NUCLEAR WASTE TECHNICAL REVIEW BOARD

SPRING BOARD MEETING

LESSONS LEARNED IN SITE ASSESSMENT FOR CRITICAL FACILITIES

SATURATED ZONE HYDROLOGY

SITE CHARACTERIZATION UPDATE

Reno, Nevada
April 11, 1994

BOARD MEMBERS PRESENT

Dr. John Cantlon, Chairman, NWTRB
Dr. Clarence R. Allen, Session Chair
Dr. Garry D. Brewer, Member
Dr. Edward J. Cording, Member
Dr. Patrick A. Domenico, Member
Dr. Donald Langmuir, Member
Dr. John J. McKetta, Member
Dr. D. Warner North, Member
Dr. Dennis L. Price, Member
Dr. Ellis D. Verink, Member

INTERNATIONAL GUESTS

Dr. Harald Ahagen, Swedish National Council
for Nuclear Waste, KASAM
Dr. Camilla Odhnoff, KASAM
Dr. Klaus Kuhn, University of Underground Research, GSF
Dr. Walter Harris, University of Alberta

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P R O C E E D I N G S

DR. JOHN CANTLON: Good morning. If you will have your seats, we'll get this session underway.

Before we get underway, let me just make a few logistical remarks. The microphones that are in front of the speakers and the Board members and are out there in the aisles in the audience are sound-actuated, and we have not worked with sound-actuated mikes before. I warn you that one mike will cut the other mike off, or if one mike is operating, you can't get in. So only one mike can operate at a time. So try to time your entry into the discussion appropriately.

Secondly, we have a formal transcript of all of our meetings, and, therefore, it is necessary if you're to make remarks that you identify yourself before your remarks start so that our record will be complete.

Well, certainly, it's my pleasure to welcome all of you here today to this meeting of the Nuclear Waste Technical Review Board. I'm its Chairman. My name is John Cantlon.

As you know, our Board was created by Congress in the Nuclear Waste Policy Amendments Act of 1987. We're charged to provide assessments of the scientific and technical aspects of DOE's efforts in the high level spent

nuclear fuel and defense waste slated for the first repository. We report to Congress twice each year and to the Secretary of the DOE.

Our Board has 10 members, each of whom was nominated by the National Academy of Sciences and were appointed by the President.

The members in attendance today; Clarence Allen, Professor of Geology, Cal Tech, Seismologist; Dr. Garry Brewer, Dean of the School of Natural Resources, University of Michigan, and a Specialist in Resource Policy; Dr. Ed Cording, Professor of Geology, University of Illinois, Geoengineer. Dr. Patrick A. Domenico, Professor of Geology, Texas A & M University, Geohydrologist; Dr. Donald Langmuir, Professor of Geology, Texas A & M, Geochemistry.

DR. LANGMUIR: I'm not at Texas A & M.

DR. CANTLON: Oh, I should say, Colorado School of Mines, right? Colorado is full of Texans, especially in the hot season. Yeah, so that's true. Colorado School of Mines.

Dr. John McKetta, Chemical Engineer, and not at A & M; Dr. Warner North, Professor of Risk Management and Risk Assessment and also a Principal at Decision Focus, a Systems Risk Analysis expert. Dr. Dennis Price, Professor of Systems Safety, Virginia Polytechnic Institute, Systems Safety Specialist; and Dr. Ellis Verink, Professor of Metallurgy in the University of Florida, a Metallurgist and Corrosion

Specialist.

My field of expertise is environmental biology. I spent my last 35 years at Michigan State University.

Our session today will explore lessons that we have learned in the typical challenge of site assessment. This session, when we get it underway, will be chaired by Clarence Allen. Our session tomorrow will focus on the hydrology of the saturated zone at the Yucca Mountain Site, and that session will be chaired by Pat Domenico.

Before we begin today's work in earnest, I'd like to take a few minutes to introduce our guests from other countries who have come to share their expertise and views with us and to listen and to learn from others who have invested considerable time and effort to put together the presentations that we'll hear today.

Dr. Walter Harris, Professor Emeritus in analytical chemistry at the University of Alberta in Edmonton this year with us to discuss the successful siting of a hazardous waste facility in Alberta. Among his many accomplishments, Dr. Harris sits on the Technical Advisory Committee on Nuclear Waste Management, a group which advises AECL in Canada on the scientific and technical issues pertinent to the disposal of nuclear waste. Our Board had the pleasure to meet with members of this committee during our visit to the Canadian Waste Management System.

Dr. Klaus Kuhn, Director of the Institute for Underground Disposal in the GSF has traveled from Braunschweig, Germany, to share his insights on lessons that we might learn from site characterization activities at the proposed high-level waste repository in Gorleben, Germany. Klaus hosted the Board's visit to Germany several years ago and then traveled to Las Vegas to make a presentation before our Board on the German program for high-level waste disposal. We welcome you back, Klaus, and look forward to your presentation today.

Last, Dr. Camilla Odhnoff, Chair of KASAM in Sweden, is here today with Harald Ahagen, a consultant to KASAM. Because of our similar roles, KASAM and the Nuclear Waste Technical Review Board, we have been involved for sometime now in an informal exchange of information and ideas. As some members of the Board have now traveled to Sweden to participate in KASAM functions, we're particularly pleased that Camilla now has the opportunity to attend one of our meetings.

Camilla, perhaps you could spend a few minutes and just tell us a little bit about the nature of KASAM and your nuclear waste management system.

DR. ODNHOFF: Thank you. First of all, I must thank you very much for inviting us. We are really very happy to be here, to be with you, and to share your

experience.

KASAM is the Swedish National Council for Nuclear Waste. It is a committee appointed by the government, and we've been working since 1985, and we have a few things assigned to us. We shall present a report on the state of knowledge of nuclear waste every third year. We have to present our independent opinion on the research and development program issued by the power industry in the nuclear waste area, and we act as an advisory committee to the government and to the authorities within the nuclear waste area.

And we are also trying to make ourselves understand things better by working with seminars, and there we try to create broad context with people working in oil fields and with oil, anti-nuclear and pro-nuclear ideas, working within communities within science and within the utilities. We have such a seminar coming up on the environmental impact assessment later this year.

The members of KASAM are representing independent competence in areas relevant to nuclear waste, and, of course, most of them are natural scientists or technologists, but we have also a doctor of theology, and she's the one putting the difficult questions to the scientists, and she's leading us in the ethical labyrinth.

We have a professor of law, and we have a high

government official, who is a doctor of social science, who is also on our Board.

So that is the mixture that we can serve the government with.

Thank you.

DR. CANTLON: Thank you.

Camilla didn't mention two other important things. She's a physiologist by training and a professor, and also has been governor of one of the provinces of Sweden. So she has been bathed by the political, as well as the academic fires, so she's very well positioned to chair this group.

Thank you, Camilla.

Clarence, you have the floor?

DR. ALLEN: Thank you, John.

Good morning and welcome to the session on Lessons Learned in Site Assessment for Critical Facilities.

We began thinking about this session more than a year ago, particularly when after a lengthy hearing, the Illinois Low-Level Radioactive Disposal Siting Commission rejected the Martinsville Alternative Site as a location for low-level waste as a disposal site.

Issues included the quality of the scientific work performed, the level of proof that was required and the criteria used. Understanding what went wrong and what went right in this and other cases could provide useful insights

into those interested in Yucca Mountain.

Although the proposed high-level waste repository at Yucca Mountain is in many ways a first-of-a-kind project, it is certainly not the first critical or highly-controversial facility that has been proposed.

The Board believes it will be useful to hear about the successes and the failures in the site assessment and licensing of such facilities, including nuclear power plants, dams, radioactive and non-radioactive waste disposal repositories, and other large engineered facilities in the United States and abroad.

The purpose of this meeting, then, is to define any lessons learned from site assessment and licensing of critical and other controversial facilities that may be useful to the Board in its evaluation of and the Department of Energy in its planning of the Yucca Mountain program.

The following are some of the questions that the Board would like to be addressed at the meeting, and I hope you'll keep this in mind for the round-table discussion that will terminate the program this afternoon.

For the particular facility discussed, what were the primary scientific issues considered to be the most important when the site was first proposed? What were these perceptions based on? How do these perceptions change as site assessment proceeded? If there were significant

changes, what specific scientific studies were critical in bringing about these changes?

For underground facilities, how critical was underground testing as compared to surface base testing? If the facility went through a licensing procedure, how different was the level of proof required in the licensing process from that assumed in the site evaluation or in "normal science?"

If the site was subject to a legal hearing, how well were the participants prepared for the hearing? Were there any surprises?

How clear were the regulatory criteria? How did the level of detail in these criteria, too much or too little, affect the site assessment and licensing?

How important were pre-licensing interactions between the regulator and the applicant? To what extent were they helpful or burdensome?

How well were science and engineering integrated in the scientific project? Did a lack of integration cause any problems?

Were there any non-regulatory, oversight groups involved? To what extent were they helpful or burdensome?

Was scientific and engineering input used that was external to the program and its contractors? If so, how, and how helpful was it?

How well focused were the scientific site investigations? Were any particular techniques used that were successful in improving this focus?

How did non-technical issues and public perception influence site assessment and the ultimate disposition of the project?

And finally, and most important, to what extent are the answers to the above questions applicable to the Yucca Mountain program?

We'll start the meeting with two somewhat different views on Martinsville, the Illinois case; one by Bill Hall, a member of the Illinois Siting Commission, and the other by Fred Snider, who prepared a review of the Commission's rejection of the Martinsville Site.

We asked the State of Illinois to give its perspective, but they declined.

We will then hear from Wendell Weart, who will tell us about the lessons learned of the WIPP Site in New Mexico.

Klaus Kuhn will follow with a discussion of insights gained from the site characterization of a proposed high-level repository waste--repository at Gorleben, in the Federal Republic of Germany.

Walter Harris will close off the morning session with a success story relating to the siting of a hazardous waste facility in Alberta, Canada.

After lunch, Lloyd Cluff will fill us in with a wide range of his experiences in managing site assessment studies and reviews for nuclear power plants, dams and liquified natural gas facilities in California.

Following him, Jim Devine, who was the focal point for much of the U.S. Geological Survey's work on critical facilities, will tell us of his experience in dealing with scientific controversy. We may be able to coax him into telling us something about the proposed Ward Valley, California, low-level radioactive site, disposal site, which has been in the news recently.

To round out the presentations, we have asked Larry Chandler of the Nuclear Regulatory Commission to give us a lawyer's perspective on science and scientific proof, particularly as it relates to his experience in the licensing of nuclear power plants.

At this point, we will be departing for a short, but very significant, break from the original program to hear from Lake Barrett and Steve Brocoum about DOE's proposed new approach to site characterization. It may be particularly appropriate to hear about this new approach after we have heard about some of the successes and failures of other projects.

We will close the meeting this afternoon with a round-table discussion among all of the speakers. We would

like to start the round-table with some comments from the DOE on the applicability, if any, of the day's presentations to Yucca Mountain. We will try to steer the round-table discussion to focus on the questions which I raised earlier.

At the end of the discussion, we will welcome comments from the audience.

So let's get on with the meeting, and our first speaker is Bill Hall, who is Professor Emeritus of Civil Engineering, University of Illinois at Urbana-Champaign. He's a member of the National Academy of Engineering, and is an expert in the field of structures and structural dynamics. He was appointed by the Governor of Illinois, as a member of a three-person commission to make the final decision on the State's application for a low-level waste repository site at Martinsville, Illinois.

So, Bill, please take the podium.

MR. HALL: Good morning, Mr. Cantlon, Clarence, ladies and gentlemen.

I'm pleased to be here to report on my experiences in Martinsville. I figured that this will be probably the most important talk that I'm going to make on Martinsville, so I prepared accordingly.

Clarence has already given you an indication of my background, and I'll allude to it a little bit more later in this talk.

I have tried to put down many of the, what I felt were the most important items that came up in the Martinsville hearing, and I said I've limited to what I think are many of the principal topics. These are many and varied, of course, in a hearing that encompassed some long period of time.

I'll start off by saying that I'm going to purposely omit talking about people or companies here today. I don't think that's appropriate. I don't think it has any place in what we're after. Any of you who are interested can obtain that information by reading our report, or better yet, by reading the 21,000 pages of testimony that we have for the hearing.

When I was approached by the Governor's Office to serve on this Commission, I was told at most it would be 20 days of service, probably less. It couldn't possibly go over 30 days. So some two-and-a-half years later, and I figured 200 days of service, we completed our work and resigned from the Commission.

It was an interesting experience, a learning experience, one of the more valuable ones in my life. I will say to some of the younger people in the audience that I'm glad it took place in the later stages of my life.

So if we will have the next one, please?

The start of the whole process, as most of you

know, of course, starts back in 1980 really when the Low-Level Radioactive Waste Act was passed, Federal Legislature, and then in 1983, I guess, in Illinois. And by doing some detective work, I found out that things began in Illinois as early as 1984 in terms of trying to find a site, and it was about in this time frame that the compact was formed--I guess a little bit later--between Kentucky and Illinois.

Illinois, of course, has the most nuclear power plants of any state in the nation, and as a result of that, I guess it was felt that the repository should probably be in the state of Illinois.

If for some reason some of the facilities, the DOE facilities, in Kentucky were to be privatized, somebody told me the other day, then maybe things might change on the outlook for where the most waste is. But I haven't seen any indication that's happening. I know nothing about it.

So initially, there was a screening. They contacted about 102 County Boards. Now let me tell you what I did here. I shortened this measurably. There is an article that I know the Board has, each of them, and others in the audience, if you don't have, I've got a few copies here, and Leon can make it available. It's called "The Politics of Nuclear Waste Disposal." This was written by a staff writer for the American Society of Civil Engineers, appeared in March of this year, and it's a pretty factual

article about what took place, especially on the political side. And I'll review a little bit of that here, but for those of you really have an interest in this side of the issue, see me or see Leon. We can get a copy of this for you.

And it's a pretty accurate assessment as far as I can tell. He passed this by the Commission after he had written it. I made one suggestion for one word change. As far as I can tell, he didn't take the suggestion, which is fine. So it's the way it is.

There were economic incentives offered in the counties up to a million dollars annually to aid the schools, infrastructure and health care, and these were well received. The criterion originally was for four square miles, and also the fact that if the County Board and County says, no, we don't want it, then we will not go to that county.

There was a change in November of 1987 in the Management Act, which all of a sudden added a provision that if the site were located within one and one-half miles of a municipality, and the municipality wanted to take on the responsibility for this site, then that could or would override the previous one about the County Boards. And this got to be an issue at the very end in Martinsville.

The thing to remember here is that at this point in time in 1987, this was still a four-square mile criterion.

So finally they honed in on 21 counties, and by the end of 1987, there were 15 of those counties left in the running. The other County Boards had voted out. In January of 1988, things started to become more exciting. They went out and made what they call windshield surveys. This means drove around in automobiles and looked at territory, which is quite proper.

By January 14th, there was only four out of the 21 counties left. That included Clark and Marshall Counties. They're adjoining counties. Now where are we, because some of you don't know perhaps. On Interstate 70, coming across from St. Louis, toward Terra Haute, and we're on the two last counties as you come into the state of Indiana. That's where we're talking about. And Marshall would be the last town, and Clark would be the--and Martinsville would be the previous town in Clark County.

And then when things began to look really super serious in the morning at 6:30 a.m., in what was reported to be a less than five-minute hearing, the city fathers of Martinsville took on the site, which by that time, incidentally, the criteria for four square miles had been eliminated, and something less could be used. We could never find out who made that decision, as we reported in our report. We were never able to figure that out.

And later in the next day, the County Board said,

no, they didn't want it in the same county, but the Martinsville city fathers had prevailed. They voted first and early.

So it had the aura of politics to a lot of the siting in this particular case, and that's part of our presentation in the report, and also picked up in this particular article.

I'd like to concentrate, now that we know that much, I'd like to concentrate pretty much on the technical side from here on.

