for example purposes.

It goes through the decisions you would make, the types of technologies you would and the bolded boxes are the handlings that would take place. Now for our counting we count one into the transportation cask, one into the transportation cask with the universal cask, dual purpose cask, that one is shown on the one above this, but it is into the thing that would be delivered to the DOE, so one there. And this line here points out utility operations, utility jurisdiction. They make the decisions on this side of the line. This side of the line CRWMS, that is where we pick up, so that is where we were focusing on. Although we recognize the importance of the other thing.

Strategies that we looked at, operating strategies. You have heard these terms today, pass through, flow through, western strategy. What are they and how would they minimize handlings? Up until 2010, everything that comes to the MRS goes into the MRS and goes into storage. Once you are full or about 2013 ramp up to about 15,000 MTU under the current legislative stuff, once you are full you have a decision. Do you take every one into storage or take another one out? Or, if you don't need to do that, you can avoid those handlings by not going in and out of storage.

Now what are the ways you could do that? " Pass through," what we are calling "pass-through" is assemblies arriving at the MRS and from reactor casks, think of it as truck casks, things coming in 2-PWR, 5-BWR configuration into the MRS. Let's get some gains from a transportation standpoint by transferring those into a big rail cask; 100 ton; 125 ton; what have you. For the purposes of our analysis a 100 ton rail cask, a big advantage in capacity. But it doesn't go in and out of storage. Transfer it directly from the "from-reactor" casks, truck casks, into the "from-MRS" casks. So you save on handlings going in and out of storage if you have no reason to go in there. If you are blending, you may have some reason. But, if you have no reason, maybe you shouldn't do it. "Pass-through."

"Flow-through," you bring a rail cask to the MRS that may be exactly the same size as the "from-MRS" cask. It may be a little smaller. But from a handling standpoint, is it worth taking it in and opening it up and transferring it to another cask. Why not just take it connect it to the dedicated train and ship it to the repository. Save on shipment miles. You have one cask coming from a reactor, maybe three coming together. But from the MRS you could maybe string out ten. So you have a savings in shipment miles, added flexibility. "Pass-through," "flow-through," ways to save on handling.

The other one is western strategy when we are looking at the generic eastern site for instance for the MRS. Now a reactor located in California wouldn't necessarily ship all the way back to the east and then all the way back out to the repository. They may ship directly to the repository once they can do that. Once the repository is open. That saves handlings at the MRS. So, operating strategies.

Technologies, these are things--this is the tie-in that I just talked about. Dual-purpose casks, storage and transportation, reduces handlings at the MRS. Cut those out. Universal canisters and multiple element sealed canisters could be used for storage transportation and/or emplacement. So it could be used like a dual purpose for a universal cask. But we did count the transfers and we did count the handlings of the canisters themselves, because there is an exposure issue that you have got to think about. But you are cutting it down. You are handling 24 at a time instead of 2 at a time. So you are cutting down the number of handlings with that. Reduction in handlings with canisters from the systems standpoint depends on where you load them and where you unload them obviously. Universal casks reduces handlings at the MRS and at the repository. You'll find that that is your biggest hit.

Results. Actual magnitude of the results may change a little bit depending on how you lay the assumptions out, but which ones come in which order won't change.   Here is the reference. Remember I said 220,000 each one handled four times gets up to about 880,000 handlings in the CRWMS, based on 63,000 MTU.

Ways to cut it down. Operating strategies. Western strategy cuts out a bit. "Pass-through" cuts out a bit. "Flow-through" cuts out a bit.   But we can combine all those. We can do western strategy where we can, "pass-through" where we can, "flow-through" were we can. It gets us down to about here about 650,000 handlings. It cuts out about 200,000 handlings. You've still got a lot but you have cut down a lot.

Technologies. As you would expect dual purpose casks cuts down a lot and if you want to cut down even more you can carry it farther in the universal cask regime. Universal canisters, universal casks; universal casks being the lowest as you would expect.

Now remember I said we didn't count lag storage for the reference case, but we went back and said lag storage could be very important. Let's look at that. Now, remember black here is the reference case. The highest one. Now the black is the one at the right here now, when we look at lag storage. So we didn't count lag storage. And we are about 880,000. Put in lag storage at the MRS, every time you go into storage you take it out of the transportation cask, put it in lag storage and then once you have enough take it out of lag storage and put it into the storage cask.

There is a hidden large potential number of handlings you have got to think about. Doing lag storage of every assembly coming in to the MRS and everyone that goes into the MRS would bump you up above 1.5 million. Bump you up 700,000 handlings from the reference case. That is a lot. Relative to the operating strategies, that could dwarf the operating strategies. So, lag storage is really something you have to think about. It is a very important judicious use. We need it. Remember, I said, minimize handlings is not the only thing; one of the things. Now we need some operational flexibility; we need some lag storage. But, you had better be careful how you use it, because it can have a big impact on handlings.

DR. PRICE: When you talk lag storage, could you define it again because I understood your definition to be you take it out of the cask, you put it into a storage and then you take it out of that storage?

DR. HOLLAWAY: Well, lag storage is just for instance in the transfer cells in the MRS, is just a rack. So not into another cask or into another storage mode technology, just in the transfer cell itself, take it out and put it in a rack and then later taking it out of the rack and putting it into the storage mode instead of transferring it directly from the transportation cask into the storage cask as one step. That is where you get almost a doubling you do it twice; one in and one out.

DR. PRICE: So this pertains--does not pertain to some of the technologies.

DR. HOLLAWAY: Correct. For instance universal casks, it wouldn't pertain because you don't unload them. Dual purpose casks at the repository you could use lag storage, but with universal casks it doesn't. And the same with--if a question came up could you combine the operating strategies with the technologies, the answer is no, because the technologies cut out those operating strategies which are focused on the MRS. Dual purpose casks, universal casks, you don't do pass through or flow through, because you are not doing any handlings anyway.

Observations that came out of that of what you just saw, this is in draft stage and I am going through comment. Observations, a combination of operational strategies, western strategy, pass through, flow through, could lower relative to the reference case I outlined your handlings by as much as 30 percent. A pretty big number. If you want to go farther than that you have to go to a different physical system design, different technology, dual purpose, universal canisters or universal casks. It can lower it as much as 30 to 75 percent. If you loaded all the universal casks, and remember I said four handlings, okay with the reference case, if you loaded all universal casks at the reactors you would have one handling. So you would go from four to one; 75 percent reduction. That is where that comes from.

A planned and efficient use of lag storage can minimize incremental waste handlings over that reference case. A very important issue to think about when we design our system. The types of things we pass on to the designer.

Largest reductions in waste handlings would occur with the use of universal casks. Now that is probably something you may have thought of yourself before you saw this, but it is nice to see the numbers actually put there so you see this as a conclusion. Largest reduction with universal casks.

But, it is only part 1. There are other things to think about. Continued observations, the first one is all waste handlings are not equal. I talk about handling canisters and I talk about handling assemblies. Now handling a canister with 24 versus handling one assembly is that better or worse? If you drop it is it worse or better? An issue to think about outside of this first part, something to think about in the other two parts of the study.

Fuel assembly handling versus cask handling. We haven't looked at cask handling, shielded, sealed or with the head off, cask handlings we haven't looked at that. And how does that boil in the equation? Another thing to think about.

And this, implementing technologies and strategies to minimize waste handlings, can and will impact other system parameters. Cask shipments and shipment miles; operational flexibility, radiation exposure; program schedule; program cost. Others--other issues out there. Just minimizing waste handlings, we are going to impact other system parameters. So we have got to think about these risk and cost tradeoffs of adopting the technologies or the strategies. So, what I just showed you there was part one of a three part study. That is not the final word the way those rank. You have got to think about what are the risk and cost tradeoffs involved, and that is part three of the study that I talked about. But, we have got to remember to think about that.

So, going all the way back to the beginning, I talked about our alternative cask and canister work. We did the MESC study and focused on a MESC system where they are loaded at the reactors, go to the MRS sealed.

I talked about the more general cask and canister concept assessments, to get our arms around the issue. Then I switched gears a bit and I talked about this issue of minimizing waste handlings.

I talked about our three part system study we plan on doing and went into part one that we have done some work on and what observations we found out of that. But, said, hey, remember those other two parts are there. And that is work. Some of this work is underway and some of the work is still in the future, but to give you guys an idea of where we plan to go with what we are doing, what we have done, how we do it and where we plan to go.

That is all I have for my presentation and I welcome any questions.

DR. CANTLON: Questions? Yes, Dennis.

DR. PRICE: I generally agree with your three part thing in that in some ways a sequence with the first part determining what goes on in the second part and the third part. If you do not completely embrace the technologies that maybe--should be--embraced, and these you presented to us today, then downstream things that maybe missing a loop all the way, that is what was behind the suggestion about the "minimizing handling" workshop. And it--the idea was to surface any technologies that may be there so you could use them, rather than a couple of people sitting down brainstorming and saying these are the technologies which we can envision, or else being pushed or pressured by potential MRS hosts saying this technology--that shows you there is a technology out there that they were concerned about. There may be technologies of a various sort, not limited just to canisters and casks. They may be involving the way you automate and handle--

DR. HOLLAWAY: Operational strategies.