There was another site, called the Geff Site, over in Wayne County, which is a little further west, which was still in the running at that time for reasons that also are not so clear. In fact, in reading, I find out there were four sites that were still in the running. I don't know what the other two were, but it was primarily the Geff Site and the Martinsville Site. But it was dropped. And this is where the word alternative--it's called the Martinsville Alternative Site, and for a long time I had difficulty understanding the word alternative in that. And so that's where it came about. There were other sites.

There was a hearing in May of 1990 and a report written, and that led to a lot more questions about criteria and how things were picked, and as a result of that, Governor Thompson decided that he needed to have a formal commission.

So he appointed this commission headed by the Honorable Seymour Simon, a retired judge off of the Illinois Supreme Court, one of the finest minds I've ever known in my life, and Carolyn Raffensperger, who was with the Sierra Club at that time as a representative in Illinois, and who's since become an attorney, and myself.

I put a dot down here at the bottom about Funds for Concerned Citizens. As we started to gear up for these hearings, realizing all of the things that were involved, we decided to do something rather unusual, and this is one of the positive things that I think occurred in the hearings, although others, I'm told, don't think so. We decided that we wanted an orderly hearing, and for that reason, went to the compact and asked them to supply what turned out to later be about $600,000 for attorney's fees and expenses for witnesses and expert witnesses for those in other groups who were going to appear before us.

Concerned Citizens received the largest amount of money. They actually received--let's see here, so you know, about $360,000. They were the opponents to the hearing, and the proponents, called PRO, received about $121,000.

City of Martinsville had a lot of expenses. This was donned by the State of Illinois, and then, of course, we had IDNS in the state, and the contractors who were carried through the state, and the funds made available to this

through the nuclear power spinoffs of funds.

This was of immense value to us. It provided for an orderly hearing. Some of us have been in many, many hearings, and we've had the public appear before us before in a rather unorganized fashion. In this case, some 63 people, I believe, from the public did appear before us. It was handled in an extremely professional manner, and the whole hearing in the sense of a quasi court went forward with order. And I would recommend this to anyone as a way to proceed, as opposed to some of the ways that we've done previously.

I think I should comment here about one aspect of the hearings pertaining to myself that might interest some of you in the room. With my background in the nuclear business over the years and other things, I was admonished perhaps 6 to 15 times by attorneys on all sides that I could only render my judgment in this case on the basis of the record. I could not use my background. I could not use my book learning. I could not consult with colleagues. I was to restrict it solely to the record.

And we went round and round on this, and I found this very interesting, and I tried to play by the rules as much as possible. And I had one attorney one day worried sick that I had gone back and talked to some of my colleagues, and she didn't know what I said, and so,

therefore, this was bad news for the hearings. So I point that out to you.

We had consultants to the Commission, as did the other parties all had consultants. Our consultants were Frank Schwartz from Ohio State University, a very well known geologist and groundwater specialist. I know him very well. Steve Esling, from Southern Illinois University, a very able, bright, young groundwater modeler; Dan Hang (phonetic) from the University of Illinois, former head of the nuclear engineering facility there, an electrical engineering professor; Joe Lock, out of Fermi Laboratory, a highly-respected nuclear physicist, who was an incredible resource for the Commission; Joe Rundo, who's Argonne, who was a health physicist helped us a little bit; and Abe Lerman, really a geochemist out of Northwestern University, was extremely helpful.

These people provided us with background questioning, helping us with preparing questions and checking into matters. Contrary to what some people think, they did not write the report or any part of it. The report was written by the Commission members and our staff, legal staff at Rudnick and Wolfe who helped us, and we did, indeed, write many, many parts of it and edited all of it very, very severely ourselves.

So we take responsibility for the report, and you

can see that, if you're so inclined by seeing that our signatures at the back end of it. I insisted that we sign the report, which we did.

Now, the last part of the process that I would tell you at this point, which is one that makes a believer out of you, is that by law, we were required to discuss on the last day, the 72nd day of the hearings, in public, the arguments for and against the site.

And we did this, we followed instructions, and we presented our arguments for some eight or nine hours. And then by law, we were required to vote publicly. We didn't go in some back room and caucus and vote. So we voted publicly, where they could see our votes, and we gave the reasons for our voting.

Now, some of you may think, well, you knew how the Commissioners were going to vote before you voted. I'll tell you honestly that I did not. I had a tenth of an inkling about how I thought my other two colleagues would vote, but I was on pins and needles when the vote was taken because I honestly didn't know how they were going to vote. And I have found out since, in discussions with the Commissioners, that my pins and needles were well deserved.

We voted unanimously to turn the site down, as you probably know.

You asked us in the instructions to me to know

something about the statutory criteria. Well, here they are. Here are the rules by which we were to operate, and I'll let you read them. I'll give you a minute to look at these. Let me get out of the way here. I don't think there's anything unusual in what's stated in here.

I would talk about No. 4 for a minute, and then that would be the last I say of that. In Illinois, of course, which is an extremely wet state, we're supposed to be outside the boundary at a 100-year flood plain. You would have been amazed at how much difficulty it took for us to find out who officially was responsible for defining the outlines of the 100-year flood plain, and it finally came down to the Illinois Department of Transportation, which I found quite interesting.

This site that was selected, Martinsville, fit that pretty well. We have Interstate 70 right south of us, a half a mile, less than a half a mile. Found out, of course, that in the Embarras River, which I'm going to address here in a minute, that a big rainstorm brought a lot of debris down, clogged up the underpass under Interstate 70, and made a big lake right adjacent to the site not more than a year or two beforehand.

So one, in contemplating 100-year flood plain boundaries, one needs to think about the unusual effects that can happen.

Next. Let's see. Oh, let me look at the last one. Okay. That one is all right. Fine. We're a long ways from the waste source. Go ahead--the long transportation route for most of the waste.

The last two pertained to this one and one-half mile business which was stuck in, and this is the model part of the statutes.

I'm really in disposal to point out something to all of you now. If you study very carefully the title of our Commission, it was the Illinois Low-Level Radioactive Waste Disposal Facility Siting Commission. Disposal facility--this was not a storage facility. This was a disposal facility, disposal meaning isolation of waste as defined in the Act from the biosphere in a permanent facility.

We'll address. All right. Now we're ready.

So one must watch the title very carefully.

Here's the site. Martinsville is located--I'll take a pencil here and mark this. Martinsville is located right across Interstate 70 here, not even two-tenths of a mile right here. I didn't put a scale on here on purpose, but I think we're looking at something here, if you want to know roughly, we're looking at something here roughly a quarter of a mile across here, and maybe at most a mile up here. So we've got a quarter of a section involved here, quite a bit less than four square miles. In all fairness,

the site goes on across Cleone Road. This is a heavily-traveled road, Cleone Road, and the site goes on across, but what use that part would have been put to in the future, I do not know.

We have the Embarras River over here a thousand feet away. Right here is the Embarras River, a major river in this part of Illinois. We have a stream on the north boundary, and we have a ravine coming up through this part here.

So at the very beginning as a civil engineer, who has been involved in siting many large facilities over the years, I looked at this with interest, noting that first of all, it's on a site that's on the upstream side of a town, very close on the upstream side of the town, in a very wet location, a location, in fact, in which there are ponds and seeps evident. On this part, up in here, right now, as you walk across the land, there are all kinds of ponds and seeps going out in there, and a major river on this side, a little creek on the north side--not so little, and a city to the south.

So one says there are problems, indeed, and that comes to the forefront. So now I've placed in perspective one part of it, as I looked at it as an engineer.

Next, we'll talk a little bit about the geology for a few moments. This is in Illinois, in a glaciated region,

a past glaciated region. I listed here approximately the thicknesses of the materials involved, and we go down through--I'm going to show you a figure next to give an example of the striations, but the surficial materials, followed by the Vandalia Till, which was meant to act as a barrier, including Fractured Vandalia Till, Sand Facies, a water-bearing aquifer, the Smithboro Till, then Petersburg Silt, Basal Sand, another water-bearing aquifer, and a Pre-Illinois silt, clay and bedrock.

Now, if we could, before you do the next one, put up the picture of the site. Keep the picture of the site out to the side, and put it back up here for a minute.

So now we come to the matter of water problems, in the sense of city water problems. Martinsville has wells. The wells are located about down here right below the screen, and their water comes largely down through the two sand aquifers that I pointed out to. They join together just about at Interstate 70, right in this area here. And also, there's another source of water, which was not investigated very thoroughly, as far as I could tell, which comes down the Embarras River, and then due to some exposed material of till material and so on, feeds directly into the wells as well. In fact, a large part of the surficial water ends up in the Martinsville wells through that route, and that was really not addressed in the hearings.

Now, let's go back, but keep that one separate.

So here's a picture of one cross-section across the site, which shows you the various layers of material, and some of the points that came into contention in the hearing. We have the surficial materials, the Vandalia Till--the Vandalia Till and some of the fractured Vandalia Till here, fractures meaning fractures anywhere from a foot to three feet apart through the upper layers of the till. We found out later there's also some fractured material on the bottom of the till.

And I would point out to you, as we're talking about uncertainties now, things that cropped up. There was one of the loggers, in handling the geological materials, who was really carefully marking down these fractures from the borings that were made. And all of a sudden we noticed a change in what was being said to us, and we've been using the logs that have been provided as his report, and so we got interested and went back and found out there were three sets of logs. It starts with the field logs, who many of you in the room who are geologists will recognize, and geotechnical specialists. Then went to eselogs, which are put on to a computer base, and then into the logs for the hearing documents.

So we finally, to make a long story short, went back into the field logs to look at a lot of this

information, hundreds of borings, and found out that these fractures had been carried along as they were found, and then for some unexplainable reason, the person who was doing this logging was replaced by someone else, and all of a sudden, the fracture patterns changed immeasurably from a reasonable expected number of fractures to almost no fractures. And it's this kind of uncertainty that was found throughout the process that we had to contend with.

The Vandalia sand here, I put in as an example. This led to a lot of controversy because a young geologist, who was the site geologist, had identified this as Vandalia sand, and this led to bring you a controversy as to whether this was a continuous body that went through the till down here and this way on down towards the water sources, because if it did, then, of course, it meant that the till was much more permeable than had originally been anticipated.

Well, a lot of this took place before we showed up on the scene, and you know, if you've read the report, that there were lots of people shifted from here to there and replaced and go on, and it was a story that is not the greatest in terms of technical endeavors, but part of the real world.

As an engineer, I live with uncertainties, I can tell you, and I'm used to this. But the uncertainties in this project were immense, and we'll address some of these as

we go along.

There was a big question about this Vandalia sand, while we're talking about it. In one place where they drilled, they found it was 18 feet thick, and then in another boring somewhere else, it would be non-existent, and somewhere else it would be a foot thick. And one of the questions that's in the testimony is to a certain individual as, "Well, these borings are a thousand feet apart. Can you be sure that this is continuous or not continuous between these two borings when they're a thousand feet apart?" And the answer was, "Yes, I'm certain."

Very interesting. I can't repeat enough that for people who are really going to comment on this case and the report, you really should go back and look at the testimony. And I would tell you that before I came here today, I did just that. I went back and looked at many, many, many volumes of it to refresh my memory on actually what was said, not exactly what was summarized.

So here we are, and here's the other--the baseless sand and the surficial sand facies are here, and this is the sand facies here, and these are aquifers carrying water down towards the Martinsville well. In addition, there's a surface water coming over here to the North Fork, or the Embarras River, coming down here, and feeding in water also, we found later in the stage, very heavily down into the wells

from the surficial drainage.

All right. So that gives us somewhat of a picture of what's going on there. Wait a minute, one more thing.

You can see that the bedrock is folded and has led to some of these interesting features.

Many, many other factors involved here. We had immense problems with questions of quality assurance and quality control, dealing with the water studies that were made, and things like ion balances, contamination of the water samples in the wells that were used for writing of these estimates. Some of the others I've attested to here in terms of the geology and on and on.

Flood plain I've addressed. Geology we've talked about. I've alluded a little bit to the surface water problem. I'll come back to that in a minute.

There was a groundwater hydrology modeling study, one of the most extensive that I've ever known about, and I've worked around most of the DOE facilities in the last three or four years, and I find nothing comparable to what went on at Martinsville. Grid size was rather far in terms of--lengthy in terms of coming to grips with the hydraulic heads and piezometry levels and things like this. But nonetheless, a good attempt was made at this. We had big arguments about uniqueness, and I was told in no uncertain terms that there was a unique solution to this modeling.

Those of you who are interested in this sort of stuff in science, AAAS Magazine, about four months ago, there was a beautiful argument on uniqueness in this field, which pointed out that there's nothing very unique about this.

But there was a big effort at modeling, and that was certainly a plus in terms of what went forward on the site.

Earthquakes, it's one of the fields that I operate in. I did not feel this was a massive, major issue. I'm not sure these are precisely the numbers that I would pick. I wasn't picking them. But this is a low facility, pretty much controlled. It's not controlled by inertial forces. This is a facility close to the ground, more controlled by ground shaking in terms of what the ground motions are and what they do, and over time, shaking in this region could be a problem in terms of cracking and opening up concrete and things like this. But that's another issue.

The interesting thing is that at the time we were doing this study, Steve Obermeyer, of the U.S. Geological Survey and a friend, was just making his studies on liquefaction features connected with the river systems in lower Illinois and Indiana, and had uncovered the fact that there had been another large earthquake prior to 1811 and 1812, dating being roughly 900 years to 7,000 years, as I recall, before that, with an average of 2,500 years. I think

that's about right.

And so we have other features in the vicinity that show that there have been large earthquakes, but the return periods here are large, of course, also. But it was interesting that this should come to bear right at this particular time in his Wabash River studies.

We had a terrible time determining what the Source Term was and the sources of the radioactive waste. They range anywhere from about a half of a million to two-and-a-half million curies. Estimates by various people. The upper three are listed as being, of course, more common in the waste and being short-lived, half-life, the type that would go to background in the time the facility would be existent.

But there was a lot of other longer life material in there, including Technetium, Iodine 129, Carbon 14, probably in the metals, I suspect mostly, and americium.

The one of most concern to us was the matter of Iodine 129, and the estimates on how much of this was present were varied, but it was enough to be quite bothersome to us. So this was an uncertainty that entered rather significantly into our thinking.

There were risk assessments made by the proposing group. These were long term health effects to a degree. These were at variance with each other, raising a whole another set of uncertainties, and I ask that you read this in

the report if you're so inclined, and you'll see why we were so uncertain about what was to take place here.

The facility itself looks like this as proposed. It's got long units.

Let's see, let's look at the next. Is there another plot there? No, I guess these come next. That's good enough.

These are lengthy. They are modules that are roughly 93 feet long, 62 feet wide, and 20 feet high. There's one on each side with the access aisle. And they build about five or six of these, and then fill these with the canisters, which I'll show you in a moment. And it was estimated it would take two or three or four years to get this set of them filled. In the meantime, of course, they're covered with soil and the--various types of soil and coverings, and there's some degree of drainage here. And when they got to the end of that filling period, they'd build another five or six of them and then another five or six of them, another five or six of them. And it was to take about 50 to 60 years to build up these three long units and fill these, at which time the facility would be under institutional control for another 100 years. So this would bring us to about 160 years.

At that time, they would fill in--this was the plan. They would fill in this central access aisle, but

before they filled in the central access aisle, they would drill holes through the floor to permit leakage to go directly into the lower layers here and drain off.

You can see, then, you have to balance this out in your thinking about disposal versus long term radionuclides that are in here versus where things are going to go over a period of time.

So I repeat again that the plan was to not leave it in this state, but to drill holes in that center access floor to accelerate drainage into the surficial materials at that time. That was strange in itself to me.

I raised a number of questions also about the fact as they built these units, and then they would come back with perhaps even a different contractor a few years later, build some more units about the quality control layer. The difficulties of seaming the HDPE liner, that's not a "HOPE" liner, that's HDPE liner on back, the business of the quality control with regard to phasing in and faring of the clay layers, which were very important in terms of water, all raised questions about the longevity of this facility, which was supposed to last 500 years, and the 500-year question came under a lot of questioning, too.

The problem here was one of wanting to know how water could get down through these materials over years and leaked. I was also kind of curious of whether somebody would

mine this in previous years, but that's a whole another subject.

The canisters are probably well known to all of you, and I don't--these were very well designed canisters. One of the big questions is how much the waste was de-watered that went in there, and that was a subject of quite a bit of discussion.

So we have this host of problems. That's good. Now, let's go to the last one. Okay. So this is the last view graph now.

So out of all of this, looking at the complete--you have to stand back and look at the complete picture. I call them observations, rather than lessons learned. To me, these are things.

Now, I would just have a few comments here, and then I'm through. I was and have been particularly concerned about the first bullet, the second bullet, the third bullet, and this bullet on long-term health issues. And let me tell you where I come from as an engineer.

Partly, I guess because of my experience ranging back to nuclear effects on submarines in the 1950s, I was part of the above-ground testing in Nevada test site in the early 50s, present and witnessed many of those; involved heavily in the underground testing program, the TAPS seals,

over a period of 15 years at NTS; heavily involved in protective structures with the Defense Nuclear Agency through all my life and nuclear power plants and so on. I've had occasion to watch with interest this business of public trust and public confidence and have been a student of this. And I have a number of experts here in the room, and I'm glad to speak for a moment to this point.

One of my concerns over all this time, I come out of a family of biologists and natural scientists, and they don't understand how I can work around the nuclear field, never have understood it, but I have chosen to do so because I think nuclear energy has a great future.

Nonetheless, I think that there is a major problem with perceived risk and public policy and public trust. And perhaps we brought this on ourselves, partly by the fact, I guess, that we started out with weapons of this type. But the withholding of information by whatever parties over the years has led to this distrust, and I think that the recent revelations that are occurring weekly, 60 Minutes--I didn't see it--60 Minutes, what, three weeks ago had a tremendous expose on it. Tribune has ailing veterans, still I think quite alarmed, quite upset, quite concerned about what has taken place.

I don't know what the solution to this is, and perhaps there will be some discussion today which will add a

little more to this.

Over the years, I had occasion to make some recommendations to the Commissioners on the Nuclear Regulatory Commission about I thought that a massive education process might be the thing to do in this country in terms of trying to educate the public about radiation. But that hasn't happened, and I still think it's necessary, but perhaps it's too hard an issue to face up to. But something has to be done in the public trust business before we get very far.

There were tremendous uncertainties. The scheduling business became a great problem, as you can sense, in the political and factual sense in Martinsville.

DR. ALLEN: You only have two more minutes.

MR. HALL: Yes, that will be more than enough.

We went through these other items I have mentioned. The long-term health issues I've just alluded to are terribly important. I suppose that the group that's responsible for BEIR-5 is now working on a new one, I hope, in light of what's happened recently, and that will play a big part in what happens in the technical field, at least, to a lot of us.

Management problems came to the forefront. There were big questions about monitoring. This had not been thought through very thoroughly as far as I could tell and

what I'm used to seeing, and we had great problems with independent review.

I will end here with independent review. The Illinois State Geological Survey had prepared a beautiful, beautiful report, Circular 546, some of you are familiar with this, and were actually serving as independent reviewers with the Illinois State Water Survey to IDNS in the early stages.

When they got into the big discussion about water-bearing zones versus aquifers, all that came to a screeching halt, and these people ended up later tagged on to the bottom end of a series of contractors in terms of giving advice.

But when we, as a Commission, asked them--this won an award during our hearings by some other group in the United States. When we asked them about this in terms--Geological and Hydrological Factors for Siting Hazardous or Low-Level Radioactive Waste Disposal Facilities. I recommend this to you. It's excellent, excellent reading. But when we asked them how this applied to Martinsville, and this is by our state survey, they were unable to support any reasoning that directly helped us. They said that this was only applicable in a site specific sense. So this then led to an additional uncertainty.

And I don't cite them any more than any other group, but perhaps it's the proper way to end in terms of just noting the tremendous uncertainties we were faced with.

I'm through, and thank you very much.

DR. ALLEN: Thank you, Bill.

I think we're running a little bit late, so we must move on.

The next speaker is Fred Snider, who is project manager of low-level radioactive waste programs for the Ebasco Division of Raytheon Engineers and Constructors.

His background, educational background, perhaps will be identical to my own, with a bachelor's in physics and a master's in geology and geophysics.

I will let him, though, explain exactly what his involvement was in this Illinois facility.

Fred?

MR. SNIDER: Mr. Chairman, Dr. Allen, members of the Board, ladies and gentlemen. I'm very pleased to be here to talk about this. I've been asked to talk a little bit about the Illinois process. We've just heard quite a bit from Mr. Hall. That will allow me to shortcut some of my normal introductory remarks because he's given a good overview of the process. Maybe we can catch up a little bit on time as I skip some of that.

Dr. Allen asked me to kind of give you just briefly how we're involved in this.

EG & G Idaho has a contract with the DOE in what they call the National Low-Level Waste Management Program.

The purpose of that program is to assist the states and compacts that are trying to site low-level radioactive waste facilities for commercial waste. They provide funding for a number of studies and seminars and coordinating committee meetings and provide a valuable service to most of the states that are involved in this process.

They had asked Ebasco Services at that time, this is the middle of last year, to do a small study relative to the Martinsville Siting Commission report. Since that time most of Ebasco has been purchased by Raytheon Corporation, and so now my official title is member of the Ebasco Division of Raytheon Engineers and Constructors, but this work was done originally by Ebasco Services Incorporated out of our office in Bellview, Washington.

I need to talk for a second about the scope of this project. As Mr. Hall reported, the hearings went on for 72 days; 107 witnesses were heard from, and almost 21,000 of pages of testimony were heard. We were not asked, in the scope of our project, to look at that material. We were asked to look at basically the Commission's report. It, itself, is about 500 pages long. We were asked specifically to look at that report and see what lessons could be extracted that could be used by other states, other groups that are trying to site controversial facilities.

The scope of our project really was to identify

those major issues or issue categories, basically do a summary of what approach and the conclusion that the three-member Commission or consultants did for that issue. Critique that approach relative to the current state of the art or state of the practice for that issue, and finally, identify some applicable lessons learned.

I can't go through all of these for all the issues, but I would like to focus primarily on those issues which would be of most interest to this Board in their role.

Let me go ahead and move on.

You've seen the provisions of the Illinois Management Act. Mr. Hall put them up, but I'm going to put them up one more time because they're fairly important to this whole process. I'm going to put them up in exactly the reverse order that they exist in the Management Act because they get more important as you go near the top of the list. So I'll start at the bottom of the list to get these passed.

The first issue has to do with the mile and a half from the state boundary of municipality unless approval is given. Mr. Hall addressed that about Martinsville, and Martinsville wanted the facility, so this criteria was met.

The distance necessary for transportation of low level wastes, that was addressed, but the proximity of the Martinsville Site to Interstate 70 made this a relatively minor issue.

The site shall be located outside the boundary of the 100-year flood plain. Mr. Hall addressed that. That was really satisfactorily resolved at the hearing and was not a major issue for us to carry forward.

These are the first three, again, in reverse order. The site should be located so as to minimize the possibility of radioactive release into groundwaters utilized as public water supplies. The site should be located in a suitable geological and hydrological medium, and the site should be located so that the public health, safety and welfare will be protected.

I don't think that any of us could argue with the policy that these three statements make, the intent of these three statement. The thing that frightens me, as a person in this field trying to help states forward, is words like minimize possibility, suitable geologic medium, protection of public health, safety and welfare. These are very open-ended. There are no specifics as to how this is to be done, no real standards by which this is to be judged. These are really the apple pie motherhood statements that certainly are right, but provide very little guidance for anyone in a position to make some kind of a decision as to whether or not a particular site meets these criteria.

And I'll be coming back to this issue a number of times because really the Management Act set the stage for

what the Siting Commission had to do.

To try to take the Commission approach and boil it down to its fundamentals, the Commission really approached each technical issue in a similar way. They first had to establish the standard as required. The individual members of the Commission were not technical experts in every field, so they were part of the series of tutorials, visual presentations to bring them up to speed for a given issue. And during that process, they basically reached for a standard by which they should be judging the material that's provided.

Following the establishment of the standard, then, the Commission compiled evidence to compare the Martinsville Site against that standard. They heard from the opponents. They heard from the proponents. There was direct testimony. There was a cross-examination period. This went on. There was quite a lot in this 21,000 pages of testimony that addressed that. And then finally, the Commission had to determine whether or not, based on the evidence that they heard, the record that was provided, whether or not, in fact, the Martinsville Site met or complied with the standards that were developed at the beginning of that process.

Again, in this particular case, the Commission really had established their own standard because they were working under that broad category of the Management Act.

Before I get into the specific issues, there's one which Mr. Hall touched on a couple of times, and really very important for a lot of us here today, and I call this slide "In Search of...a Safety Criterion."

The Commission specifically stated that the existing regulatory standards, by that they mean 10 CFR 61 dose requirements, EPA dose requirements, dose requirements of Illinois statute. They were relegated to a category called "helpful guideposts." This was not the standards that were adopted by the Commission. These were the kind of an informational process that they went through to learn about.

They were unable to come up with any conclusive statement of what a safe level of exposure was. They said there was no standard on how low is safe.

Basically, by reviewing the information provided to them, the Commission finally came to the conclusion that they were very concerned about exposing any member of the public to any amount of additional radiation. This for all intents and purposes led to the adoption by the Commission of a zero release criterion. This was relatively early in the process and had fairly significant impact on a number of the activities that went on following that.

Our review of the Siting Commission's report identified six major issue categories. There were a number of sub-issues within each one, but they kind of lumped

themselves naturally into these six areas: Calculation of Source Term, which you heard a little bit from Mr. Hall; the durability of the facility; quality assurance; seismicity; the use of models, both groundwater models and performance assessment models; and a strategy for site characterization.

What I'd like to do is briefly go over some of the highlights of each one of these, and especially with applicability to the current program that the Board is interested in for the high-level program.

For the Source Term, the Commission heard three totally independent performance assessments provided. Each of those performance assessments had its own assumptions, its working assumptions as to what the Source Term was, what assumptions were made in terms of reactor decommissioning schedules, all the uncertainties that are involved in establishing a Source Term.

The uncertainty became the issue. The conclusion that the Commission said in their report was the uncertainties rob the analysis of credibility. This, I guess from a technical engineering standpoint, is a little distressing in that the very fact that there were uncertainties now start to call in the question of the credibility of the entire process, and that's a fairly dangerous link to make, but one which we'll see recurring throughout the process.

The Commission has said that they would have been happier if there had been better data. They also said they would have been happier if a probabilistic approach had been taken towards the Source Term, and that is, instead of coming up with assumptions about that Source Term, identify either a probabilistic distribution of Source Term of a minimum/maximum expected range, whatever. However, to say that we would have liked to had that during the hearing process didn't make it all of a sudden happen. That couldn't be developed at the time.

So the lesson maybe learned from this is that maybe there's a way to look at Source Term in a probabilistic way. I know the NRC's technical branch position is starting to address that issue right now for the Low-Level Waste Program.

Facility durability, the Commission first sought to determine whether or not the facility itself, the design, the engineer design, would provide the isolation of the waste that was required for the facility. That turned into really a long series of discussions on the durability and the viability of concrete as the prime--to waste migration. There were some concerns here, things that are shown in quotations here that no one could actually prove that the concrete canisters or the concrete overpacks or the vaults themselves, could remain leak-tight for 500 years.

The conclusion made by the Commission was that the

facility--it was unlikely that the facility could provide adequate protection against the long-lived radionuclides.

I guess the difficulty here was, is I'm not sure that any of the engineers that designed the facility, or those people who work in concrete, ever claimed that the concrete would be leak-tight for 500 years. That wasn't the claim to begin with. It was a standard which was applied during the course of the hearings. The problem here, as we saw it, was that the standard of performance by the designers and by the makers of concrete was not the same as the standards applied by the Commission as to how the concrete actually had to perform.

So I think the lesson here is that before you get into a discussion about concrete, you have to pre-establish what are the standard of performance that you're going to judge, the performance values that you're going to hear about, and the actual issues related to concrete.

This is an issue that comes up over and over, the standards, again because they were missing from the original Management Act.

Quality assurance. Quality assurance is a topic which those of us in this industry recognize that a quality assurance program doesn't ensure that the quality will be there, but the lack of a good quality assurance program, or the mistakes in a quality assurance program, can undermine

the credibility of a technical process, no matter how well it was done.

Many of the issues raised in this Commission hearing had to do with review and verification of data. It was found in a number of cases QA procedures were not followed. The conclusion by the Commission was that the failures of the project's quality assurance and control seriously detracted from the proponent's case. This turned out to be really an Achilles heel because they found in certain areas QA problems with the geochemistry program or some other programs, and that rolled over then, well, if you can't do a geochemistry under a good QA program, how can we be assured that your concrete manufacturers are going to be making concrete, well, for the next 50 years, and how can we be assured that your HDPE liners we've put in, how can we be assured that the clay liners will be placed properly, just became a basic fundamental problem, so that it went to this fairly broad conclusion at the end, leading to a serious detraction of the proponent's case.

The lesson here, for anybody that works in any of this business is, again, the QA is not necessarily assured that there is quality, but if there's a failure in the QA program, you certainly can undermine the credibility of the entire technical process, independent of how smart and how well intentioned the technical people were at the time of the

work.

Seismicity, as Dr. Hall mentioned, seismicity was not a major issue, but there are some lessons to be learned here. Both a deterministic analysis was done and a probabilistic analysis was done. There was a lot of discussion about how come those numbers don't come out the same, and it's very difficult to explain that to people who are not in the business.

Interestingly enough, from my standpoint, having come from nuclear and geologic hazards assessments, the issue was not whether or not the facility was going to fall down. Nobody thought it was going to fall down, since it's already pretty much of a concrete massive to begin with. The issue of seismicity came around to not large earthquakes and damage to the facility catastrophically; it came down to could, in fact, repeated small earthquakes over a long period of time incrementally cause widening of cracks in concrete or generate cracks in concrete.

This was a little different focus than a seismic assessment is usually done. The conclusion of the Commission was that the earthquake risk increases the likelihood of cracking in the concrete and/or the liners in the clay cap, and may provide additional pathways for water and contaminants.

I think the lesson here, having read the report,

and looked back at some of the information that was provided during the hearings, is the most difficult thing here was to communicate to a non-technical audience, what does conservatism mean? What is the relationship between conservatism and uncertainty? How do those things play hand-in-hand, and what is appropriate conservatism, and how do you actually communicate with that is, because after all, they're asking about what's going to happen with earthquakes for the next 500 years or 1,000 years. Seismologists can't predict. We can forecast, and we can maybe identify trends, but they are asking for much more information than that for the purposes of the assessment of the Martinsville facility.

Use of models. The groundwater flow model was extensively discussed, painfully in my view. They went through each of the parameters, the hydraulic connectivity, vertical gradients, horizontal gradients, vertical gradients, effective porosities, you name it. Each portion of the model was gone over in great detail. The conclusion in the Commission's report after that discussion is that the magnitude of the potential errors was large. Then there's a few hundred pages of report before the next part of the conclusion, and that is that the site has not been adequately modeled or characterized, and the burden of proof was not met, that the MAS is in a suitable geological and hydrological medium.

That second sentence fails both the NRC criteria under adequately modeled and characterized, and the suitable geological and hydrological medium fails one of the Illinois Management Act criteria.

So this was kind of a death knell for the site at this point.