DR. PRICE: Yeah, operational--there may be a lot of things that float to the surface if you are determined to flush out all of the technologies. That is what was behind the idea for a workshop.

DR. HOLLAWAY: And a good idea.

Now this part is drafted as of May, about a month and a half ago. This second part should be done for draft this month. This third part, we are not attempting to bring a final conclusion, this is the way to go. Put our own weightings in and say this is the answer, this is the final number. We want to service these issues and talk about what the issues are that are involved with the focus being, once you know what types of things, certainly others, no question. But you have some ground work. What types of things? What potential limitations are out there, some of them? What is an assessment, a look at what tradeoffs are involved. Then we would have a good ground work for workshop. And that is really the focus here is to lay out that ground work because we have to have a lot of other parties besides just the people working on this particular system study involved a lot of other minds, a lot of other viewpoints looking at this certainly. So, this should lay out the ground work for a work shop that would come later.

Now, the content of the workshop, the schedule of the workshop, the location of the workshop, out of our jurisdiction. That is up to DOE and I would point to Bill Lemeshewsky, Office of System and Compliance and the rest of DOE for when they would like possibly to set up something like this related to having this ground work laid.

But, I completely agree with you. The idea is instead of just sitting down in a room and discussing all of this let's get some of it down on paper so we have something to talk about.

DR. PRICE: Well is your idea then to iterate these three?

DR. HOLLAWAY: That is right. Absolutely. That is why this is not final. That is why it is draft. This one will also be draft. We want to iterate this. We want to get all the ideas. We don't want to close any doors on this. Let's make sure we have all those ideas out there. And we don't know everything, but we can lay out the ground work for it so we can put together some type of a focus group or some time of a workshop to think about these issues.

But again, the reason the workshop isn't even addressed on here is that it is not M&O's scope to come up with a determination of what would be in it, where it would be and when it would be and I would defer to the DOE on that issue. But this should lay the ground work for that. A very good point.

DR. CANTLON: Dr. Domenico.

DR. DOMENICO: Maybe you can just clear up something for me. Is it true that of these options the universal cask would force you into a cold repository?

DR. HOLLAWAY: Not at all.

First of all--

DR. DOMENICO: I've touched those things.

DR. HOLLAWAY: When you think about universal casks it is almost analogous to the robust waste package. You have a thick-walled package basically.

Now as far as thermal loading of the repository, that is based on how long do you age the fuel? How do you blend the fuel? And how much fuel do you put in each one? Now we could have a universal cask that holds three assemblies. We could have a universal cask that holds 20 assemblies. We are not cutting out any alternatives there. In fact the size of it, think of it as analogous to the robust waste package. The size of it is going to determine your thermal loading. The size, how many assemblies are in that package and how are they spaced. But, the universal cask itself does not cut off any of those options. In fact, it dovetails quite nicely with the robust waste package concept.

DR. DOMENICO: I understand the universal package is indeed a robust package. But I was under the impression that it also eliminated the escape of heat.

DR. HOLLAWAY: No.

DR. DOMENICO: No.

DR. HOLLAWAY: If we talk about a universal package, you are probably going to be talking about a metal walled package.

Now the Delta T across the wall package is very low. It is almost like a canister. It is like the canister we have now; 3/8ths of an inch. Add more metal the Delta T across the wall of the package is not that great. But it doesn't affect that. We still have a lot of flexibility.

DR. DOMENICO: I see.

DR. CANTLON: Is it realistic in looking at a national system to assume that the most constrained reactor really has to be a constraint on the system. Wouldn't it be realistic to visualize that if you have got a severe constraint in one reactor that the utility ought to be doing a little modification to adapt to the system?

DR. HOLLAWAY: The utility could do potentially modifications helped out by the DOE, certainly subject to negotiations. Or the fuel could be taken somewhere else. Possibly to a DOE facility. Possibly to another private facility, yes.

Now, remember when I talked about the MESCs where I said they are all loaded there and I said this is a limited scenario? That is why I said that, because that was a very focused drawing of boundaries around it and saying let's look at this one, realizing that there are other ways to do it. And certainly that is one of the most obvious options is loading them where you can, but where you can't taking them somewhere else and load them.

And we do this cask and canister assessments, we are going to point that out and talk about that. The MESC assessment did not look at that, but that is not because we don't think it can't be done, because those were the boundary conditions for that study which is why I pointed out that it was just a limited study. But we will definitely look at that. I think that is probably a great idea. Trying to impose on every reactor to line up and do something possibly with or without consent is very difficult; very challenging.

One way to look at the picture, but it is only one way, but there aren't an infinite number of ways. There are several ways we can look at it and that is what we want to scope out. What are the different ways that you could do that? You could take it somewhere else and load it. You could take it to the MRS and load it, which is subject to what does the host want. If you couldn't do that you could take it to the repository and load it. So there are other ways to look at. We are certainly, certainly thinking about those.

Taking the needs, dealing closely with our waste acceptance group and taking the needs of the utilities into account, I myself worked for Virginia Power for awhile and the Tennessee Valley Authority, so thinking about the issues of what the utilities see and what they do and don't want to see is very close to home for me. So, I definitely think about those issues.

DR. CANTLON: Following on, the utility gets the great benefit of getting out from under the continuing liability of having fuel on site. The trade off might be to adapt to the national system, rather than the national system be expected to adapt to every utility.

DR. HOLLAWAY: And certainly subject to negotiation.

And what we would be able to offer, we have enough flexibility to be able to go the utilities and say we can do it with System A all loaded at the utilities, or we can do it with System B, take it somewhere else and load it where it can't be loaded at the utilities. But, you guys are paying into the fund, so you guys think about it amongst yourselves of what you think is an equitable system. Because, inter-utility equities is a very important issue.

But what we will point out here is that from a CRWMS perspective, we have got the flexibility to look at a lot of different ways of doing it.

DR. CANTLON: Any other questions?

MR. SHAW: I had a couple of questions and a couple of comments.

I think it is notable that the utilities within the last six to eight months have taken it upon themselves to look at the universal canister as a concept they are very attracted to.

They also have taken up some of the questions that John Cantlon has just raised, and that is the fact that not all utilities will be able to use the universal canister. The initial look at this is to say--is to take something large like a 24 PWR type of assembly for a universal canister. And we do have to contrast the universal canister from universal cask because they are different concepts here. A good example could be Yankee-Rowe which has a 25 ton crane, has no capabilities of increasing that capacity without major modifications to the structure of the facility, has no rail spur that could take anything of that large tonnage away from there. So you have utilities which do have limitations. Yet, utilities in general are looking at the concept of a universal canister that is one that is very desirable from their point of view of being able to once and for all seal up a system and not be forced to open it again.

The second point I would make is that EPRI has been sponsoring recently a study on universal canister concepts as well. And this looks at both the heat thermal limitations, which may be a significant factor in the highest temperature you can get and how many elements you can put in there in the effective heat transfer that would take place away from there, along with the cost. And that report should be out sometime within the next couple of months. It is nearing completion now.

Then a question I had for you. In the reference case, it seems to me that you have an additional problem that you maybe haven't had it in. And that is the problem of waste. And here it is low level waste because you are now shipping material inside a canister that you are now going to take out. You have the problem of the corrosion products and other materials that are in there that could be inside that spent canister which now has to be cleaned and you do have residual waste that comes with that.

DR. HOLLAWAY: With the MESC system.

MR. SHAW: I beg your pardon?

DR. HOLLAWAY: With the canister system.

MR. SHAW: With the canister and the MESC system you do not have that. But with your reference case you would have that where you would have to clean that.

Sandia has recently been sort of exposed to the problem of what they have called weepage on the actual canister itself, where you get surface contamination that you think you have cleaned off at the site and then you receive it at the receiving point and find that you are above the limits, because this material has somehow been embedded in the cask and has come out as a result of that. So, some of these issues with regard to low level waste and decontamination of these systems have to go into the reference case as well.

DR. HOLLAWAY: Those are very good points.

We thought some about the low level waste issue and what that would mean. We included some of it in the report, but probably not the detail that we should have. It is definitely something that merits consideration. A lot of times we get very focused on high level waste, but low level waste should definitely not be overlooked. It's a very important issue. Thanks.

The EEI and the EPRI work I am definitely very aware of that and that is going on. We are in touch with the

EPRI people that are working on that to jump start our work.

DR. CANTLON: Dr. Reiter.

DR. REITER: Leon Reiter from staff.

I have a question, a perspective question. I am sure you don't have a definitive answer. I hope you will have one. Perhaps either you or Larry Rickertsen could give us an answer. We are told that the basis of the EPA criteria 40 CFR 191 is that the repository shall cause no more than 1,000 additional cancer deaths over the next 10,000 years. If we believe some of the performance assessments that we have seen and do some simple linear scale, this could be a lot less than that.