The thing that really I think is important here, especially for a number of you folks involved in the High-Level Program, is there was a fairly large conceptual leap that was made here that's quite subtle until you start wondering about it in the middle of the night, and that is that during the discussion of the groundwater models, the discussions were uncertainty. The discussion was what detail does the model have to be to reflect the site? When is it enough that the site reflects in a general way the movement of water on the site, and what are the uncertainties built in?

Well, you can have a lot of discussion about uncertainties, but suddenly, the word magnitude of potential errors shows up in the conclusion, and I guess this bothered us for quite a long time until we realized that the conceptual leap had been made, was that uncertainty means error. And I don't think that anybody in the technical field makes that conceptually, recognizing that we're trying to quantify uncertainty, but that doesn't mean that it's just

wrong.

So this we thought was fairly telling on the very words that were chosen, which then led to finally the ultimate conclusion that the site was not suitable.

In addition to that lesson, which is one that frightened me to death, the overall lesson is that you really have to pre-establish again what are those standards by which you're going to judge a groundwater model before you get into it? The groundwater can never be 100 per cent of the site, especially a site like Martinsville. It's more difficult to do a groundwater model for a low permeability site than it is for a high permeability site, and it was always going to be difficult.

But the uncertainties turns into errors problem, is one that we found to be quite telling to jump from a technical standpoint to a political or a public standpoint.

There's quite a bit of discussion about the strategy for site characterization. There were a number of times during the Commission when the Commissioners found that there was a lack of an overall strategy. For example, they said, well, you should have known that the till beneath the site was going to be difficult to model. You should have targeted your program towards coming up with the parameters you needed to model that till.

There was a perceived lack of interdisciplinary

coordination. They asked the geochemists where they got their data for the hydraulic connectivities, and they said, oh, we got it from stratigraphers. The stratigraphers said, no, we never did that part of the work.

And, you know, it's easy now in hindsight to look at that. On the other hand, you have to recognize that a site characterization program of this magnitude has a very large number of disciplines, all working feverishly to meet schedule, and it's very difficult for anybody, one small group or person, to get an arm around the whole thing and do this interdisciplinary coordination.

Unfortunately, these types of issues undermine the credibility and adequacy of all the technical programs, saying, well, if these guys aren't working together, maybe nobody's working together. Maybe the whole strategy was somehow, you know, misdone from the beginning.

This led to a conclusion that the study produced only limited hydrogeological data, inadequate to resolve critical issues about the site. Again, that's a fairly damning statement after about $60 million had been spent characterizing that site, and it came really from the three bullets above that.

I think the lesson here is one that we've seen in other cases, in other states, in other processes, and that is that typically, groundwater and performance assessment models

are started late in the process. You go out, you design an exploration program, you drill a lot of holes, you bring all that data home, you give it to the computer modelers, and you say, here, go to it, get me a groundwater model. And, in fact, that may be backwards. It may be that what has to happen is that it's the groundwater and the performance assessment models that start the process. Those are the things that you do first, and that you drive the site characterization work by the results of the modeling and by the iterative approach of the modeling, the idea being one only idea to drive that, and that is basically the reduction in uncertainty. The uncertainty is what really gave the Commission pause in this process.

What should have happened in a technical standpoint, again in hindsight, is very simple, but the reduction in uncertainty would have been paramount to the success of this process, and, therefore, the integration of the performance assessment and the groundwater modelling iteratively going on, okay, guys, we need some more data in the northwest quadrant; guys, we need some better data on effective porosity in this area; guys, we need some better recharge data. That stuff can be done as people are still in the field, as the process goes forward, so that ultimately the groundwater and PA models have all been integrated, and the end thing ends up at a final product at the end.

It's easy to say, but it's also very easy to go back and look at what happened in Illinois and see that, in fact, that was a major difficulty when it got to the hearing process.

So this one back up just for two seconds because I think these are the three that are important. The suitable geologic medium, the minimized possibility, the public health, safety and welfare protected. These are the ones that the Commission kept coming back to over and over and over again and kept becoming the basic standards by which all the technical information was evaluated and finally led to the rejection of the site.

There are a couple of other minor general observations--or not minor--but other general observations that I'll just touch on very briefly that may be of some help to this Board. Just a few of them here:

One, scheduling. The hearings preceded the license application. That really has two impacts in this process. One, it means that the three Commissioners did not have the benefit of an extensive technical review of a license application. It did not have the benefit of the judgment of technical professionals in their evaluations. They were left to make the technical evaluations based on the record that they heard in a hearing process. They didn't have a document from an NRC or another technical review body that said, we've

looked at this, we're the experts, we think that for dose or for design, or whatever, that this is adequate. The Commission had no help with that type of review.

So in that particular case, this, we thought, was a fairly important difficulty with this process that that had not been done at that time.

Secondly, and kind of a surprise one, I guess, was that many of the--or a number of the design features of the facility were not yet in place at the time that the hearing started. They would have been in place by the time a final license application went in, but it didn't seem like they were critical things that needed to get done at that particular time.

That turned into, unfortunately, during the hearing process, another source of uncertainty. If the designers of the facility said, well, we haven't addressed that issue yet, or we haven't decided what to do about that yet, that just added to the overall aura that the people didn't have it together, that the process wasn't taken to its limit, wasn't taken to the end.

So the proceeding of the license application had those two impacts. One is there was no technical review body available, and secondly, not all the design features of the facility were in place.

The Commission noted a number of times in their

report that the credibility of the witnesses were critical to the decision. Because the Commissioners were not all technically versed on all the issues, they looked at the demeanor of the witnesses. They looked at how well the witnesses did under sometimes very brutal cross-examination, and they had judged the technical merit of the arguments, based on how well it was presented and how well the individual withstood the hearing process.

This is a frightening concept in many ways. I mean, that means when we decide to hire somebody or get somebody to work on a project, we have to look not only at how technically competent they are, but also how well they could speak and how well they could perform under a very difficult antagonistic process. This is frightening for all processes. It will be controversial in the public arena.

The Management Act, I'm not going to dwell on it again, but it did allow wide latitude in judgement. It gave the Commission basically no constraints into what they had to judge. The Commission was not necessarily held to existing performance standards. In retrospect, the proponents, had they been able to stop the process and say, look, we're not going to move forward until we all agree on the standards by which we'll be judged, might have helped, although that question was asked, and the Commission responded that they'll base their results on the record, and there's no more

discussion to be had. But that's certainly something that if you had to do it over again, you might refuse to play until somebody defined the rules.

Finally, the standard of "Burden of Proof." This was what was required of the proponents. Burden of proof is something which may not be achievable in a technical process, especially one which is supposed to last for hundreds and hundreds of years. The Commission was seeking in many cases absolute proof that things were going to work just the way people said they were going to work. And that's just not where the technical people from the proponent's side came from, and when they were asked to go ahead and promise that this was going to work, if they didn't promise, it was a credibility issue for the process, and if they did promise, it became a laughable issue because they said, how could you possibly promise over this many years?

So I don't know how you deal with that, but certainly that was an issue which could not be really addressed at the proper level within this hearing process.

And that's all I have to say. Again, that's a little different view of the Illinois process. And I don't know if we want to take questions now, or how we'd like to move forward with this.

DR. ALLEN: Thanks, Fred. I think we'll call it quits for that. However, this was the only facility we're going to

discuss today where two different viewpoints are expressed by people here. And, therefore, I think it's only fair, perhaps, to give Bill Hall a couple of minutes if he has any particular comments on this.

MR. HALL: Thank you, Clarence.

Well, I'm interested in--everybody is free to give their own opinions. So I think this is interesting to me to hear your views on this.

I would agree with you that the uncertainty business was a big player, as I said myself, but it wasn't quite the way you put it. In my mind, it was not just the uncertainties. It was the level of uncertainties that's involved.

As engineers, and even attorneys and so on, you live with uncertainties all the time. It's part of our life. But if you study the record, I think you will find there's a very high level of uncertainty in many, many, many issues, and that--as you identified, that was definitely a factor.

To think that concrete could last 500 years, we're going to hear more about that today, so we'll stand by.

I would point out to you that in Illinois, highway pavements start to deteriorate in a radical way at 12 to 15 years, for what it's worth.

And I think, I don't know, you used the word "frightening" a good many times. I'm making a note of that.

I'm not sure--well, that's interesting.

That's all I've got to say.

DR. ALLEN: Thanks.

MR. HALL: Yeah.

DR. ALLEN: Warner, I've seen you smiling and frowning several times. Are you impelled to say something?

DR. NORTH: Well, I'd love to hear from Professor Hall to the letter that I found at my place here directed to the governor and signed by a group of four people. I believe they are the Illinois Radiation Protection Advisory Council. I have no idea how that group is constituted, whether they're self-appointed or they have some institutional charter. They are clearly quite critical of the Commission that you served on, and I wonder if you would care to make a few comments with regard to the views they've expressed in this letter?

MR. HALL: I saw this letter about two weeks ago myself for the first time. I know none of these individuals at all, never heard of them before, so I can't speak to their credentials at all.

We have a number of physicians appearing, at least in the Midwest, I can't speak about the East or the West, who are raising questions about medical waste and places to put it and so forth. It's a very small amount, as I understand it, a very small amount of the waste that's to be considered.

I don't know, I have some suspicions about their allegiance and maybe's who's paying their salaries and things like that, but I'm not even going to make a comment about that, from some things I've heard. It's all secondhand. I really have no opinion. I haven't discussed this with any of the other Commissioners, who may know some of these people. So I'm at a loss to offer any--go ahead.

DR. NORTH: Well, let me be more specific. Their Point No. 2, they said, "Instead of conducting a technical review on the Martinsville Site, the Siting Commission resorted to a subjective measure, the credibility of the witnesses of the Department of Nuclear Safety."

A question that occurs to me is did you ever have a charter for a technical review of your own, as opposed to carrying out a hearing on a technical review that was supposed to be done by the proponents of the site, giving equal time to the public opponents of the site? You know, it seems to me their criticism might be a bit unfair compared to the charter that your group had, but I can't comment not knowing the details of how you were chartered?

MR. HALL: Which, your Item 2?

DR. NORTH: I'm looking at their Item 2 on Page 2.

MR. HALL: On Page 2. Well, I mean, they're expressing one thing that Fred Snider here talked about here, too, but--and when you have a jurist heading a Commission, you are

bound to have these things. It's quite interesting and revealing.

But from the technical side, I'm not quite sure of the question you're answering, because as one in the technical field myself, I felt that we did as much as we could do technically in bringing out the issues, and that was the primary thing we were after. So this is unfair in my mind.

DR. ALLEN: Okay. I think in order to stay on schedule, I have to move ahead.

Thank you, Bill, thank you, Fred, for some very insightful discussions.

We'll now take a 15-minute coffee break, no more.

(Whereupon, a break was taken.)

DR. ALLEN: The next speaker on the program is Wendell Weart, who is one of the senior scientists involved in the whole Radioactive Waste Disposal Program in this country. He is, of course, Manager of the Nuclear Waste Technology Department at Sandia National Laboratories and has had particular responsibility for the program at WIPP.

So, Wendell?

MR. WEART: I was pleased when I was invited to come here and talk about some of the lessons that we've learned on WIPP over the years, when Leon approached me. And I said, "How many days will I have to talk about this?" And he said,

"Well, more like 30 minutes." So I'm going to summarize some things that have stuck in my mind over the years, and perhaps you'll have an opportunity to explore some others in the question period later.

The WIPP project is an old one, of course, in terms of many of these activities. The topics that I will be talking about today, I'll go through in this order: I'll give you a brief history of WIPP because many of the lessons being learned, I think, are incorporated in some of those historical milestones.

Just to acquaint you with the geology of the WIPP Site, for those of you who are not aware of it, I'll go through that very briefly. I'll talk about some of the major scientific issues that we have had to address during site characterization. Those are different to some degree than the issues involved in site selection. I'll talk about some of the surprises we got, briefly about some of the regulatory and stakeholder issues, and then a brief summary of some of the important general issues that I think apply to WIPP.

One of the reasons, I'm sure, that I was asked to come here is I've been involved in this program for about 20 years. Interestingly enough, when I first got involved, I was working for the State of New Mexico on Governor Bruce's Kings committee on technical excellence. I find it somewhat interesting that he is once again governor, and I'm still

working on WIPP.

But when people ask me, how come you've managed to stay around so long, I think, well, perhaps that's one of the lessons I haven't learned. I sometimes show this view graph, and you'll note that I keep crossing out the number of years. It's a very old slide, and I'm now up to 20, but I probably still have about the same qualifications.

I always start back in 1957. That was when the National Academy of Science first recommended geologic disposal to the AEC, and particularly indicated that salt would be a good medium in which to put these wastes for reasons that most of you are aware of; that is, plastic material deforms, self-healing, closes up any manmade openings, and tends to prevent natural fractures and openings from occurring that could allow water ingress.

The original WIPP Site selection occurred in the '73 to '75 time frame. The initial site that was selected by Oakridge National Laboratory, and on which Sandia began to pursue activities, turned out not to be a desirable location. Nice way to start your work for your customer, the AEC, is to tell them that this site that they've picked out for their repository isn't any good and you've got to start over. But in one sense, that may have been an advantage to us because I think it helped establish early on some of the credibility of Sandia Laboratories in advising what became DOE as to the

technical scientific aspects of the program.

The conceptual design was completed early, in '77, and Title 1 was completed in '79. Now, that's interesting because at that time, we hadn't even started to go underground at the WIPP Site, and subsequent results have shown that we might have been a little clever, a little smarter, had we waited to complete some of that design work until we were underground and had learned a little more about the behavior of the salt at this particular location.

We had lots of information about the behavior of salt in general. We had studied lots of other potash and salt mines. We had done lots of modeling. But we found that even with our best attempts, we had some surprises, and I'll mention these a little later.

In 1980, we completed what we thought would be our surface-based site exploration studies, pronounced the site acceptable to proceed with full facility construction. We were, however, slowed down by some lawsuits. In the meantime, we went into the lab and field, did some work on one of the issues that was one of the primary concerns that came from the early attempts to find a salt repository in Lyons, Kansas, and that was the issue of brine migration.

We did these studies in the lab and in some locations in the field and potash mines, concluded that there wasn't really an issue there, and we were to later be

surprised by that conclusion.

We developed our underground in situ R & D program in '82, and in '83. When we got access to the underground, we implemented that; a fairly large-scale program that looked at the rock mechanics effect, initiated intermediate-scale experiments on plugs and seals, and some of that work is still going on because these programs are of lengthy duration, and they're not ended in a short period of time. Some of the experiments have been decommissioned. We, for instance, now believe that we understand well enough, for purposes of modeling, the global creep effects in salt.

The SPDV program is the Site Preliminary Design Validation. It should be DV, not VD. The facility construction began, and in situ commenced, as I mentioned, in '83. And before we really had much in the way of results out of this Design Validation Program, the final design criteria were developed and produced.

Up until this time, we had no formal regulatory guidance on WIPP. There were no standards, either from DOE or from anyone else on site selection. We selected the original site with some of the problems of Lyons, Kansas, very much in mind; the problems of boreholes, water intrusion, and, therefore, when we explored the vicinity for a site location, we gave great care to making sure we excluded boreholes that penetrated through within a mile or

two of the site region.

This turned out to be a very limiting criteria, and in retrospect with what we have learned now, probably not as important a criteria as some of the other aspects, but in those days it was one of the things that really pinned down where the specific site location could be.

In 1985, as I mentioned on the previous slide, we did get some guidance from the EPA, on general, generic guidelines, that DOE agreed they would meet for the WIPP site. We're not, of course, licensed by the NRC, as you know, but we do have to show that we can comply with the EPA regulations.

No sooner had we got a good start on doing some modeling to do that, and it was remanded, and has only recently been re-promulgated, not an official forum even yet. Will be published in the Federal Register probably in July. But we know what it's going to be, and we're working towards that.

It was in this time frame of about 1988 that DOE formally asked Sandia to do performance assessment modeling on WIPP. Prior to that time, there had been no formal performance assessment program.

Since we have developed that program, it's been shown to be a very powerful tool in helping us evaluate where we can put some of our resources and trying to get the most

bang for the buck, if you will, in clearing up the remaining areas of uncertainty.

Performance assessment, however, is only as good as your knowledge of the basic processes involved. Some of the things that we worry about now, in 1988 we wouldn't even have modeled because we didn't know they occurred. And so it's necessary to carry a basic development of understanding of the physical processes that can go at a site, along with the development of performance assessment techniques to help guide your program.

Now, we had a very ambitious program to proceed with WIPP, and WIPP was constructed and ready to accept waste as early as 1988. The program was put in abeyance for a number of reasons. There were lawsuits filed, and Admiral Watkins of the DOE decided to step back, do a full readiness review of WIPP, which took over a year. But when we got ready to bring waste in again, we got within, in fact, a couple of days of sending waste to WIPP for testing purposes, and there was a lawsuit filed by the State, NRDC and some other intervenor groups that brought WIPP to a halt again.

One of the things I find interesting, though, is that over the years, we've been in court, and I've had to testify a number of times, but on those things which came to the court involving technical issues, we did not lose. Those things which came to the court on procedural issues, we

almost always lose. And that was a lesson for me because it told me that no matter how well you may do your scientific work, that alone is not going to be enough if you don't observe some of the procedural issues that are sometimes short-circuited.

We had a program finally to do some testing, as I mentioned, which we brought to a stop. DOE then went to Congress and said, we need a Land Withdrawal Act. Part of the reason WIPP was stopped is there had not been an appropriate transfer, one of these procedural matters I mentioned, the land transfer from the Department of Interior, from BLM to DOE, was going to be done administratively. The opponents said that that's not correct. It can only be done by an act of Congress. They prevailed in court, and so Congress passed the Land Withdrawal Act eventually. But it was not just to transfer land. It had a number of other items attached to it, one of which was to transfer the responsibility for certifying compliance with EPA's regulations from DOE, who had been self-certifying, to the EPA.

This was, I think, in my view a good step because one of the major issues has always been the credibility of any government agency, and I must say probably particularly DOE, to self-certify itself.

And so this, I think, brought an additional degree

of comfort and credibility in the eyes of the public in New Mexico.

Let me show you, for those who are not familiar, what the general nature of the WIPP facility is like here.

There are four shafts which provide access to the underground. The main waste shaft is here. It's totally enclosed within a building that has controlled ventilation, operating at negative pressure. One shaft to exhaust air, one shaft to bring air in, and another shaft for men, materials, and to haul out the salt muck.

Now, most of this area down here has not been developed, but Panel 1, labeled right here, has. Those are the areas in which waste would eventually be put. Panel 1 was excavated in the mid-80s, when we thought we were going to emplace waste in 1988.

Given that, one of the reasons that we're in salt is that salt starts to creep and close, and that we had originally thought that the maximum time any panel of rooms would be open would be five years, and probably less, and we've now been open far longer than that. People begin to become concerned about the stability of the rooms, particularly since we were going to put test radioactive vessels in this room for experiments. That, of course, is not now being done, but we have found that from our design validation experiments up here, that in a period of eight to

ten years, we can expect to see enough deformation in the salt beds that we will start to get fracturing and suffer the potential problem of roof collapse.

We did mitigate this first room here with extensive structural support so that that wouldn't happen, so we wouldn't get a massive roof fall on our radioactive test vessels. The fact that this remediation cost over a million dollars gives you some idea of the lengths to which the operating contractor went. But in general, we would not propose to do any structural support in these rooms because after all, when we do finally start operating, we want the rooms to close in a reasonably quick time.

Most of the experiments at WIPP are conducted in this northern area. We had a large number of heated experiments in which we simulated disposal of Defense high-level waste. This particular room was an over-test, came close to the conditions of spent fuel, but still not as hot as commercial spent fuel.

Those experiments have been completed and have now been decommissioned. It seems like everyone's lost interest in high-level waste and salt nowadays. But the data is there, if it should ever be needed.

A lot of rock mechanics experiments, and rock mechanics was one of the areas where we found some surprises. I'd like to talk about some of the major areas that we

looked at in characterizing a site. Some of the things that were prominent in our minds initially during site selection, I don't show here. I mentioned boreholes, and making sure there were no boreholes within a mile of the site boundary. But these are the things that were concentrated on after the site had finally been located:

Dissolution of salt. It's always been interesting that salt dissolves so easily in water, why do we like it? It's one of the things we always have to address to the public. Well, of course, that's true, but, in fact, this salt has been there for 250 million years, and we found that it leaves an excellent trace behind if it is dissolved.

So we're able to use the fact that salt does dissolve and is dissolving to tell us those things that we needed to decipher to learn how rapidly these kinds of processes can go on. But regional dissolution of salt was one of the earliest things that we looked at.

In these general geologic, hydrologic arenas, we worked very cooperatively with the USGS. We had the Special Projects Branch in Denver and the Water Resource Branch in Albuquerque working with us very closely during these early days.

Another type of dissolution, which we spent quite a bit of time on, is something that I refer to here as Breccia Pipes. In some regions we found that salt could be dissolved

at depth, and that when this dissolution region became large enough, the overlying rock would collapse into this large void and create a breccia chimney. We called these Breccia Pipes, even though they're not the classical Breccia Pipe that most geologists think of.

We were concerned about could this occur at the WIPP Site, could it lead to a path for water transport? We studied those, found that, in fact, they only occur in regions which overlie the Capitan Reef, which provide large quantities of water for this deep dissolutioning, do not occur out in the basin, and, therefore, not a problem.

Natural resources. From the very beginning, we knew that there was going to be some degree of conflict with natural resources. There is no way to operate in the Delaware Basin, the area in which we had an opportunity to look for a selection of a site, and avoid natural resources. But two that, of course, are of concern are potash and hydrocarbons. It turns out that potash is probably really not a threat to the site because it's several hundred feet above the repository horizon in salt, and even if it should be mined, our later studies were to show it probably does not result in a breach of the repository.

Hydrocarbons are a different problem. They're at depth, and exploration for those, of course, would cause human intrusion through the repository.

To just summarize where we stand today in our thinking of the site and the repository integrity, we have found no natural processes which can lead to a credible breach of the repository, but we do have to consider human intrusion, and human intrusion is the scenario and several variants on that that lead to the potential release that we have to model and perform an assessment.

We spent a lot of time looking at tectonics. The salt undergoes deformation because of its plastic nature, and when this basin was tilted, a few million years ago, that gentle tilt where the salt abutted against the Capitan Reef caused some deformation. And we found out later that this deformation, which leaves the salt pretty much intact, although folded, will fracture and hydrate beds within the salt, creating fracture porosity in which brine can slowly accumulate, giving rise to what people have called brine reservoirs. And when you drill into these unexpectedly, you may get a significant flow of brine until you shut it off at the surface.

Seismicity, we looked at in the early days. This is an aseismic area for all practical purposes, but there were regions of earthquake seismic activity over in the Central Basin Platform. We found that most of that was, indeed, related to secondary recovery of oil, water flooding. The natural faults that we found in the area, the closest is

some 65 miles to the west in the Guadalupe Mountains. So we're in a pretty good situation with that regard, but we did use this program to develop the basis for designing the surface facilities.

Hydrology. One of the big areas that we got involved in is Karst geohydrology because to the west of the site, there are areas where that occurs, and it was natural for some of the concerned people to say, how do you know it doesn't exist at the site? We had people proposing that we would have open channels leading radioactive water directly to the Pecos River in a matter of weeks, when our modeling said it's more of a matter of several thousand to more than 10,000 years.

But we spent a lot of time on that, and today, we are still spending a great deal of time and resources trying to define better the conceptual model for hydrologic flow and transport at the site.

As we have learned more and more, we find that things are not as simple as they'd seemed. We know we have both fracture and porous flow. The extent to which transport is partitioned between those is a subject of ongoing laboratory and field studies.

To give you the overall setting, this is the Delaware Basin, right here is the southeast corner of New Mexico right there. There's the WIPP Site. The WIPP Site is

located where it is because basically a thick salt at the right depth with no boreholes, minimum resources, that kind of site selection criteria. The site selection criteria that we used, in fact, became virtually the basis for the site selection criteria for DOE in later years. But one of the things that I mentioned, dissolution, there is dissolution going on in that Nash Draw, leads to some Karst geology in here, and it was the extension of that over to the site that people were concerned about.

I spent a lot of time, had a lot of experts involved. Some of you were involved on the Board, in fact, I believe at one point in time, reviewing and hearing some of this information. We believe that that is no longer a threat, and I think most people agree with us.

In cross-section, this is a generalized geologic cross-section in vivid technicolor that gives you a picture of the site. We're in the middle of a section of evaporites that's over 3,000 feet thick. Within the lower evaporites, there are some fairly thick anhydrides, and where these beds approach the proximity, within a band of about five miles or so of the Capitan Reef, you start to get salt flow, deformation, and where you get this kind of deformation in the anhydrides, you get the fracture porosity and good potential for brine reservoirs to occur.

One of our surprises, because we knew this, tried

to avoid this, that even this gentle structure right here resulted in the creation of a brine reservoir. One of the interactions we had with one of our oversight groups, the Environmental Evaluation Group, that was a subject of a lot of modeling and scrutiny, we both, DOE, EEG, came to the conclusion that even if you drilled into this, it was not a significant safety threat. But they asked that the facility be rotated. Originally the waste disposal area was going to be built here at the north end. They suggested it be built at the south end, and we did that, an example where we were able to listen to and pay some attention to a stakeholder, and which has worked out well.

The aquifers that are of concern are the Culebra, which are up here over the salt, and that's the aquifer on which we are doing and have done most of our studies. There is some potential for some discontinuous perched aquifers higher up in the section, which occasionally stock could get water from, and which we may have to pay a little more attention to with the recent revision of the EPA standard.

The issue of the aquifer, its model, conceptual model, dissolution, some of those things are summarized here. I'll only show it to indicate that we believe that what we see today at the site in the hydrologic arena is really a relic of a past Pluvial period, and that the area is now draining. Previously, we believed that the general water

flow direction was from northwest to southeast, as shown here, but the dark arrows show the direction presently, basically to the south.

These lines show where successive removal of halite has occurred in the upper parts of the section, up in the Rustler above the Salado formation. And you'll notice that there's a progression of dissolution across the site. This has caused differing degrees of subsidence and fracturing in the Culebra dolomite, this principal aquifer. That's one of the reasons that the picture is as complex as it is, as it were in quite a transition directly over the WIPP Site.

Some of the surprises that have occurred on WIPP; I mentioned rock mechanics was a surprise, in spite of the fact we'd gone to a number of mines, modeled the behavior of those mines, done lots of laboratory testing and modeling. When we got underground and had a couple of years of experience behind us, we learned that the salt in our site was creeping about three times as fast as your best ability to predict. Rooms, drifts were closing three times faster.

And to give you some idea of the feel for this, a typical waste room, like I showed you, it's 33 feet wide, 13 feet high. Floor to ceiling closure progresses after a very quick transient period, at a rate of about three inches a year. So it's not a trivial enclosure rate.

We found that this creep rate had to be resolved in

order to give our long-term modeling any credibility. We spent a lot of time and money doing that, and we now have, we believe, the ability to predict from first principles very closely what's going on. Right now we're concentrating on being able to predict and model fracture development and fracture healing.

The first thing that we did when we got underground was to try and confirm the mining horizon that we had picked from boreholes. We had done a lot of coring. We had selected a horizon. But when we get down in the shaft to do hands-on visual examination, we found that all the core we looked at, this very thin clay seam, had been missing from our cores, probably in the rock. We just didn't recover it in the core. It was a natural break, and because it could be detrimental to have a ceiling for your drifts too close to this clay seam because of collapse concerns, we had to relocate the position of our underground horizon after we got underground. We would not have predicted that from just the surface studies. We would never have been able to predict a closure rate from just the surface studies.

I'll jump ahead to brine seepage because as I mentioned earlier, we had done lab studies, we had done field studies in potash mines. Concluded brine was not an issue for us.

After we got underground, we began to notice that

brine was appearing in the excavations enough that walls would be wet, enough that it would leave behind precipitates on the walls, and this became known to the critics. We had, of course, mentioned it to the Environmental Evaluation Group, to the NAS, and the critics, however, immediately made it a cause celebre. It became subject of a National Academy of Science Special Panel to look at brine seepage. The critics claimed that instead of the rooms closing in on the waste and collapsing everything to a solid, it would end up like a slurry, and when somebody drilled in a thousand years from now, it would squirt up like a fountain of toothpaste.

We spent a lot of time and resources on this. We're still doing work on this. We have established that there's no credibility to the slurry concept, but in more recent years, the concern has moved to a different arena; that is, will there be sufficient brine to corrode the metals, the aluminum and steel, that are put into these waste rooms, thereby generating gas from anoxic corrosion?

So we're still studying brine, but the original panic that was caused, you might say, exemplified by our local cartoonist, turned out to not be the worry that the critics thought.

I have a whole series of cartoons that I could give a whole talk from, from our local cartoonist. He's very good, capturing both sides of the issue.

But we don't hear too much about that anymore, although we, ourselves, would like to understand the extent to which it could possibly be a factor in metal corrosion.

I've mentioned these other issues, such as the hydrology. Much more complex than we at first believed. We thought it was a fairly simple situation. We have, oh, probably about 50 boreholes in the area. Specifically, you can look at the hydrologic situation. All total at the WIPP Site, we have over 100 exploratory holes to look at confirmation of the geology and the hydrology. We've done lots of geophysics in the early days and a lot of ground truth.

I'll move on to--what time am I supposed to be through? 11:01--so this will be a quick review of regulatory issues.

I've already mentioned the standards which EPA will hold us to, and they, themselves, will now be the agency to determine whether or not we are certified. This public confidence issue was a big one. One that came to us late was the hazardous materials standard RCRA often referred to, and in particular VOCs, because the volatile organic compounds must be modeled, travel different paths, pose different concerns than radionuclides, which are carried in solution.

And so this has caused different kinds of problems for us because DOE has chosen to satisfy this regulation by

saying that there will be no migration of these hazardous materials. It's caused EPA some problem because their standard was developed for shallow land burial, not for repositories, and there has to be some give and take and development of how you apply this standard to a deep geologic repository. It has caused us to do, and continue to do, a lot of new studies.

Focusing on fluid transport in the Salado, we don't normally think of fluids moving through salt beds, but we have the potential for building up enough gas pressure that that could occur.

One of our programs which was recently modified was the plan to do radioactive experiments at WIPP. DOE has recently decided to cancel those tests in favor of pursuing getting the similar kinds of information in the laboratory. This, of course, was a very political issue in the state of New Mexico, and so right now, things are rather quiet.

We do have a stipulated agreement with the State of New Mexico, which governs our relationships with the state as an institution with the Environmental Evaluation Group. I believe that this while sometimes can be frustrating, has overall proved to be a worthy approach to working with the state and to getting external oversight and adding credibility to our program.

We've had external reviews on WIPP since the late

'70s by the EEG, which is a group of primarily technical people. We have had reviews since the '70s by the National Academy of Science. They have a panel that meets with us quarterly to review our program.

Let me go just to some of the broad issues. And what we have found at WIPP is that you're never as confident of your position as you are before you start detail studies, and I would venture that that may be true not just for WIPP, but wherever you go. We thought WIPP was a pretty simple site. It turns out that as you get more detailed knowledge, you find more detailed questions, and the problem is, when have you done enough?

These studies inevitably find issues, and the critics will exploit those. And so you better be prepared with the answers because these issues are not always laughable ones. Sometimes they're serious ones. They come up with laughable ones, too, but often you can't laugh them away. So you better be prepared to address the critics' issues.

Because you find these surprises, it's nice to have found a site and to develop a repository design that is robust enough to still be acceptable in terms of meeting the standards, to comply with the standards, no matter what variations in models, or what variations in physical parameters that go into those models, your more detailed

investigation can show. I think we've been fortunate at WIPP in that respect.