Here we are talking about a case of almost a million handlings. How do the kind--doing the same kind of extrapolation, what kind of additional cancer deaths would these handlings cause? How much?

DR. HOLLAWAY: From a preclosure sense, because we tend to focus on postclosure. I don't have an answer for that. We definitely will look at that and that is exactly what Part 3 of our study was going to look at that.

Now, Larry--do you want to say anything about that?

DR. REITER: Larry does a lot of backs of the envelope type of calculations I am sure.

DR. RICKERTSEN: The 1,000 health effects in 10,000 years, when you calculate that in terms of an individual does turns out to be on the order of five or six orders of magnitude below 100 or 10 millirems per year. So the if the scale that you are looking at for dose limitations, individual dose limitations on casks and canisters run in the order of 4 or 25 millirem per year, clearly the biggest safety issue that we have in terms of individual dose is in that particular phase, the transportation, MRS, and so on phase. The repository scale which is based on population dose turns out to have much lower impacts in that regard.

Does that take care of your--

DR. PRICE: To say the obvious though, I think the mishandling, an opportunity for mishandling is greater with the greater number and that is where the bad exposure might occur.

DR. RICKERTSEN: They are obviously tied together. But, what I am saying is that if you are looking at the EPA standard it restricts the individual dose much lower than the kinds of things that we are concerned about in this other case. There is a coupling between them. One will have an impact on the other. But the safety impacts and the preclosure and transportation phases and so on are much more severe than postclosure.

DR. REITER: Can you take in account the number of health effects and the number of individuals that come in contact with it?

DR. RICKERTSEN: Yes. However you do it. When I say four or five orders of magnitude, you can pick up an order of magnitude by doing it a different way. But your orders of magnitude--

DR. REITER: So what you are saying is that the health impact upon society of the handling is much greater--

DR. RICKERTSEN: Much more important than the post-closure effects in terms of individual dose. There are people who argue that still for a repository that population dose is a critical factor. You have been in those debates.

DR. HOLLAWAY: What you are driving at is what comes out of when we initially looked at this was that minimizes handlings unto itself, doesn't necessarily mean anything; it's a surrogate for other things. What are those other things? Risk. Radiation. Exposure. Potential economic risk of losing a transfer cell, losing a facility for awhile and be shut down. Those other issues. So it is really a surrogate for other things. And that is what leads us into the realization that minimizing handlings unto itself is not the whole picture and we better think about what those other things are. What is it a surrogate for? How much is it a surrogate? What other things are there. And that definitely needs to be looked at and that is part of the picture. That is why we framed the study the way we have. I don't have the answers for you now; hope to have them sometime down the road. But we know that is something that has got to be looked at.

DR. CANTLON: Another element in the waste system, in many of the other areas of hazardous waste, the regulations read that the original generator of a waste has continuing liability even after it is put into a repository. If you put toxic materials in waste, ten years, fifteen years later, the original generator has got to cost share in the clean up. Is there built into this operation any continuing liability for the utilities to handle a mis-sealed and other kinds of things in transit and is this an incorporated element in what you are looking for?

DR. HOLLAWAY: An interesting thing related to what you bring up there is where that comes in is with the canisters. We talk about sealing them, because somebody has got to take the liability of verifying that it is really sealed correctly. That is certainly not clear at this juncture. At any event, someone has got to take the liability for bolting the cask up. I think the utilities would probably take that. They are used to doing that. Welding a canister closed is another issue and a very important issue.

Now that is framed in the Nuclear Waste Policy Act that when the DOE takes title to the material, that basically the materials are paying "X" and that is it. But, what other issues are related to that? I certainly can't answer that here. That is up to the U.S. Congress. But that issue of welding those canisters and verifying--somebody signing that is saying yes, this is done correctly, given that the utilities are doing the operations, that is a very major issue, and that was pointed out in our report.

Any other questions?

MR. GERTZ: I just had one quick question. When you talked about western strategy, it is a little different than the western strategy that Bill Bailey talked about, because he talked about western strategy, I believe for an MRS, and you have not looked at a western MRS strategy.

DR. HOLLAWAY: No, no, that is what I am talking about. And what the western strategy means, is if the repository is 500 miles and the MRS is 2500 miles, you may bypass the MRS and go directly to the repository.

MR. GERTZ: Even with eastern shipments.

DR. HOLLAWAY: Yes.

MR. GERTZ: Okay. You've got that considered.

DR. HOLLAWAY: Other questions?

DR. CANTLON: Okay.

DR. HOLLAWAY: Thank you.

DR. CANTLON: Dr. Gottlieb.

DR. GOTTLIEB: Now this is a continuation or an update of the presentation I gave at the February meeting in Augusta. And the discussion will focus on the system implications of repository thermal loading. Now the specific repository implications and the performance assessment issues will only be addressed insofar as they are already known and understood. And I will speak on these topics but I will cover the reasons, background, assumptions and analysis methodology very quickly, because that is primarily review of material which I have given before, although there are several new members of the Board who may not be familiar with that. I will concentrate on the conclusions, or I shouldn't say conclusions, but I will concentrate on the results that we have thus far.

First of all, very quickly, the reasons for the study, the first reason is that there have been several alternative thermal management strategies proposed. These have been mentioned already in this session and I imagine yesterday as well. And, in addition to the questions of the performance assessment dealing with those strategies themselves, there is the question of their impact on the entire system and the requirements that they impose on the system. And, so in order to reflect an understanding of those impacts we are undertaking this study. Now, the study is not going to make any recommendations. It is just going to say what the extent of the impacts is and what the feasibility from an overall system point of view is.

Now, in addition to addressing the overall question of what the impacts are, we want to be as specific as possible to assist in these system needs, particularly in terms of milestones and decision points. Although, as I said, we don't recommend specific alternatives or we don't direct decisions, we have material which is important for the background in these kinds of decisions and selections.

Now the specific objectives of the study, within that context are to identify overall system scenarios. A system scenario deals primarily with waste movement all the way from the reactor storage pool to emplacement in the repository. To identify system scenarios which tend to support the thermal loading strategies, then to analyze the impacts of the scenarios and to relate to program critical milestones and to provide design basis guidance.

Now, this diagram shows the context of the study; it is not a flow chart in any sense. But, it simply shows that the study is operating in an environment of external issues here; thermal management strategies being considered here; and then an extensive effort at assessment, performance assessment, design, site investigations and so forth relating to the MGDS. Within this overall context, the study focuses on the movement of the waste stream through the entire system, through emplacement in the repository.

The study participants are relating to that context are of course the DOE/OCRWM on whose behalf the study is done. The M&O in Fairfax, or more popularly now, Vienna, is responsible for studying management and scenario generation of system analysis. The M&O Las Vegas is responsible for those parts of the system which deal with the MGDS particularly waste package concepts, thermal analysis and operations concept for the activity.

The M&O in Charlotte is responsible for the design concepts of the MRS and we are closely coordinating to reflect that for them to understand the implications. And then the National Labs Sandia and Lawrence Livermore doing studies relating to performance assessment.

These three areas, of course, are under development right now, and so they are continually turning out new results and we are trying to reflect those as quickly as possible.

Now, the study is divided into two phases. The first phase dealing primarily with the waste stream scenarios or system scenarios, and determining their feasibility and Phase II to look at refinements of the thermal strategies and the scenarios to support them, and then to refine the assessments of the impact.

The first phase of the study will be completed next month. The report will be out by the end of next month and Phase II will be primarily in FY'93 hopefully to be done by July of '93.

Now, I have alluded to thermal loading strategies. We have for reference purposes used three--these are not baseline in any sense, these do not represent commitments to design, these just represent points on the spectrum of alternative thermal loading strategies. There is the long-term hot strategy which keeps the repository dry, according to present performance assessment calculations for five to ten thousand years. That is characterized by a target areal power density of 114 kilowatts per acre.

Now, this areal power density is a convenient reference point to use for characterizing these scenarios. Although, actually the long-term thermal performance for the long-term hot repository is dependent upon really the mass loading, or the number of MTU per acre rather than the APD. However, if you factor in the requirements of some limitation on the temperatures in the rock in the near-term and so on and so forth, that sort of maps into an APD. That is why we use APD here and also it is convenient to use for the cold scenario where it is more important because the critical parameter here is keeping the rock temperature below the boiling point or perhaps even below 60 degrees C as have certain desirable characteristics. With that kind of a target, a temperature target APD is a more meaningful parameter.

Then in the middle, we have a alternative which is similar to what was set forth in the SCP and which is sort of the present baseline, except the primary difference is that we are talking about fuel that is nearly 30 years old, whereas the SCP analysis was for 10 year old fuel. And the fact of the matter is now if we take an average waste stream generating from the current EIA data base, it comes out more like 26 years at emplacement if we follow the reasonable kinds of throughput scenarios that Bill outlined in his talk earlier.