Then we found that we shouldn't oversell or oversimplify some of the perceived attributes of the site. The example, perhaps, is this brine seepage issue at WIPP. We had always told the public that one of the reasons we're in salt is because it's dry. Well, salt is dry, but as soon as you see a drop of moisture glistening on the walls--and the critics perceive this to be an indication salt isn't dry, and you told us it was.

So you need to be aware of problems that may crop up. Whether they are real issues for compliance or not, whether they're issues for safety, if the public perceives that they're different than what you told them, it will be an issue, nevertheless.

Now, I've already mentioned that I think involving stakeholders, the EEG has been beneficial. I think it has been helpful, and I think it has been viewed by the public as a mechanism of bringing some external credibility, someone looking out for the state interest.

I think that this will be amplified now that EPA is the official certifier, but EEG carried that role for many years.

I think that being frank, forthright and involving the local citizenry was a plus. The community around

Carlsbad and WIPP site is very supportive. That's more than we can say about communities 300 miles away, and perhaps we should have done more discussion, information in communities like that, and not just focusing on the surrounding areas.

And one I added--interesting. One I added just as I finished talking with some people here at the meeting, one of the things which I think is important is continuity of project memory, continuity in the sense of programs, programmatic approaches, although that sometimes is out of our control because that will be determined by the new administrations as they come into power, and there is impatience in these programs with sticking to a course and getting on with the job along that perceived course, and everyone thinks that perhaps this modification will shortcut that, allow us to speed it up and do a little better job.

The words out here, I believe, were programmatic and technical. You need some technical continuity, and this is more than just a standard QA documentation. You need to have traceability in your detailed studies. But we have found in talking to oversight groups, review groups that come in, is that they can't take the time to read through 20 technical documents that define the story of the WIPP hydrology and how we got to the present understanding we have.

What we are doing now is providing some narrative

discussions of how we got from the early days of our understanding and beliefs to where we are now, so that these can be read and people can understand how we came to be where we are, because I have to admit, if you come in today and look at some of the things that we do and are doing on WIPP, you'll throw up your arms and say, what a stupid situation to be in. But there's a lot of history that goes into this. People don't understand it, and they'll never understand it just from reading technical reports.

So we're in the process of going back and developing these historical narratives.

Thank you. Sorry to run a little late.

DR. ALLEN: Thank you, Wendell.

I think in the respect for the timing of later speakers, we simply have to move right ahead. Don't forget that we do have a question and answer session this afternoon where all the speakers will be present.

The next speaker this morning is Klaus Kuhn from the Federal Republic of Germany, who was introduced earlier. He, since 1965 has been associated with underground storage of radioactive materials. He was the first scientific staff member of the Institut fur Tieflagerung, which you will all recognize as the Institute for Underground Research, I think.

Klaus, it's all yours.

MR. KUHN: Thank you, Mr. Chairman, members of the

Board, ladies and gentlemen.

I'm very pleased to be here to give a presentation about the situation of radioactive waste disposal in Germany. When I heard Wendell opening his statement and talking about the old times, this reminded me also of my first contacts to the U.S. Program of Radioactive Waste Disposal, as far back as in 1967, working for Frank Parker in the Project Salt Vault in the Lyons' salt mine in Lyons, Kansas. And ever since then, I followed the American program, and their very parallels. There are many parallelisms between the program in your country and ours. You will discover them during my presentation.

I decided to change the title a little bit from the proposal which I received from the Board, and I just named it "Gorleben, The Endless Story."

Germany is a very small country. Before unification, we had about the size of the state of Wyoming, and after unification, there's about 30 per cent of the territory added to the countryside. You'll see that nuclear power is quite important in the Federal Republic of Germany. 34 per cent of the total electricity is produced in Germany by nuclear power. And on the next slide you'll see that about 20 nuclear power plants are in operation in the Federal Republic all over the country. Only water reactors are in operation.

Only water reactors are in operation, 13 pressurized water reactors and seven boiling water reactors. And, unfortunately, the projects for high temperature gas cooled reactors and also for the fast breeder reactor have been given up.

There are three interim storage facilities in operation for the time being at the locations of Gorleben, Greifswald and Ahaus, the two at Gorleben and Ahaus for the interim storage of spent fuel from the power reactors, and the storage at Greifswald is being used for the storage of the spent fuel from the former Sovietic type reactors, which were in operation in Greifswald before the Soviets declined, or the Russians declined to take back the spent fuel as it was agreed formerly.

This is a view into one of those interim storage facilities. We use the dry storage concept with the self-shielding containers without artificial ventilation.

You'll see that we have reprocessing contracts with Cogema in France at La Hague, and also with BNFL in the United Kingdom at Sellafield. The metric tons of heavy metal which have been contracted are given here, and also, the options which are available to the German utilities. But there's a public discussion now going on if these options should be used or if final disposal of spent fuel should be preferred.

Nevertheless, the first vitrified waste will come back November this year, resulting from reprocessing at Cogema and later on, also from resulting from reprocessing at Sellafield.

Direct disposal of spent fuel from the high-temperature gas reactor, a prototype of which was in operation, is already legally possible. The direct disposal of spent fuel for light water reactors is on the legislation, so that we have a double condition, being able to dispose of vitrified high-level waste from reprocessing and also direct disposal of spent fuel.

A pilot conditioning plant for spent fuel of light water reactors is under construction at the site of Gorleben.

There are three repository projects either under operation or under construction. The first one is the repository at Morsleben, which was the former repository for reactor waste in the former GDR, which is now operated by the Bundesaunt fur Strahlenschutz, and the other project is the Konrad Mine for non-heat generating radioactive waste, mainly from nuclear power plants, and the issue of today's presentation is focused on Gorleben, where the radioactive repository for heat-generating waste, that means for high-level waste and for spent fuel, is being performed.

Some 20 years ago, in the early '70s, a Nuclear Fuel Cycle Center was planned in the Federal Republic of

Germany, including a reprocessing plant, waste treatment facilities and a repository just lying beneath these facilities.

If you want to see this Nuclear Fuel Cycle Center nowadays, you have to go through Japan. That is built at the Rokashamura Site in the Aomori Prefecture.

The first site selection procedure resulted in proposing three different sites for this Nuclear Fuel Cycle Center, the names of which are indicated on this slide here, but neither of these three proposals was accepted by the State Government. And this brings me to a very important point of all the situation, that the relation between the Federal Government and the State Government is of outstanding importance.

So the State Government of Lower Saxony came out with a different proposal in February, 1977, which hosted the salt dome of Gorleben, and this is a view of the Gorleben salt dome. The lengths of the salt dome is about in the long axis 12 kilometers, and the width is about 4 kilometers.

After some discussion, the Federal Government accepted this site in June, 1977, and then after some preliminary discussions, the famous Gorleben Hearing took place in March and April of 1979, and there was also a gentleman from Albuquerque taking part in this famous Gorleben Hearing. And I've just asked Wendell--he's

completely out of the business doing something else.

This Gorleben Hearing ended by the decision by the State Government in May, 1979, and there was this fatal statement of the then acting Prime Minster Ernst Albrecht, which is also used today. He said, "The reprocessing plant can be realized from a safety point of view, but cannot be carried through politically."

This was the end for the Nuclear Fuel Cycle Center, but he admitted to explore the site, that means to explore the salt dome, for the construction of a repository.

So even in May, 1979, we started with the first exploratory drilling.

In the years afterwards, there was a very extensive site characterization being performed. You see all the figures here, and you see here an area of about 300 square kilometers, which was investigated mainly for the hydrogeological situation of the overburden, and especially the cap rock situation above the salt dome.

And as Wendell told us, you'll never know the site exactly before you have looked into it, and one surprise was that salt solution take place in the geological time period at the contact of the cap rock and the salt, and that we detected by drilling several boreholes that salt dissolution, especially potash dissolution, did occur up to about 150 meters into the salt properly.

Nevertheless, the planned target horizon for the repository is farther down at about 900 meters, although that's no real threat in spite of having this effect down there.

We go to a very beautiful overview on the general situation on the salt dome, and as you can see here, salt, as Wendell also told, is not only composed of rock salt alone, of halite, which is indicated in blue, but you have some integrated beds like the potash seam, which is shown here in red, and then anhydride seam, which is shown here in green.

The interior is also consisting of salt. It is not shown because it cannot be interpreted from the boreholes to this area.

We drilled also two boreholes in order to sink the shafts for the underground exploration mine, and this was located pretty well so that they explored a full core of 900 meters of pure rock salt.

Then shaft sinking started in 1986, and there were two reports published by the Bundesaunt fur Strahlenschutz, BFS, one in May, 1983, summarizing all the results from site exploration from the surface, which formed the basis for the decision to continue with underground site exploration, and an updated report in April, 1990, which again confirmed the expected site suitability.

What I want to underline is that detailed

underground site investigation is absolutely necessary, I think, regardless what type of geologic formation you are looking into, and I know that the Board was claiming very much and backing up this demand, too, that detailed underground site investigation is necessary also at the Yucca Mountain Site.

This is giving a guess how the underground situation at the proposed disposal level in the depth of about 900 meters could be looked at, and you see that you have a very intensively folding of the salt formation, and also we have the anhydride beds, so that we have to locate the disposal areas according to the local situation. And, therefore, a very detailed underground site investigation is necessary. A program for this has been set up to sink the two shafts here at these locations, and then mine out drifts and have extensive exploratory drillings backed up by geophysical investigations.

Rock mechanical and thermo-mechanical data of salt were previously elaborated, and, therefore, we are of the opinion that only on-site confirmation of these data is necessary.

And Wendell touched about the possible presence of brines. We are of the opinion that this is not expected to cause problems.

But there are also, of course, unexpected

geological results, and I picked out here the case of the Gorleben groove. This is, again, the hydrogeological situation on the surface, and what we expected the overburden situation to be is shown here in this slide that we would expect to have an aquiclude consisting of clays and cap rocks and some fresh water and salient water occurring.

But then by extensive drilling, we expected the Gorleben groove, and the Gorleben groove is crossing the salt dome from northeast to southwest, and it was generated by glacier during the Elster glaciation period in Quaternary. This is 500,000 to 350,000 years before now.

And this Gorleben groove is partially filled with Quaternary loose sediments so that not a complete protection of the salt itself is available.

And the overburden of the salt dome is a complicated system of aquicludes, aquitards and aquifers. But on the other hand, the hydrogeological investigations have proved that the deeper part of the Gorleben groove is filled with saturated brine, or saturated salt solution. And we made some calculations also with a computer program to model the groundwater flow on top of the salt dome, and these computer programs use fresh water data, and at present there is no computer program, at least to our knowledge, available, which takes also into consideration the flow by saturated salt solution.

So the next step was to initiate a development of such a computer code to take also into account the diffusion processes within saturated salt solutions.

And I wanted to point out that the political critics of the Gorleben project came up, and they are supported by so-called scientists. We, who are working for the project, are not called critical scientists. We are just scientists. And they claim that the only the plain existence of the Gorleben groove is a knockout criterion for the site.

We make the statement that the overburden situation of the salt dome is only one barrier in the total system, and we believe that it can be proved that in spite of the existence of the Gorleben groove that the total system of the Gorleben repository is able to meet the safety goals.

Another unexpected technical problem occurred during shaft sinking. Because of the specific geological situation in the overburden, which I just have outlined, the freezing technology has to be used for sinking the two shafts, Gorleben 1 and Gorleben 2.

And to give you another example, another shaft, Kolenfeld, for a potash mine was sunk already in 1965. That means nearly 30 years ago with the same technology within a total time span of four years with a freezing section to 243 meters.

And sinking of the Gorleben shaft, Gorleben 1

started in September, 1986, after completion of freezing, and we are still in the procedure of sinking.

One reason was that at a depth of about 230 meters, unexpected inhomogeneous stress distributions occurred within the frozen Tertiary clays, which endangered the preliminary precast concrete lining. And there's a view into the shaft, and you see here the preliminary lining formed by these precast concrete blocks, which were endangered.

Then we were looking into the possibilities of what to do, and it finally came out that supporting steel rings could help to diminish the unexpected inhomogeneous stress distribution. And the a shaft accident occurred because this ring, No. 20, was not properly welded, fell down onto the shaft bottom and killed one miner and injured five.

By comparing this same accident, if it would have happened in a coal mine or in a potash mine, it would be a fourth liner in the local newspaper. But because being in a shaft, which is supposed to serve a repository, there was a complete issue in this which, as a result, stopped shaft sinking operations for about two years, and a new concept was to be developed for the preliminary lining. And this preliminary lining, then, consisted of some steel rings, which were then mounted down into the shaft.

The next slide is showing you a picture for the mounting of the steel rings, and you see here the rock and

the installation of these steel rings.

Meanwhile shaft Gorleben 1 reached the depth of 312 meters in December, '91, and again, sinking was interrupted because of brine detection in pre-drillholes within the fracture zone, which was caused by the contraction of the salt through freezing. This phenomenon was known from literature and from sinking other freezing shafts. Nonetheless, again, a big issue appeared, and the tightening of this fractured zone by drilling and injection was performed in December, 1990, to June, '92.

Then the foundation of the final lining system could be installed in November 1992 to March 1993, and this is a sketch of the foundation.

And finally, the inner lining was mounted, and the inner lining consists of a steel sheet. The annulus between the steel sheet and the concrete blocks is filled with bitumen, and the mechanics stability is given by a reinforced concrete shelf.

Since August, 1993, the final lining was mounted and shaft Gorleben 2 met the same fate. I'm not going through here in the details.

And the present situation is of the two shafts, that the upper part in shaft Gorleben 1 penetrating the overburden is completed since August, '93. The freezing pumps were shut off in August, and it is standing still since

September last year because of lacking license for continuation of sinking.

The same is being true for shaft Gorleben 2 with a little delay. Freezing pumps were shut off recently, about two weeks ago, and there are still some works to be done. By the end of April, that means within three weeks from now, also shaft Gorleben will stand still because of a lacking license for continuation of sinking.

Talking about licensing, I have to tell you that the German Atomic Act of 1957 delegates licensing for all nuclear installations, including repositories to the Federal States with a supervision by the Federal Government, presently by BMU, and this as a result comes to the consequences that political impacts by State Governments on their licensing authorities occur, especially by those State Governments which are formed by Red/Green Governments who want to phase out nuclear energy in Germany.

So there's a continuous discussion and continuous differences between the Federal and the State Governments.

Directions are given by the Federal Government according to Article 85 of the German Constitution, and this, of course, is not creating a good atmosphere between the Federal Government and the State Government.

And there was a question when we started to sink the shafts and to prepare the Gorleben underground

exploration mine. Should it be licensed according to the Atomic Act, or should it be licensed according to the German Mining Law? There was a long discussion, and finally, we decided to use because it is an exploration mine. It has nothing to do with the radioactivity at the first moment, to do the exploration mine under German Mining Law.

But this, again, had some consequences. Mining Law, again, does not provide for participation of the public. It is an old traditional law in Germany more than 300 or 400 years old. Again, mining authorities are State authorities, and there's no possibility for directions of the Federal Government.

One very important statement is that the mineral rights of the salt below the ground belong to the landowner, and that for an exploration mine, there's no possibility for expropriation.

In consequence of this situation, there's a continuous and numerous number of lawsuits going on since many years and no end to be seen.

If we come then to the next step, to the lasting procedure of the repository itself, there's prescribed in the respective paragraph of the German Atomic Act for construction and operation of a repository, a specific procedure which is called Planfeststellungsverfahren in German, which is not to be translated into English.

But there are some consequences included in the specific licensing procedure. There are no partial licenses possible like, for instance, during the construction for nuclear power plants. The licenses are granted in portions.

On the other side, all other relevant laws, like, for instance, for construction, for water and nature protection, are concentrated in this one single process, and a very large disadvantage is that a new licensing procedure is necessary if substantial changes would occur.