Now the specific assumptions for the Phase I study are very briefly summarized here. And, the one thing I would like to point out is a target that we have worked toward in analyzing these scenarios is to levelize thermal loading. And I'll talk about the reasons for that in a moment. But this means primarily that you want to keep as close to a constant APD as possible in your emplacement, so that you don't have great variations from one part of the repository to the other, or even along single drift.

We have used robust waste packages, although by the time you get down to this small size, which is necessary for the cold strategy, it is not a very large package. But by robust we mean a thick-walled package and drift emplacement.

Now this drift emplacement is also a variation from the SCP, but we are not precluding the borehole emplacement that was set forth in the SCP, but our additional analysis are now for drift emplacement and whatever comparisons we do can be done against borehole emplacement if that is appropriate at some later time.

The other things I want to point out is drift spacing. There have been calculations made form 85 feet to 100 feet and those drift back and forth, and we are trying to understand the reasons for the differences and we will be as consistent as possible.

And the repository emplacement area, we have spoken of is 1250 acres. This is used for reference in comparing particularly the area requirements for the cold alternative. I'll show a map of where that fits into the total available area.

Now, the potential benefits of levelizing are in three general areas. First, to reduce the thermal stresses which can arise from temperature inhomogeneities along the drift. The second is to simplify the design and emplacement operations by providing a uniform environment and uniform ventilation and other maintenance situation. Which, these things would be complicated if your waste package heat output is varied by a factor of 2 or so. The question we have to resolve in the Phase II is just exactly how uniform or how levelized is really we are trying for. Is it ten percent variation, 20 percent variation? We are not sure now.

And, then also if we have thermal performance targets then levelizing assures of being able to achieve both for the hot alternative and for these two reasons and for the cold alternative as well, because the cold alternative requires no more than a maximum temperature anywhere in the repository.

Now, I mentioned the alternatives for levelizing. Typically, when we are blending to go into a waste package, we are talking about carrying hottest and coldest assembly available. And this also has the added benefit that you can get maximum utilization out of your transportation casks, maybe, if the NRC will buy this argument. There seems to be some question about that. But it is an objective to work for anyway, we think.

Then there are, at the repository the alternatives as far as infilling, leaving spaces and going back and placing packages, hot package next to cold package, so that even if you don't have absolute uniformity from package to package you can have uniformity from one pair of packages to the next.

And there are various degrees of elaboration on that, depending on how much you can complicate your repository operations by saving packages for putting in from subsequent years.

Now, this just very briefly is a pictorial representation of the previous slide talking about the alternatives for the way you can accept the fuel for how you can operate the MRS with respect to blending for age and burn out with heat and then the ways of operating the MGDS, varying in package spacing and blending within the waste package and then doing the alternatives of infilling and relocation.

DR. CANTLON: What is the acronym there, the second one from the bottom.

DR. GOTTLIEB: This is what you do with high level waste C/DHLW. That is something that we have always been talking about defense high level waste. There is actually some commercial high level waste, so we put that in. That is a new one. You did catch that.

Now, the effect of blending, I am not going to talk too much about this, although I have some other slides if people are really interested in going into it. This is just one alternative of the many that I showed in the previous picture. This one has blending at the reactors at the MRS to achieve instead of, if we talk straight, oldest fuel first, acceptance with "pass-through," "flow-through" at the MRS, what would happen is we would gradually build up hotter and hotter fuel being emplaced. This is the local APD running from about 85 kilowatts per acre up to 160 kilowatts per acre. And this is for a target of 114, which is the hot alternative.

Then a precipitous drop off when the reactors stop shipping and we take the stuff that has been sitting in the MRS for 20 years and has now gotten very cold, and we take that out. So that is about the worst case as far as levelization is concerned. It is the most convenient case for operations, but it is the worse case for levelization.

Now, instead we have some inventory transactions at the MRS throughout this period, which would still be--would still be "flow-through" for rail, but much of the truck would be shuffled in and out of inventory. We could achieve a fairly level close to 114 kilowatts per acre at emplacement throughout the entire time period.

Now to very briefly run through some of the mechanics here, this is a sample scenario data sheet. We have been talking about various modes of operation at the MRS and the repository and so on and so forth. This idea of the scenario data sheet is just to capture all of this in one record for a particular scenario that we are operating on so that we have documentation and we have tracks to know what we've done and why. And so it lists scenario number, what the thermal management strategy is, how the fuel was--the allocation rights, the selection criteria and so forth.

Now to summarize some of the results so far, looking at the three scenarios and their variations. Now you will note that I have six variations of the hot scenarios and four of the cold and only of the SCP. That just represents our concern with looking at the newer things first. These are all intended to be treated equally in the report. But the difference among these is, the first set of hot scenarios is for the nominal reference waste stream at 3,000 MTU per year, which actually turns out to be not quite an average of 30 years old, but actually 26 years old.

And then looking at blending at the reactor acceptance or blending at the MRS. And then looking at the results of that which I will show in the next slide. But, essentially if we address ourselves to the issue of feasibility, all of the scenarios listed here on this chart are feasible from the standpoint of the waste stream. Now there are some immediate concerns when we talk about 56 years old for this, 56 years old for this, which corresponds to an average aging of 30 years and does not fit in at all to the strategy--to the overall program strategy at the present time. But we are putting it here just for comparison purposes.

In all other respects all of these scenarios can be satisfied with a reasonable waste stream. Now there may be--there is some concern raised, usually when we talk about acceptance being other than OFF. And actually, of course, we don't know what the acceptance is and OCRWM has a limited control over what that acceptance is. There is some discussion about how cooperative the reactor owners would be with regard to blending at the reactors. But we present this as an example of what can be done.

DR. CANTLON: What does OFF mean?

DR. GOTTLIEB: Oldest fuel first.

This represents only a fraction of the cases we have considered so far and we are in the process now of doing our final analysis and we will have a variety of other acceptance strategies reflected in the final report, because of course, we don't know what it is going to be. But we would like to be able to show the benefits of certain acceptance strategies.

Now, further details of that--of those scenarios presented in the previous chart are given here. Particularly here where I wanted to focus on was the area required for a repository to handle these scenarios. Now the long-term hot scenarios, the group of four here all deal with non-aged fuel. In other words average 26 years at emplacement. And, the repository uses less than half--the emplacement area required is less than half the 1250 acres. And it turns out interestingly enough, that we use 33 foot spacing between packages and that is just enough to fit the high level waste package in between, so that all the high level waste can be accommodated in this same area by just putting it in between the waste package. The amount of extra heat that is added is less than six percent, because obviously the high level packages have a lot less heat output than the--only a small fraction of heat output of the spent nuclear fuel.

If we aged above ground to provide the longer term hot, this being typically 6,000 to 8,000 years, this being in excess of 10,000 or 12,000, then we would have a higher emplacement density, mass emplacement density and we could use only this small fraction of the total area of the 1250 acres.

Now, on the other hand if we try to achieve the cold objective, then we run up with unaged fuel, we have 2.75 times the 1250 acres and with aged fuel, 30 years aged fuel, we have about 1.5 times the 1250 acres. And of course, the SCP as it was designed just fits the 1250 acres.

Now, since I am talking about that I will skip out of order slightly and go to what the map of repository looks like as presented in the SCP as based on the Sandia technical report which analyzed this.

This area here is more or less the small porkchop that Hugh Denton showed in his talk yesterday. And, the 1250 acres comes if we take out what is nominally planned to be the ESF area. Now the area up here plus down here the north and south extensions and they bring it to a total of 2200 acres. If you will look at your charts you will see that at the bottom there.

If you take off this northern piece here, that drops it down to 1850. But we concentrated on this 1250 here which is believed to be the best part of the repository. These other areas that are shown here this sort of horseshoe around the repository satisfies the requirement of being the minimum overburden requirement for the repository. And, it looks to be reasonably free of faults, although there is a concern that there is significant faulting here, the imbricate fault zone. And this may have some faulting too, plus the fact that this area has the problem that it is not contiguous. I mean it really is contiguous, but you don't meet the overburden requirement here, so you have to either get down lower or figure out some other way to get over it.

So if we take the entire horseshoe then we could meet the requirements for the cold strategy without any extended storage. But it is doubtful that the entire horseshoe is going to be suitable. So that presents it in the context, I think, of what is now known and understood about the potentially feasible repository area.

DR. CANTLON: What extended storage would be required to stay within the smaller area to keep the cold?

DR. GOTTLIEB: To stay within the smaller area.

DR. CANTLON: Yes. How much extended storage.

DR. GOTTLIEB: To stay within the smallest area would probably then up the storage to 60 years or so.

DR. CANTLON: Sixty.

DR. GOTTLIEB: Yeah. The slide I showed here--pardon me. This one here 1.5 times. This is storage for 60 years. The average age if you stored it for 60 years would be 90 years. That would then bring this down to 1. That is what I am saying.

This itself is for storage for 30 years.

DR. DOMENICO: Can you repeat the last conclusions? I heard--it is not likely that the whole horseshoe can be used, something to that effect. Does that mean--

DR. GOTTLIEB: That is not a conclusion. That is just current thinking.

DR. DOMENICO: Is that the same as saying you really do not have enough space for a cold repository unless the fuel is aged for some what, 60 years or so? Is that the main conclusion here?

MR. GERTZ: We don't know enough to say that we have enough space--

DR. DOMENICO: No, I just heard something like that, Carl. I think something about the whole horseshoe cannot be used. Is that right?

DR. GOTTLIEB: Now, I didn't say it cannot be used. I said there are questions. There are areas that are more--the central porkchop looks like the most promising area. The other areas are more questionable.

DR. DOMENICO: And that still is not considering the fact that in the since we are not underground yet, we don't know just how bad the material is gouged into any of those faults and how much of that space is totally unusable because of the geologic disturbances. Correct?

MR. GERTZ: That's the exact area. It is based on the limited number of boreholes we have in those areas at this time. And some geologists believe perhaps it is good enough. Some geologist believe perhaps it--the probability is if you look through all that, look at the geologic history, that it may not all be useable. But there is certain probability there that it could be all useable.

But we really don't know enough, I guess, Pat, is what really what we are trying to say.

DR. LANGMUIR: Another question for you. We have had quite a bit of discussion in the past about the potential of enhanced cooling using something like heat pipe approach. Has DOE discounted the possibility of using a heat pipe approach to make it possible to put the waste closer together and use smaller amounts of the repository block?

DR. GOTTLIEB: There are a number of cooling methodologies of ventilation, et cetera, that have to be explored, and that are being explored now as part of the MGDS design. And part of that is being factored into our study.

In particular heat pipe is a performance assessment thing, and as far as being specifically considered in this study would come in in Phase II. That is still under investigation. I don't know exactly where it stands.

Now to summarize very quickly, since I am running over, the hot repository scenarios, which are feasible are either blending at MRS and/or reactors with no particular strategy of infilling or relocation in a repository. Or, some blending at the MRS in reactors with, or no blending at the MRS in reactors with the repository accomplishing the levelizing by either infilling or variable package spacing.

And, the other note here is that since the area requirements that I showed in a previous slide are less than half of the 1250 acres for the 63,000 MTU, plus the 7,000 high level waste which you can fit in -- then you could easily emplace the 86,000 in the 1250 acres. Now of course we have to recognize that the NWPAA specifically states this repository is only going to do 63,000. But that still is a consideration, I think, so that is why we mentioned it.

And then the cold repository is summarized by these two scenarios. Things to point out is that this 24,000 MTU emplaceable means that is how much we can get into the 1250 acre narrow porkchop that I showed. And, even with the 30 year storage we could get 50,000 MTU emplaced. So, that is why I would say that to get all emplaced within the 1250 acres with the cold strategy, we would need something close to 60 years storage.

MR. GERTZ: Before you leave that would you put your map back up. I just want to--I'll speak into your microphone. You must keep in mind that our ramp going to the north is about right here and our ramp going to the south is about right here, if I draw that on. And that would certainly provide us some opportunities to explore some of this area as questionable as we start with our ESF, so the conclusions we are making are based upon a few boreholes. We will know a little more with that ramp. We still won't know much about this area.

DR. DOMENICO: Gee, that seems like another good idea to get underground, Carl.

MR. GERTZ: I want to get underground. I agree.

DR. PRICE: Dennis Price. I have a question here about your OFF assumption. I think OFF assumption is good for mosquito repellant but I am not too sure how good it is with respect to a 26 year average emplacement age. You already identified that you don't know what you are getting with it. But, wouldn't a conservative assumption be that you are going to get the hot stuff out of the pool?

DR. GOTTLIEB: Well, that is a possibility and that--our final report will have that alternative in there. We are going to address that. We have done that with our Throughput Study and we will do that with this study.

DR. CANTLON: Have you completed your presentation.
DR. GOTTLIEB: Yeah. I've got a couple of more slides, but it is not necessary.
DR. CANTLON: Go ahead and put it on.
DR. GOTTLIEB: We are late anyway.
DR. CANTLON: Discussions? Questions from the Board?
DR. DOMENICO: I've got an observation or a comment to make that is mine; it is not the Board's. Maybe I'll try to convince the Board to make this an official recommendation later if I can convince them.
But I am not thrilled to see Yucca Mountain converted into a geothermal area. Now it may be good for the program. However, at times DOE has hired boards of consultants to resolve certain problems, like the Szymanski issue there were consultants. The DOE hired Al Freeze to put together a group of consultants to address certain issues and Al Freeze is a tremendous hydrogeologist and that was done through Sandia.
It seems to me that there are not enough people on this project, or not enough people working on this project that have the physical, chemical background to assess the coupling, hydrologic, geochemical mechanical aspects of converting this region into like I said, geothermal region. I hate to see the decision made on the basis of systems analysis. I would like to--I mean systems analysis--I think

this would be a very good position for DOE to seek out some leading consultant in physical phenomenon and let him put together a panel of three or four people in certain areas, mineralogy, chemistry, stress strain phenomenon and look at this and give you a report like you have gotten with the other major issues, because I think this is a major issue that is not being addressed from the physical side.

Now, we have heard the umbrella effect, but that is a model calculation. That's a model calculation in a rather idealized environment. I think I would be much more comfortable if we had people from the physical side that said yes, it is okay to go up to 270 degrees C over this prolonged period; we see no problem.

That is my suggestion. Again, that is just as an observer looking at this. Because, I think this is very critical point that is really not being addressed from the physical side. From the modeling side, from the systems analysis side, but now let's look at the physics of the problem.

This may not be the right place to say this, Carl--

MR. GERTZ: And Pat, no, certainly we debate that within the project as you are well aware. And we will certainly take that idea under consideration, which--

DR. DOMENICO: If you need a few names, I'll be very glad to get you started.

MR. GERTZ: Once again though, I think that then has to balanced again and maybe they should ask the same question, does that assure that it is dry for 10,000 years. Because, if we can ensure it is dry for 10,000 years, we don't really care much about the other characteristics. If no water gets there we are in pretty good shape.

DR. DOMENICO: Well, I don't think it is good policy to have a smoking mountain out there in the desert. I don't think that that would lead to a lot of assurance. You know what I am saying.

MR. GERTZ: When you say smoking mountain, I think of a--

DR. DOMENICO: That sounds like a song doesn't it?

MR. GERTZ: I think you have to put in perspective that 57 kilowatts per acres is how many thousand watt lightbulbs. You know, not to many. We don't want to give the public the illusion that it is going to be a smoking mountain.

DR. DOMENICO: Well, I don't want to repeat myself, but I mean I really think that it is being addressed from systems analysis. It is being addressed from modeling. I think you have got to put some physics on this. I think some good high temperature chemists, some good physicists and good mineralogist, people who are aware of geothermal areas, and you have done this before on three or four major issues. And nothing is more major than this.

MR. GERTZ: And of course that leads to the overall performance, if we can assure it is dry, that enhances our ability to meet the regulations, because water transport is the question.

DR. DOMENICO: That's a different question. That is your assumption. I am saying what is the physical effects of achieving that? And--

MR. GERTZ: Does it compromise our ability to isolate waste.

DR. DOMENICO: Does it compromise your zeolites--God knows what it can compromise.

MR. GERTZ: I don't want to debate it much more, but we don't need zeolites if it is dry. We don't have to worry about them.

DR. DOMENICO: If you can be rest assured that it is indeed dry.

MR. GERTZ: That's true. That's the key.

DR. CANTLON: Other questions from the Board?

DR. PRICE: I have a comment. I am just pleased to see the studies in systems engineering and would like to make a comment on the need to maintain a flexibility to absorb throughout the process of convergence all of the inputs that may come and that systems engineering not be a thing that tends to freeze things up. Just like other things.

I did notice that, and it was even stated from the speaker about certain things being within jurisdiction and outside of jurisdiction. And this is a troubling aspect of looking at the total system. We do have the problem of jurisdictions and I think probably there is still prevailing some compartmentalism even outside of the fence.

But on some of these issues that are especially important to the utilities and notice that Bob Shaw indicated they were doing some things along some similar lines in the utilities. Is there a mechanism or could you develop a means to have a very close cooperation such that you might not have to end up saying there is four handlings. Of course, we did not look at any of the handling inside the utilities. Just kind of get past those barriers that stop you from taking the complete look at some things. And I think it goes outside the fence and inside the fence.

DR. GOTTLIEB: Well we certainly want to address that issue, and we certainly before this study is over we will have some utility input either through EEI or whatever. We will have some utility input on the question of the feasibility of blending at the utilities and so forth.

And I would like to point out that the only reason for putting these boxes here is to show areas of responsibility. The point is, the key thing here is coordination. And these groups are all tied together and it is not compartmentalized. And anything that gets done here affects the whole system and we make that information known immediately.