And finally, prescribes public layout of planning documents and public hearing with intervenors, and we just went through this procedure for the planned repository of Konrad. And I heard about 72 days of hearings for the Illinois State. We can beat you. We had a public hearing of about three and a half months.

Coming back to criteria, as early as in 1982, the German Reactor Safety Commission elaborated what we call "Safety Criteria for Disposal of Radioactive Wastes in a Repository." These were enacted a year later, and these criteria define the overall safety goal according to the German Radiation Protection Ordinance to be a maximum dose of an individual shall be less than 0.3 mSv/a per year, and this has to be proved by a performance assessment for a time span of about 10,000 years.

It is also written in the safety criteria that this

has to be done by a site specific safety analysis. That means taking into account all the site specific data and results which we have achieved during the site investigation period.

This criteria also makes use of the systems approach and some multiple barrier system. You are certainly accustomed to the multiple barrier system.

Very important is that the criteria cover the normal expected behavior of the repository system, as well as the consequences of accident scenarios.

I think there's a basic difference between the situation in your country and in ours, that our criteria take into account the general geological situation which cannot be standardized. So it's absolutely necessary that you are not specifying figures or numbers, but establish some margins of discretion. And the licensing for the repository shall be performed within these margins of discretion according to the level of science and technology at that time, taking into account the site specific situation.

Consequently, it is not necessary, and I want to underline this very strictly, it is not necessary to find the best site for the repository, but it is necessary to find a site which is able to meet the safety goals within the systems approach.

The Gorleben site here, another beautiful view of

it, is investigated with an exploration program from the surface, which I covered in the beginning of my statement, and hopefully with a detailed underground exploration program.

The exploration program from the surface is finished. It has been performed between '79 and '85, and the results achieved from this investigation program formed the basis to continue with underground site exploration, and the site is called to expect--expected site suitability is given.

Underground site exploration, again, I want to point it out, is absolutely necessary to get a detailed picture of the internal geological structure of the salt dome.

The questions--how can the site be evaluated? And there are two extreme possibilities. One is the first slash, site evaluation can be done straightforward, either by application of the present state of knowledge in geological exploration and of mining experience, and the other extreme is site evaluation can only be done by a complete performance assessment, which is also called sometimes a safety or a risk analysis, for the planned repository with a perfect set of site specific data.

I believe that the site evaluation process will lie somewhere in between those extremes, and I have enlisted some of the yardsticks which have to be used for site evaluation.

Of course, you have to regard the legal requirements. There are technical requirements, like depth, area and so on.

I think it is absolutely necessary that the performance assessment methodology is available for site evaluation, that you should use the multiple barrier systems approach and that you should use as much as possible from the experience from prospecting and mining, negative and positive. Positive experience is normally published. Negative experience is normally hidden in the files. But nevertheless, it's very important that you also make use of the negative experience from prospecting and mining.

And I think it's absolutely necessary to use underground research laboratories because you cannot investigate everything in the laboratory.

And one further item which I consider to be important is that there has to be concurrence in the site suitability between the applicant and the licensing authority. If they fight each other, you will be lost.

Some words about interaction with the public: The famous Gorleben Hearing, which I already mentioned, was chaired by Professor Carl-Friedrich von Weizsacker, who was the brother of the German President. He's a theoretical physicist, researcher and a philosopher, and a very famous man, and did an excellent job at that time.

Then, again, a number of public hearings occurred

and are listed here, especially one in April, '88, after the shaft accident. There was a public hearing by a committee of the German Parliament. And then in May, 1990, the government changed in the state of Lower Saxony, which is the host state for the repository project, to a Red/Green coalition. They installed a committee with the objective to consult the State committee for its target to phase out nuclear energy.

You can see the political position which is forming the background for all the story. And again, the Lower Saxon Government held a bond hearing last year with their own objective to bring up all the negative aspects. And so as a consequence, nobody of the applicant took part in this part of the hearing.

We did continuous information of the public about all technical and scientific results of the Gorleben projects, and as I mentioned already, a public hearing with the intervenors is prescribed in the licensing procedure.

If I may give my very personal opinion on public hearings and discussions at least in our country in Germany, they were not interested in solving the problem of siting and constructing a repository, but they were interested in fighting a religious or ideological war against nuclear power.

To summarize about what we have learned so far from the Gorleben story, I think it is absolutely necessary that a

consensus between the public and the applicant is necessary, or the general public in total on nuclear energy, and understanding for the need of a repository must be established in spite of the NIMBY and NIMEP syndrome. Maybe the NIMBY syndrome is known. That is "not in my back yard." But I learned that there's another one. This is a NIMEP syndrome, "not in my electoral period."

In the Federal system, like in Germany and like in the United States, it is necessary that a basic understanding between the Federal Government and the State and Local Government is required to site a repository. The legal situation should be clarified in advance as detailed as possible in order to avoid lawsuits. You never really avoid them totally, but you should strive for this.

It is necessary that clear licensing requirements and responsibilities are at hand, and the criteria for site selections and site evaluation should not be too stringent, should not be too specified, and should make allowances for the system's approach.

And finally, a basic understanding, a basic positive understanding between the licensing authority and the applicant is necessary.

Just to finish some lessons with the next one.

A certain flexibility within the licensing procedure is recommended.

Time schedules, which were already mentioned in formal presentations for site investigation and repository construction, should be as realistic as possible, but must be continuously adjusted.

The quantities and qualities of radioactive waste to be disposed of in the repository must be kept "a jour." And I know this is one basic reason that our Swedish colleagues are in a very favorable situation, for they have a very clear-cut amount of waste for which they are looking into the repository question. In our case, the quantities and also the qualities of waste are constantly changing. I mentioned the problem of high-level waste and direct disposal. So it is absolutely necessary to keep these figures "a jour."

You will face unexpected geological results and technical problems if you go underground. And the procedure for site evaluation and acceptance should be established. I already touched upon the experiences in geological exploration mining. Positives and negatives should be used as much as possible.

And one aspect which has not been mentioned so far, neither by me nor by any presentations, is that costs are not to be completely neglected.

Talking about shaft sinking, every normal mining company would have gone bankrupt if they would have to pay

for this shaft sinking procedure, and in my personal opinion, a positive interaction with the public should be strived for, without the possibility that the public opinion prevents finally the project.

Just being abroad in a foreign country, having the chance to talk to a United States auditorium, I would repeat two proposals, which I also made about half a year ago or three-quarters of a year ago in a conference in France.

I think we could make some very important steps further if we installed an International Commission on Nuclear Waste Disposal, in equivalence to the ICRP, and this is already being strived for, and we have found very positive results up to now, and we are having the first meeting for a fact-finding mission next year.

And finally, maybe it is not so important for this country as large as the United States, but for all the small and tiny countries in Europe, discussions on international repositories should not be a taboo any longer.

Thank you.

DR. ALLEN: Thank you, Klaus.

Perhaps I have time for one short question from the Board, if there's any comment or question, or the staff.

If not, then let us move ahead to a success story for a change. Walter Harris, who will be speaking on successful siting of a hazardous waste facility in Alberta,

Canada. He is Professor Emeritus of Analytical Chemistry at the University of Alberta.

Walter?

MR. HARRIS: As the result of an intensive, at least it was for me, four-year program, an integrated hazardous waste treatment facility was successfully sited in Alberta. As far as I know, no other public jurisdiction in Canada or the United States has succeeded in siting and subsequently constructing such a major integrated hazardous waste facility to properly manage organic and inorganic hazardous waste. But at the end of four years, we had agreement, on not only one, but two sites, both highly acceptable to the immediate public.

Unfortunately, the person most responsible for the conceiving and directing the public part of the program of the siting process has had health problems and--let's see if I can get it on the slides here.

Anyway, as I was saying, unfortunately, the person who was responsible for directing the program has had health problems, and on account of this, the definitive firsthand analytical account of the events concerning this siting success has not been written and will not be written.

But my impression is that the several principal participants in the process have somewhat diverse conclusions as to the activities and operations that were critical to the

success, and a number of external experts have produced reports, which I have seen, which are highly recognizable in the context of what actually went on.

In any case, I was one of the major participants and was associated with the program from the beginning and throughout the process, and I was involved in about 100 public meetings carried out border to border in Alberta. Many of these meetings were confrontational, and I hoped that my retrospective will be of some interest. Some aspects might be adaptable, and others might be irrelevant.

I can only make a moderate attempt to present an analysis from the important social and philosophical prospectus, but I think some 20/20 hindsight should be of some help.

I will describe what was done without trying to guess what parts might or might not be adaptable to the nuclear program, but I hope to provide a framework for some questions.

It appears to me that our siting experience illustrates a crucial importance of openness and integrity. It also became clear that it is important to avoid seeking purely technical fixes for a mainly social, psychological, political type of problem. To give a bit of chronology, about 15 years ago, a private company proposed building a treatment facility for hazardous waste near Fort

Saskatchewan, which is a town near Edmonton. They organized a public meeting, as they should. It became a huge protest meeting with cancer, birth defects, dioxin, lethal chemicals in the forefront of the comments by the protestors.

In response to this meeting, the government almost immediately declared a moratorium on siting activities, and throughout the process, no jurisdiction was prematurely targeted as the site.

The government committed funding and a number of staff to work on the problem of management of hazardous waste, and the Minister of Environment appointed a Hazardous Waste Management Committee, which was one that operated for only four months. It comprised three members from government and three private citizens; a farmer, a fireman, a sociologist, two technical persons, and a bureaucrat. Public relations and other assistance to the committee were provided by the government, and this committee was an uncommonly effective committee with a very high level of mutual trust and respect among the six members.

In my role as a technical member, it was essential for me to avoid going off on tangents and to focus on the central features. Basic technical honesty was critical for me.

This government-public committee set out to the main features of the waste problem, including the need to

take into consideration public involvement, legislation, financing, ownership, storage, transportation, transboundary movement, definition of hazardous waste, classification, technology, gathering, siting criteria, risk, detection limits, toxicity matters, public safety, and environmental impacts. We did that in four months. Information suitable for an accurately informed public was certainly one of our objectives.

The public component of the program was largely directed by an experienced sociologist, and throughout the years, the position taken by him was one of cooperation: "We will not come into your district without invitation." Openness was an implication of his often repeated statement, "We jointly have a problem to solve."

It was certainly critical to be frank and informative with the media, and accordingly, personnel were attached to our committee experienced in working with the media. At the information meetings organized throughout the province, public input was invited. A number of information bulletins were prepared and distributed along with the committee reports.

The first committee was followed by four more. The next one was a committee from the Environment Council of Alberta, and presumably, the Environment Council concluded that the problem was mainly in the technical arena, since

three of the four members were technical people on this committee.

The next committee was the Hazardous Waste Management Team. It considered such matters as legislation, transportation, management and site selection. And during the next couple of years, information meetings were held border to border in the province, and the chairman for these meetings were normally local citizens or field workers, and very rarely employees of government.

Another committee was the Non-partisan International Proponent Selection Committee, which reviewed applications and recommended to government a short list of four companies from the 19 that submitted proposals for building and operating a plant.

Well long in the process, a two-day seminar was held for about 70 delegates from across the province. These delegates were selected by the various districts, at which there had been information meetings, and the seminar itself was an expanded information meeting, including an opportunity for interaction among the delegates, which was very important.

About this time, the information meetings were changed.

I'm sorry, I missed a slide here.

Yeah, so about this time, the meetings were changed

to a more formal structure in contrast to earlier ones where a panel was available to answer questions posed by members of the audience. The new format helped to focus questions on topics on which there had been a presentation. For example, questions relating to technical matters were followed--a technical presentation, or regulatory matters on a regulatory presentation, the transportation matters similarly.

In my part of the presentations, I dealt with technical matters. Hazardous waste were described, such as used oil, spent acid, solvents, sludges, and the chemistry and technology of their destruction, and the management of the products formed were discussed. I showed slides of some European facilities. This is the incinerator facility at Avenhausen in Germany.

Technically, it was necessary for me to come to grips with matters such as zero, absolute safety, toxicity and the detection limit regulation problem. When explained, most people recognize and accept that zero is unattainable and that absolute safety can never actually be proved. And my impression is that the public responds positively to straightforward honesty in these matters, and they accept qualitative judgment terms when you're considering risks.

Following a series of three information meetings at the town of Ryley, a plebiscite was held. Ryley is near Edmonton and near the major centers of the production of

industrial hazardous waste. Ryley is in a county where there was violent opposition to a plant, but they voted on the matter and voted about 80 per cent in favor of hosting the plant.

About a month later, Swan Hills, which is probably the town you've heard about, also voted on the matter. Swan Hills is about 200 kilometers from northwest of Edmonton, and in both towns, as is indicated on the slide here, that about 80 per cent of the citizens voted in favor of hosting a hazardous waste treatment facility.

In both jurisdictions, there was no attempt to gain public acceptance through what might be called host fees or bribery. A few months after these two jurisdictions voted on the matter, another jurisdiction did reject the possibility.

Ryley is near Edmonton and makes the most sense for a site from nearly all points of view. And another jurisdiction was Strathcona. This had strong local support, but in keeping with our idea of not targeting a jurisdiction, that county was not investigated, but it would have made the most sense.

The Special Waste Management Corporation Act was passed with the objective of ensuring that facilities would be developed and the management of hazardous waste properly taken care of.

Well, in March, 1984, Swan Hills was chosen by the

government as the site. Ryley publicly disagreed. They put a big ad in the Edmonton Journal, disagreed with the decision of the Minister of Environment. Swan Hills, after all, is more remote from the center of production of the hazardous waste.

In April of that year, the Special Waste Management Corporation of seven members was formed, and they were told by the Minister of Environment that the choice of Swan Hills, instead of Ryley, was a political decision and for us not to question it.

At about this time, rather large amounts of money became increasingly involved, and then political took over, and I have some material that you can see on that, if you wish.

In September, 1987, was the official opening of the hazardous waste plant at Swan Hills, and this is a view of it. The facility is jointly owned by a private company and by government through the Alberta Special Waste Management Corporation and operated under contract. The town of Swan Hills receives no host fees from the plant, and furthermore, the plant is not part of the tax base, since the plant is outside of the town boundaries.

A couple of years ago, the plant needed to be expanded to handle the volume of waste, and after a series of public hearings, such an expansion was permitted, and that is

the current state.

I'd like to now give you some impressions. In both the positive and negative senses, the media were significant players in the siting success. In the positive vein, a number of thoughtful, knowledgeable editorials did appear, and the editor of one local paper was certainly well informed and played an important role in the successful siting.

On the negative side, many reporters are too busy to be excessively concerned with validation of information. For example, in the early going, typical headlines were "Alberta Proposed as Chemical Waste Dump," "Chemical Dump Hearings," and "Ryley Threatened by Disposal Plant." The word "dump" was prominent in early news items, even though dumping was never proposed. It was destruction of the hazardous waste.

Other words that instill dread were also prominent; deadly PCB, cancer-causing PCB, dioxin, birth defects, poison plant, like an atom bomb, spew, those kinds of words. Reporters, of course, know that fear has a very high potential to entertain, and that's part of their job.

There is some evidence that our attempt to educate rather widely had some success and that the word "dump" appeared much less frequently after a couple of years and through the later stages.

Throughout there were repeated calls by the media

to move ahead quickly, to pass regulations, to choose a site, and they were focusing on the problem and not the solution.

The activities of positive local leaders were very rarely seen to be newsworthy, while the negative voices would receive a lot of media attention.

A number of town councils and chambers of commerce extended invitations for their district to be considered as the site. Such invitations were normally followed by the formation of a protest group, "Friends of..." or something or other. And along with heavy-handed intimidation, one group imported an activist of Love Canal fame and an expert who was formerly an EPA employee. Another group imported a veterinarian from out-of-province, and normally the leaders of concerned citizens groups, protest groups, were usually ones who would be viewed as knowledgeable professionals; a Dr. A, an optometrist; Dr. B, a veterinarian; a high school principal. And these normally dispensed dread, misinformation, irrelevancies and twisted information from reports.