DR. PRICE: My idea may be idealized, but cooperative levels such that you are able to identify the details of the study in such a way that you call for the data you need and they get the data and they know what the study is, and you don't announce the results of the study to them, but they are part of contributing to--certain parts--where especially there is a great deal at stake for them.

DR. GOTTLIEB: Definitely.

I can say that most of this presentation has been reviewed by this groups here and parts of it by this group. So, we are in very close coordination, which represents a joint product.

DR. CANTLON: Dr. Cording?

DR. CORDING: I wanted to go back to the general comments that we have been making in the last two days. I think that to some extent it may be preaching to the choir, but I would just like make sure that we are working toward being on the same page and same stanza of the book to carry the analogy on.

It seems to me that regardless of the budget, we need to treat the ESF tunneling as if it is on the critical path, because I believe it is. I believe that nothing much is going to happen in characterizing the site and we won't be able to reach dates unless we start tunneling. And whatever that budget is, it seems to me that we should consider what it takes to get one TBM started say in FY'94, with enough area, electrical, mucking capacity back up to do an efficient operation. It has to be efficient to go some distance, of course. But it seems to me we don't need to do certain things like, and I would like to discuss this more with you, but in things such as permanent portals that might be designed for accelerations that are those for which the repository has to be designed.

Then, just this personal perspective at this point--

MR. GERTZ: I just need to stop you a second on that, because our regulator doesn't necessarily agree with us on that. That since the ESF would become part of the repository and we have had this debate with them on these shafts, that we believe we need to go through a full regulatory review of that particular aspect of construction. But, you know, we can debate that later.

DR. CORDING: I guess my point is that it is not that one can't achieve that, but to do it before you start TBM tunneling is something I would like to discuss with you more and I am questioning.

The other is in regard to precedence of say tunneling over additional dry drilling set ups. I think that is something that I would like to get your opinion on the DOE's reaction to that at some point.

And then the other is evaluating perhaps in a top down way at some overview of how one can shift SCP testing from surface to underground? How can that be done? It looks like we have two-thirds of the testing budget on surface based testing and when we are working towards a very extensive platform underground that would serve, I think, give us some opportunities that perhaps we haven't been able to factor into the situation at this point. Those are my prime comments.

DR. CANTLON: Other questions or comments?

DR. LANGMUIR: Just looking at your overhead coordination among principal study participants, and I am hoping and assuming that there is a secondary set of participants that are built into this same loop. This is coming back to what Pat Domenico had to say. But more specifically, you talk about stress distributions, temperature distributions, but I presume you also intend to consider consequences of those distributions to waste isolation, which means you are looking at all the other lab organizations, the USGS, that deal with subjects such as, well the waste isolation obviously. The source term, all the ways we could impact the isolation of the waste as it relates to the choice of thermal loading strategies. It has got to be tied into the same loop. They have to be part of the process all the way through.

DR. CANTLON: Other questions from the Board?

Staff?

Let's get Dr. North, first.

DR. NORTH: I'd like to give an overall impression and I'll turn this into some questions.

I am delighted to see the extent of the systems engineering that we have heard today. I share Dr. Price's feelings about that. On the other hand I am struck with how much more you need to do. How much we are hearing a first phase and there are many, many issues for which we need to go into much greater depth in order to get the insights.

As an example, the occupational radiation exposure from the handlings. The one through four rankings seems awfully primitive relative to getting at the issue. Really, how do these strategies compare in terms of the very large amount of dose that we are going to be subjecting the workers to in one place or another.

I mean at this point we have a sketch. We don't have a detailed analysis that really allows us to understand that problem very well, and it would seem like communication across the border to the utility industry on this issue, is at a very preliminary stage if at all. There is work they are doing that Bob Shaw talked about. There is probably a lot more cooperation that could go on in this issue.

The point I am leading to is to commend you for getting started, but noting that you are barely started.

Then, I am very concerned, I think we are all, about the pressing 1998 date and the budget problems. And, now that I understand what you are doing on Mission 2001, I would urge that there be a follow on effort going back into the study plans in detail and asking what do you need, and when do you need it, with respect to performance assessment, with respect to understanding the site suitability issue and its relationship to the data you were going to obtain. And then looking all the way to the license application.

And it seems to me you have to look at the potential that the discussions you had with the NRC on the site characterization plan may be quite out of date when we are considering ramps versus shafts. And that you may want to open up a lot of those discussions again and think about what can you do against various time and schedule limitations, spreading it out from one set of numbers on the budget and one set of numbers with regard to the time, so that there is a data base in place to reconsider this program.

If in fact what happens is that the Congress is simply unwilling to give you the money that comes up with the budget that you have got and you have got that 1998 date enshrined in law, you didn't make that. That was something that was imposed on you. But, it seems to me that everybody is going to be asked potentially, what is going to happen? What do we do if the Congress doesn't decide to give you the extra money you are asking for. And it seems to me that you can only address that question reasonably if you go back and look at the study plans and think out what information do you need and when do you need it, and have an exercise that will allow us all to look at that.

At this point, I can't judge based on the SCP and the study plans and the performance assessment I have seen. What is it that the program really needs to do? And is there any reasonable alternative to the baseline strategy? So, my question really is, what are your plans in this area and when might we hear about various next stages on it?

DR. CANTLON: Maybe John can make that part of his closing remarks.

Are there other questions or comments? From the audience?

MR. NGUYEN: I am Tien Nguyen, I work for Bill Lemeshewsky. With respect to some of the comments that we have heard earlier regarding the need for closer cooperation with the utilities such as things as universal containers, some casks and others, I would like to comment that we have been in very close touch EEI and their contractors.

Specifically, I have been in contact closely with Michael Schwartz, one of the key contractors supporting EEI and the EEI universal container task force. We have sent graphic boards to him. We have set up the meetings between the EEI universal container task force and our associate director for storage and transportation Ron Milner.

I would also like to say that we have been in touch--both we and the M&O system analysts people have been working closely with the contractors supporting EPRI in their evaluation of the uses of cask concepts. And personally, I have had a good working relationship with EPRI's Bob Williams and Ray Lambert the key people who I believe are sponsoring this EPRI study on universal casks. I have known them for seven years.

So, we have been coordinating with them on certain aspects of this program. I would like just to clarify it for you. Thank you.

DR. PRICE: Yes. But may I just make a comment that in the presentation there was no presentation that was coordinated between the utilities, who obviously have an interest in a lot of things. In other words you presented your thing and it stopped. Is it all feasible to end up with what would be a joint report?

DR. CANTLON: Other comments from the floor?

MR. WILDER: Dale Wilder, Lawrence Livermore Lab.

I would like to comment or maybe try to put into perspective a comment that was made about uncertainties. And I certainly agree with the suggestion that we may need some peer reviewing on some of these coupled processes.

The impression that I was concerned about was one that was expressed that uncertainties are greater for the higher thermal loading scenarios than for the cold. And I need to be up front and point out that indeed we do not have validated models at this point and our laboratory experience is somewhat limited. So, what I am saying is based on a very preliminary kinds of looks at the issues.

But one of the big uncertainties is the coupling between the various hydrology/geochemical processes. We are starting to look at some of those couplings, but I would point out that if you are below boiling, you have a condition where you not only are coupling rock water interaction, you are also coupling with manmade materials, waste package materials, shotcrete or whatever happens to be there. Whereas, if you are at the elevated thermal conditions, you are having rock water interactions, some farther beyond the area where you have manmade materials present.

Our calculations show that within a very short period of time, you are going to be moving the drying front away from the manmade materials. Some preliminary calculations show that we are looking at rates of somewhere between 6 to 8 meters per year, movement of the boiling front in the first year and so you are not going to have long resident times. And of course, a lot of that coupling is not only a function of the temperature, but also the residence time.

Secondly, looking at some of the manmade materials, once again very preliminary, we have not been funded except through the international program to look at some of these fundamental materials. But the unstable gel phase in concretes becomes stable. I am not saying that the concrete necessarily performs better, but at least the unstable gel phases becomes stable at elevated temperatures. And so the uncertainties once again are potentially reduced.

Hydraulic conductivity, orders of magnitude, variation in hydraulic conductivity. Thermal conductivity are a few times kinds of variations. And so if you get to the point where you are dominating by thermal conduction rather than by hydraulic conductivity, your uncertainties will be decreased.

I guess I would also suggest that you consider where are these processes taking place. If we do have the rock water interaction taking place so that you do change the hydraulic properties, in the extended thermal or the extended dry out if I can use, that. I hate this hot/cold, because cold isn't cold. But in the extended dry out, those kinds of interactions are taking place well away from the waste itself and you created a zone which can buffer not only hydrology but also geochemical. So, I would caution you not to assume that uncertainties are worse in the elevated thermal case.

Thank you.

DR. CANTLON: Other questions?

DR. DOMENICO: I guess those were addressed to me.

We have heard those arguments before and we don't disagree with those arguments at all. But, I think also we have to keep in mind that you have made the key--the key word as our model calculations show. And I think a lot of your heat transfer calculations are done on conduction alone and don't have convection built in those models, unless I don't know anything about the later models. So, I am not quite sure that convection is in there. But, like I said, we have heard those arguments before.

And you might have noticed that in our last report we did not come out and say your hot repository was no good. We didn't say that at all. We said we would look at it. I just thought that at this stage, as I will mention again without beating a dead horse here, that some of the basic physics and chemistries as it affects the rock and the coupled phenomenon should be examined.

Because, when you say it is dried out, that will be the result of a model calculation.

MR. WILDER: That is correct.

DR. DOMENICO: You see your model calculation say it is going to be dry and I don't trust model calculations.

MR. WILDER: My comments really were not addressed directly to you. They were addressed to an earlier comment that had been made about uncertainties. And I do not disagree with you that we have got to do something to get a handle on these models. I really appreciate the comments that the Board has made about needing to get underground, because we have got to validate these models.

By the way, our calculations are not only conduction. We have done some calculations looking at convection as well. We have compared them with the, although it is very limited, the field experience at G Tunnel. And so, thanks.

MS. HARRISON-GIESLER: I am Diane Harrison-Giesler, Department of Energy, Yucca Mountain Project, and I will address Dr. Domenico.

I just wanted to just sort of in defense of the project as was presented at the October meeting to the full board that we have been evaluating the physical impacts of the thermal load on the geochemistry and the geohydrology and the biological impacts to whatever the surface of the repository, on the ground surface. So, we have been doing the work that we have been able to do at this point. I don't want you to be left with the impression that we haven't been looking at that.

And the results of those studies will most certainly be a part of the decision as to what temperature the repository would be.

DR. CANTLON: Other comments?

DR. DOMENICO: Domenico, one last word here.

Again, I think that is fine that DOE is doing that. I think--frankly I think this is a big enough issue like the issues that Freeze looked at or the issues that we tried to resolved satisfactorily the Szymanski problems, it should be looked at by an outside group. And that is my idea of an outside consultant. It should be looked at by an outside group.

DR. CANTLON: All right, if there are no more comments or discussion, let's hear from Dr. Bartlett.

DR. BARTLETT: Oh, I would like to take a whack at the last word of the smoking mountain.

DR. DOMENICO: That's a John Denver song.

DR. BARTLETT: I agree it is certainly significant. And was indicated we are looking at it now and undoubtedly it will be the subject of a dedicated group, let me say.

There is a dedicated group right now that is called the NRC, Nuclear Regulatory Commission. It might be beneficial for us to do the same thing, but I would like to ask Pat a question back. And that is, at what level of site characterization data would such an evaluation be appropriate? Because as was indicated the present level is low. We don't have a lot of data. We would have to do a lot of extrapolation.

I think frankly at first guess, we would have to have a pretty complete data set to make such an evaluation worthwhile. In otherwords, it can't occur until we are well into the data acquisition and data interpretation phase. First guess, but we can dialogue on that.

Another response, if I may. ESF uber alles, I can give you the short course on intense political pain. Because, I have been there. I did this a year ago. Out of what I believed was necessity, I delayed the ESF for lack of funds. And I have been suffering the consequences of that ever since, and as you know we may be facing an intense lack of funds again in the coming year.

The fundamental basis for the decision last year was simply we cannot destroy infrastructure for the program, no matter what the funding level if the program is to continue. We may change the program, but as the program is presently constructed under the guidance and requirements from the Congress and from the Secretary, we can not just ESF uber alles, arbitrarily without destroying something perhaps, depending on the funding that is available. We wind up with a different program.

And, depending on what funding we do receive in fiscal '93 we will see what actions we have to take.

I could not agree more that there is nothing more significant and symbolic of progress than getting started underground. I think we all know that. But as a prudent and responsible manager of the entire program, looking at as I mentioned to you back in January, these dual goals of equal rank, et cetera, I have to take all of that into consideration. I assure you I will and we'll see what happens.

Now, let me summarize what I think we have tried to accomplish in the last day and a half with you. Basically, from my point of view, I think that we tried to accomplish or present to you five basic things of material over the last day and a half.

First of all an emphasis that the program is in fact focused on getting results. We are not just studying things, we are trying to produce results in accordance with the requirement of our mission, the Secretary's plan and everything else.

Secondly, and this is in response partially to Dr. North's comment, the second point as I wrote it down. We are taking a very careful look at what results are needed. And, we are in fact, as was indicated in the presentations looking at this question of the scope of work required, updating it in order to have it more focused and more timely in terms of things that might have changed since that initial scope of data requirements was established back in 1988.

Thirdly, we are developing the means to produce the results. And two key things about that were presented to you. First the convergence concept for the operations and the management of the process of producing results effectively. The interfacing of all these operational functions that have never had to be interfaced before in any kind of project, that is what the convergence is all about. How do we make the process of producing results happen?

And secondly, a very important thing, it tends to get overlooked, the concept of baselining, driving an anchor and it ain't perfect to begin with but it is the starting point and then the change control board so you have the system of traceability and accountability that we must have to indicate where we have been and how we got to where we are going with the results.

The fourth major point, through the system studies we are producing the basis for some of the key decisions. And as was indicated we are really just at the beginning of some of the significant system studies that will guide and provide part of the basis for key decisions. I would just remind the Board that the bases for decisions are not just purely technical in many cases. But these studies will provide clearly part of the bases for defensible decisions in the future. And we are trying of course to keep the system studies paced with progress and the rest of the program.

A final point, I hope it is evident to you, it is to me, that the M&O is in fact actively and effectively engaged in transitioning and it is in transition into its key role of program management and integration. It is still a moving aspect. Many things are not yet complete. But, they are moving toward our goals and they are very effectively taking on some of the responsibilities in value added way that we were looking for, and we will of course be engaged in the transition for approximately another year. And then when we get to steady state, I hope we will be effectively producing these results, the key role played by the M&O and with our convergence process and everything else operating in an effective way.

I would like to thank the Board, very much again for the opportunities and the insights, the guidance that you do provide to us. We very much appreciate it. Thank you for the meeting.

DR. CANTLON: Thank you, John.

I'll respond, but let's hear from Nevada first, though.

MR. FRISHMAN: I want to thank you for allowing me to make a few comments and we had asked for this opportunity about a month ago, I guess.

I would like to welcome all the continuing and the new Board members to my continuing saga of end of the meeting runs of thoughts.

Today I wanted to talk about a couple of specific things that I noticed in your fifth report that came out in June. And they represent, I think something new, I think maybe inadvertent, I am not sure. But I wanted to point it out to you, because I think it is important to point out because you may have sent some signals, that you didn't intend to send, and if you did intend to send them, I would like to try to persuade that maybe you shouldn't have done that.

If you look at in your report in the discussion of seismicity and I noticed this before the recent events, so I think it is--maybe other people think that the seismic events were highly fortuitous, well it was serendipitous here.

You point out in your remarks regarding seismicity that you say: "In general, however, the Board views earthquake related vibratory ground motion as primarily an issue of appropriate design and construction rather than an issue of site suitability."

Now where I take issue and you will see how I get to this, is you are saying that it is not an issue of site suitability. You do it again in another area. You do it in the area of thermal mechanical effects. You say: "Thermal mechanical effects for any strategy appear to be repository design concerns rather than suitability concerns."

I take issue with that again, partly because of the statement that the use of the concept of suitability and partly because if you go back to your fourth report in December, speaking on the same issue, you say: "To investigate many of the thermal mechanical effects properly, sophisticated instrumentation using new technology will be required. This instrumentation should be tested in an underground environment over the expected range of temperatures prior to its full scale use. The results of the G Tunnel test of thermal mechanical behavior of rock and fluid gas conducted at Ranier Mesa int he '80s were informative but not definitive. The G Tunnel test provided an initial shakedown of procedures and equipment and provided experimenters with some experience in working underground. But the tests were terminated before the prototype testing was advanced enough to be able to develop and evaluate revised testing strategies."

So, I believe you are maybe even a little inconsistent with yourself in this point. Now let me show you what I mean about saying that it is an engineering issue rather than a suitability issue. Let's go to the preclosure guideline on seismicity.

This is the disqualifying condition in tectonics and if you look at that disqualifying condition, you see that it is essentially an engineering based disqualifier in the first place. Now, for this reason alone, if you have a disqualifier as part of the guidelines and the purpose of the guidelines is to determine site suitability, then to eliminate an issue from a suitability determination and say that it is merely a matter of how the engineers fix it, not a matter of whether the site itself is suitable or available for application of engineering fix, I think in itself it is a violation of the Secretary's only standard for determining suitability.

Now, let's look inside this guideline, this qualifier for a minute. You see the use of the words "reasonably available technology". The Department of Energy in the guidelines had defined "reasonably available technology". "Reasonably available technology, means technology which exists and has been demonstrated, or for which the results of any requisite development, demonstration or confirmatory testing efforts before application will be available within the required time period."

Now given what we all know and a lot of what you have heard over the last day and a half, regarding the uncertainties both in how to study the site, never mind what we know about the site or can know about the site, and also the uncertainties in the Department's approach to thermal management which is strictly an engineering approach, whereas the NRC looks at thermal loading primarily as an adverse condition.

If you take all of that together then, look at the definition of reasonably available technology, link it into this, I think that it is premature and probably improper to say that seismicity is not a suitability issue. And I think it is the same to say for thermal mechanical effects.

Now, I hope you are following my logic on that and I guess what I am trying to do is suggest that from the standpoint of your reports, it probably does not serve well to make these kinds of statements that then can be essentially adopted by your audience; the Secretary of Energy; and, the Congress. It is premature, and I think it does a disservice. And I am trying to point it out to you in a reasonable and logical way based on the context within which we all have to work, which is the guidelines at this point.

The other reason that I point it out is that, and we have been through this discussion before, both on an individual basis and as a group, is that I don't believe that your discussions of suitability are really within your statutory charge. I think your statutory charge is a different one. And, that charge, may I read it to you again? I know we heard it at the beginning of the meeting, but I would like to read it to you again.

"The Board shall evaluate the technical and scientific validity of activities undertaken by the Secretary including site characterization activities and activities relating to the packaging or transportation of high level radioactive waste or spent nuclear fuel." It doesn't say anything or include in your charge the necessity or maybe even the responsibility for saying anything about whether the site itself is suitable. It speaks to your recognized and appointed expertise in overseeing the Department's technical and scientific program.

And I urge you to continue to consider these statements that I have been making to you over the years on this very subject. And I think over the past couple of days we have seen your application of that expertise in a very good way in terms of the probing questions that you have been asking about some of these presentations.

I think the suitability issue you know as well as I do is extended way beyond the technical and scientific validity of the Department's work and I would suggest that your inquiry is at least--from an official standpoint is best confined to the scientific and technical, since the rest of it we all know is the tar baby that we are stuck with.

Now, let me go on and make another point that I think I need to convey to you. It is in line with just what I have been pointing out. That is that I did appreciate in your report the approach that you took to focusing on one of the major technical and scientific unknowns of the program, and your strong encouragement that there be some immediate and very rigorous effort put into trying to understand that particular element because it is such a driver in the entire program. And all the way through the system, not just at the level of disposing. Although, I think, or I hope most of us agree that the disposal site, if there is to be one should be the primary consideration in the thermal management exercise.

Now, I heard and I guess a comment that disturbed me very greatly this morning from Dr. Bartlett and it came as a result of Dr. Price beginning to question and getting almost up to asking or making an observation that really is one of the problems that we are seeing. And you almost asked but didn't, so I will. What is the scientific and technical effect of the firm milestones of this program?

You have the 1998 date, everyone has been working very hard with that over the last day and a half. And I think a lot of your questions collectively sort of went in the direction of saying, well, and someone did ask directly at one point, if you didn't have that would you be doing this differently? And the answer was yes. We would be looking at different things. We would be looking at them in different order. We would have time to look at them in a different way. We would have time to consider more variables.

The thing that John said, disturbed me enough to want to point it out and then make a suggestion to you. John pointed out that a technically optimal option for the system may not be the one that is adopted, because of the need to get on with solving this national problem. That is very disturbing to me. That drives the--it hammers home the impact of the schedule.

It hammers home what we believe in Nevada to be a functional decision that the repository site is Yucca Mountain in spite of all the protesting that we are only studying it. That single attitude and the reflecting the firmness of this schedule and as you all see, right now in the midst of a total rebuilding of the program, that attitude alone may be the most dangerous thing that I have seen for ultimately safely handling this waste that I have seen in a long time in this program.

Now, what I would suggest because of the importance that I see in just having analyzed this small piece of what was going on here, I really would like to propose and I think this is something in line with at least the suggestion that has sort have been unspoken at the table. I would like to propose that you consider for your next report continuing with the approach of at least a major portion of the report being focused on a single topic.

I would like to propose that you investigate in that next report the impacts and importance to science and technology and the validity of the Department's scientific and technical program and activities relative to the immovable milestones of 1998 and 2010. I think that may be the most valuable contribution that could be made right now given the speed at which the M&O contractor is working through revising this program to a massive extent, if you notice. I noticed. And the speed at which some decisions are going to have to be made.

We see a looming MRS decision that is driven by the 1998 date. We see the complications in some cases that the MRS throws into the system. We do not have unanimous belief in the country and among any of the players that an MRS is really necessary in the system to do anything other than to meet that 1998 date.

So, I would suggest that I think it became clear, at least to me, that there are some major scientific and technical impacts that are being caused solely by this one issue of immovable deadline. And I think maybe since you report to the Congress and since you report to the Secretary, the Congress and the Secretary are solely responsible for those dates. I think maybe the service that can be performed next within the next six months is your applying your expertise to what you think those impacts are and reporting them to the decision makers.

I guess that is enough again for this time, and thank you for the time to make this presentation and I really do urge your serious consideration in this area.

DR. CANTLON: Thank you, Steve.

The Board operates of course as a Board and it is not pertinent and correct for an individual to respond to questions. We don't respond to DOE's questions on our recommendations, immediately. We sit back and cogitate. So we will take your recommendations and comments under advisement and get back to you later.

John, did you want to make any response?

DR. BARTLETT: If I may, Mr. Chairman.

Steve is basically asking are the milestones compromising science? No, they can't, because if we tried to compromise the science and do less work to the milestones we would get trapped when we got into the licensing reviews. The results would be just flat out found inadequate. So far, what we have assessed is that we are not in a position where I have to go to the Secretary and say, we are not going to make it, because we don't have enough money at a high enough level to stay on schedule. We are getting very close to that. But that has been the situation so far.

There is just no way we can compromise the quality or the scope of work essential to meet the requirements of licensing reviews. If we do get in a situation where the funding is in our opinion not sufficient to do that amount of work, by the milestones, they will slip. We are being driven of course that we are under--one of the milestones is a contract milestone. And it is also a legislative requirement.

So, that's the driver and that is the kind of problem that the Department overall faces, why the milestones are maintained as strongly as possible, but we internally of course evaluate what is the scope of work required to meet that and then what are the implications of the resources we get to accomplish that scope of work.

There is no way that the milestones can compromise either the quality or quantity of work necessary to get the work done.

MR. FRISHMAN: I would like to respond to that if I may just very quickly in two areas.

One is I just happen to notice one thing as it went by quickly today in a presentation that maybe is not a compromise, but it compromises the process. The very process that John is most concerned about and that is his accountability to the Nuclear Regulatory Commission and licensing.

I noticed in the discussion on thermal loading, the assumption in the Phase 1, or the assumptions on Phase 1 include a robust canister or container. And what we found out or just through questioning, a robust container means a thick-walled drift emplaced container. Now that is carried through the entire--that is an assumption in Phase I that is carried. It was listed in the handout. Those were the assumptions for Phase I. And, so the analysis is done on that basis.

Then you go to Phase II and look at the product of Phase II, which is a set of recommended options for decision. Now that decision ultimately will be made by DOE at some time because of the schedule in the very near future, and if the decision is one of the options, then you have the option that is very different from the baseline program right now, and maybe there is nothing wrong with that, but where you have the problem is if you buried that decision this far back in the program, ultimately the NRC is going to say, what is the design basis for the thick-walled drift emplaced container? And you are going to have to go back and invent it because you didn't go through the exercise of original analysis for design basis. So, that is exactly what John is worried about. And you have a decision that is being driven very fast right now.

The other part is just in terms of the reason for the deadline and the milestone, John says, you know we have a contractual obligation. Well, in a recent letter from the Secretary of Energy to Alan Keesler, he told Alan Keesler, who I think we can all accept as maybe representative of the nuclear utilities right now, he told Alan Keesler the Department General Counsel had determine that they are not bound to performance in waste acceptance by 1998. Or they do not believe that they are.

So, if they are not bound, then how serious is this deadline that is turning out to be from my point of view a drop dead to a lot of parts of this program. And also, is driving the most contentious part of this program, which is the perception that Yucca Mountain is the site, because if it isn't the whole program goes on its ear beyond where anyone is willing to have it go who advocates that we need to go to geologic disposal as early as possible.

Those are my two responses and I think they need to be considered in line of what John has said, because what John said is the same thing he always says.

DR. CANTLON: Thank you, Steve.

MR. FRISHMAN: Thank you.

DR. CANTLON: Well, we want to thank DOE and its representatives here and the M&O group for what we think has been a very, very excellent set of presentations. I think this brings to the Board a kind of overview that we have felt we needed to guide our examination of some of your more detailed work. Where does it fit in both in terms of time and process and so on.

Again I want to commend the individual speakers for an excellent set of thoughts and content, very high in quality. So, we look forward to step number two.

Thanks very much.

(Whereupon, the meeting was concluded.)