I felt for me to be duped into correcting items of misinformation would have been a mistake on my part, since more very quickly surfaces. I did attempt it at some point. My conclusion was that I should simply continue to describe the important features of the problem and solution as

accurately as possible.

Now throughout our province, there was, of course, widespread recognition that hazardous wastes are an inevitable component of modern society. Such wastes are generated by, of course, large corporations and also by individual householders. It was recognized that an integrated facility was needed. Our treatment facility should be somewhere else--you know, the NIMBY attitude. That wastes can be responsibly managed from a technical point of view was recognized by many, and, of course, including the vast majority of citizens in Ryley and Swan Hills.

Late in the process, I learned of the existence of "how to" manuals that give directions and advice on how to protest and forestall decisions, and their advice from such sources include such things as saying, "Raise enough hell politically and through the media to get the plan postponed 'for further study,'" "Stay on the attack," "Keep them tied up denying you information," "Get help - import professionals." Discredit with terms such as "Latest studies show that," or "That's controversial." Fabricate fear through the use of words such as spew, birth defects, dioxin, cancer, of course.

For the most part, politicians were invisible and silent in the public meetings, and I think that was a situation that probably helped in the running of the program.

An industrial association that might have helped obtain the economically more favorable site, that is Ryley, they only became slightly visible after the decision was made. So that was unfortunate.

In the minds of the media and much of the public, including many scientists, there is an almost universal and instinctive belief in zero, that any level of a toxin is too much, and that certainly was one of the problems.

A minor problem in the program was from overeager supporters, who in their zeal went well outside their areas of competence.

After a series of information meetings in one area, the vote was taken for a rejection, as I've indicated. I think the negative vote was in part the result of one of the organizers, who having heard it many times, began to give the technical background. He began to act as though he was a technical expert and pretend what he was not. In public meetings, I saw the negative reactions to his presumed technical knowledge, and I guess I have to say that scientists should not pretend to be experts--too expert in solving social problems, and non-scientists should not pretend to be science experts.

Another unfortunate thing is that there were some fairly intense conflicts among varying members of the community, and even within single families. The commitments

on both sides tended to be very high and to become emotional.

The current situation is that Ryley, the first town to vote in favor of hosting the facility, has not been left out. It now has a facility to collect, store and transfer hazardous waste to Swan Hills, and I think they're somewhat satisfied with that.

As I've indicated, a backlog of Alberta wastes that need destruction by way of high-temperature incineration have been accumulating, and companies are forced to stockpile wastes and are not now getting the service they need from the Swan Hills plant. And the expansion of capacity for high-temperature incineration went through public hearings, and it has now been quadrupled, and the additional facilities are about to start up.

A decade ago, a Swan Hills Special Waste Liaison Committee was formed and continues to be active. It interacts with the company and with the community. Information bulletins are regularly prepared and distributed by the owners of the facility in the community. There are a very large number of both national and international visitors to the site, and the general attitude in Swan Hills is probably accurately reflected in their statement that "We don't need Edmonton or Calgary telling us we have a hazard here. We haven't got a bloody hazard here."

And more recently, a Wall Street Journal report

quoted the mayor as saying, "I wouldn't come into town and protest too hard on a real cold day. You might not get a room or a meal."

Swan Hills owns the plant, is very proud of it.

Pressure is increasing for Alberta to take out-of-province wastes, and technically, of course, that would not be a problem, and there would be economic implications. But the possibility of taking out-of-Alberta wastes would, however, be a political decision and one which would have to be taken only after consultation with the public.

At the present time, there is certainly one group that would like to shut down the plant. Their positions seems not to be one simply of NIMBY, but I don't quite understand it. I don't think sincerity is in doubt. Their motives, to me, are unclear. They have no alternative solutions, other than storage. As stated, the belief in zero is almost universal, and zero is something, of course, that can never be measured analytically. Emissions are not and can never be probably zero. Yet, for example, a Greenpeace spokesman said, "Anything above zero is unacceptable."

Well, to me, it appears fortunate from the point of view of appropriate and responsible management of Alberta's hazardous waste that Greenpeace was not active on the siting question during our siting activities.

What was the key to the siting success? Well, at

the official opening of the plant, the platform was filled with politicians congratulating themselves. I think if you ask them, they were the key to the success.

If you asked a newspaper editor in Swan Hills, I think he would say he was the key to the success.

If you talk to one particular field worker, he was the success.

I think if you talk to one of the media experts that was attached to some of our committees, she was a key.

If you talk to a geographer who came into the program late, constraint mapping was the key to success. It certainly was important. This person has become a siting consultant, and I think is erroneously viewed as the expert in our program.

This geographer, obviously, listened to a psychologist who was involved in a peripheral way. This particular psychologist had a great deal of self-assurance, and believes that perceptions are of central importance, not facts, and clearly form is more important than substance. And she recommended that one should not meet the public with a suit and tie and slides and so on. Maybe if you ask me, I was a key to the siting success. I certainly played a key role for both Ryley and Swan Hills, and contrary to advice, I wore a tie and suit and used slides.

I talked with one of the leading residents of Swan

Hills, and in his mind, he was the key. Well, I think in a way, all of these were necessary components, and none of them sufficient in the site.

The conclusions: I think if you talk with someone who had nothing to do with the program, I obtained the impression that the siting success was simply an accident of no particular significance, or they come up with some simplistic explanation that fits with some preconceived notions.

When I presented some of this material at a conference in Baltimore, I was astounded to hear that the Alberta siting success was a result of a competitive process, and that blew my mind.

Well, in my judgment, in Alberta, we avoided three blunders. I think it's a blunder to target a jurisdiction prematurely, and we did not do that.

It's a blunder to pass regulations for the ongoing problem of hazardous waste without the means to meet them. For example, when appropriate facilities are not in place to pass a regulation, which was done certainly in another providence in Canada, to prohibit liquid dumping after some future date, and the Environment Minster then, of course, was being increasingly discredited for permitting illegal dumping.

The third blunder, I think, is to assume that the

siting problems to be solved are mainly technical and to undertake a siting problem program that is mostly technical, and accordingly appoint inappropriate program management. I think it's attractive, of course, to think of a siting process as a reasoned and rational process, and I think that reflects an overly unreal and technical point of view of society.

Well, I think we avoided these three blunders. In my judgment, I think the important factors in the process were the following 10. Here's the first five: The declaration of a moratorium on site selection, and no jurisdiction was targeted at that point.

Secondly, regulations were not formulated and passed until the means to meet them were in hand. A conscious decision was made to postpone the passage of regulations. Pressures are always there to pass tough regulations and then assume that a problem has been solved.

Thirdly, the appointment of the government-public committee to outline the problem, the features of the problem, and the early recognition by that committee that the problem was mainly outside the technical arena, although, of course, sound technology is, of course, essential, siting is mainly a social, psychological, political problem.

Persons who are technically competent and trusted and trustworthy need to interact with the public on technical

matters, but nevertheless, to endlessly seek technical fixes for social, political problems, I think, is a futile operation.

On the matter of committees, the most effective one by far was the one that I indicated. It included the fireman, the farmer, two technical, sociologist and bureaucrat. In that committee, it was important for me, as a technical person, to avoid going off on technical tangents.

The worse committee was the one that had three technical people out of four. Their approach, in part, was that a facility not only be safe, but seemed to be safe, and accordingly that committee, from the point of view of seemed to be safe, they recommended that a treatment facility should best be sited in the center of nine square miles. Well, recommendation caused me more distress than that one, since a facility that needs to be sited in the center of that area has to be seen as incredibly dangerous.

In Europe the facilities that I visited were typically sited on 10 acres. Well, I think technical people too often fail to present a sense of perspective. I think they're too concerned with making themselves fireproof.

A fourth factor, I think was to have had the direction of the public part of the program mainly in the hands of a mature and experienced sociologist who didn't listen too much to the psychologist.

A fifth factor was having personnel who were experienced in working with the media and being frank and informative with the media.

A sixth factor was organizing information meetings border to border and inviting input, with no target of anybody, just information meetings.

In my mind, the most single important operational factor was the two-day seminar for about 70 delegates selected by residents to come to an expanded information meeting. The interactions there were extremely helpful.

An eighth factor was the eventual adoption of more structured information meetings that I've mentioned, so that comments and questions were focused on particular topics. Earlier, what I call "sitting duck" format with a panel to answer questions I think should be avoided. That format lends itself to manipulation and plays into the hands of protesters.

Another factor was cooperation with local leading citizens. A base of accurately informed and committed local support and leadership was certainly essential, and it's important to work with the informal, as well as the formal, leaders of a community and to openly provide information.

And a tenth factor was an attitude of respect for the public, basic honesty, openness, cooperation. We have a problem to solve jointly.

Well, this is a very quick overview of what went on from my prejudiced point of view, I think what gives you a flavor of that. Unfortunately, as I've said, the definitive firsthand analytical part of this siting success has not and will not be written, and with that, I leave you with my statement on it, on the siting.

Included in the material that has been circulated are some of my brief comments in response to the 13 questions posed by the Board. Concerning the last question on applicability to siting a nuclear waste repository, I offer the opinion that it is well to avoid seeking purely technical fixes for a problem with major social, psychological, political components.

Thank you.

DR. ALLEN: Thank you very much, Walter, for an interesting and provocative talk.

We'll now break for lunch, and since we need about an hour and 15 minutes, we'll reconvene at 1:40.

Thanks to all the speakers this morning.

(Whereupon, a luncheon recess was taken.)

A F T E R N O O N S E S S I O N

DR. ALLEN: Our first speaker in the afternoon session is Lloyd Cluff, who's Manager of Geosciences for Pacific Gas and Electric Company. Prior to that, he was Vice President and Director of Geosciences for Woodward-Clyde Consultants. He's been involved in any number of controversial siting cases of various types, and he's going to give us the benefit of his experiences.

Lloyd?

MR. CLUFF: Thank you, Clarence.

I was intrigued by Dr. Camilla Odhnoff's remarks early this morning about the ethical labyrinth, and, also, I would add psychological labyrinth, and we've heard a lot about labyrinths this morning, and this is certainly a fitting venue to have this meeting here above the casino and be forced to go through the labyrinth downstairs to find the restaurant. There's a lot of analogies to siting critical facilities in terms of every barrier, many of which are there, it's to extract money from you. And so I think there are a lot of similarities.

The presentations so far have called attention to

conflict and controversy. My focus is also on that, but to illuminate the ineffective use of the adversarial and confrontational process.

And I chose a rather provocative title because that's what I'm going to talk about, are four projects about entrenched warfare that often accompanies the process of siting, designing and building critical facilities. It always leads to the expenditure of billions of dollars, benefiting only a select few. It is a waste of resources and a disservice to society. I propose that the solution to these problems to entrenched warfare is in the process. It's the human behavioral aspect. Not that technical things aren't important, they always are very important, but we don't pay enough attention to what motivates individuals to take certain action, and it kind of gets into geopsychology, and we need to pay more attention to those aspects, along with the technical matters.

I have chosen four case histories that are shown on this--well, they're not shown yet, but the map of California is the seismicity map of all historic time from about early 1800, 1803, I think, to 1987. See in the coastal areas very strong seismic activity that's close to the big active faults, and, of course, the seismic activity that follows, the fault zone that traverses at the base of the Sierra Nevada Complex.

And so there is a part of California that's in the central portion, the Great Valley and the Western Sierra Foothills that up until a few years ago was considered devoid of any significant seismic activity.

So I'm going to start off by talking about two proposed dams. This is back--and I'm speaking now as though I were back in the early '70s. So I'll talk about two proposed dams, the Auburn and the New Melones, and then the LNG facility down along the coast, and just north of there, the Diablo Canyon project.

Now, during the 1960s, feasibility studies were completed for these two dams. In fact, studies were done even back in the '40s and '50s to help in deciding where to locate these big projects. And in the early to mid-'70s, Congress approved funding, and site preparation and construction started at about the same time on the Auburn Dam and the New Melones Dam.

On July the 1st, 1975, a moderate magnitude, 5.7, earthquake struck in the vicinity up here, 41 miles north of Auburn near the town of Oroville. This earthquake focused public attention and concern on a part of California that, as you can see from the seismicity map, was not considered an area to have active faults or significant seismic activity.

This earthquake was caused by slip along a fault. The Oroville earthquake occurred here, and there is a fault

system that is shown on the same map called the Sierra Foothills fault system, and the earthquake occurred because of slip on a small segment of the fault here, and so both the U.S. Bureau of Reclamation and the Corps of Engineers, Corps of Engineers responsible for the Melones Dam, and the Auburn was the Bureau of Reclamation, both of those agencies decided in early 1976 to have an independent evaluation made of the significance of this earthquake to their facilities because both facilities were located very close to, if not on parts of, that Foothills fault system.

My company was selected to do both of those studies, since Woodward-Clyde at the time was doing a very large inland nuclear power plant siting study for PG & E that had been going on for several years, and in that process, we had identified this Foothills fault system as a potential issue should PG & E decide to locate nuclear power plants along the rivers here in the Great Valley, which was one of their thoughts.

And so we had identified this fault system as a potential issue in that while no one had conclusively shown that the fault was active or inactive, there was some suggestive evidence that demonstrated that it could be capable of releasing moderate earthquakes. And sure enough, in 1975, an earthquake occurred.

So I'm going to talk about Auburn Dam, spend a

little time on the details. The technical details from Auburn apply to all four projects. So I'm going to spend the bulk of the technical time here. They're identical in all the cases. It's just the characters changed, the issues were the same.

This is the reservoir that would be impounded behind this huge dam, 4,150 feet long, a double-curvature, thin-arch dam, 196 feet thick at its base, and 40 feet thick at its crest, and 700 feet high.

It was to be built on the American River near Auburn. And in the area of the dam site, because of the erosion, all of the young geologic deposits had been stripped away by erosion, so it was difficult right at the dam site to make any assessment of fault activity from the classical geomorphic or stratigraphic point of view.

There's not a focus on here, but--oh, yes, there is, too. It doesn't seem to be working.

DR. ALLEN: Nothing's happening.

MR. CLUFF: Yeah, maybe someone could help focus that. I think it's the other thing on top. There we go.

This is another dam in the Sierra Foothills. This is a thin-arch dam as well, but it's about a tenth as long as the proposed Auburn Dam and about half as high. So you can imagine this huge dam that was going to be built in the area of the American River.

And another important aspect of this is the downstream aspect; the Auburn Dam here, the Folsom Lake and existing Folsom Dam was here, and then directly downstream of the community of Sacramento.

The fault that slipped that produced the 5.7 earthquake caused these zones of cracking, and there was great debate in the beginning on whether or not that represented surface faulting. As you can see from this closeup, this was not a very impressive fault scarp. However, looking at photo imagery and so forth, and I don't know, from my angle, knowing where it is, there's a very strong linear feature right through here. And this feature had been identified in the nuclear power plant siting studies as a potential fault that had characteristics that made it suspicious and needed to be investigated should PG & E want to build a nuclear power plant in the vicinity.

Sure enough, that was the fault that ruptured, called the Cleveland Hill Fault, and so we dug trenches. You can see from the trench spoil pile the different materials. There is a change in geology across that feature, and, of course, once you open the trench, you can see the fault. The surface cracking was right above here, and so sure enough, that surface cracking was along the fault and interpreted to be the result of surface faulting, or the cracks were the result of.

And in other trenches along that same fault, this old soil profile of Paleo B horizon was dramatically deflected in a normal sense where it crossed the fault. Since there was only two inches of displacement, the conclusion after detailed studies here was that this represented cumulative slip over many thousands to tens to perhaps hundreds of thousands of years, and that two inches of normal slip was a typical earthquake on this fault zone. So we had a confirmed active fault along a segment of the Foothills fault zone here.

With the Auburn Dam being here, the New Melones being here, the focus of our studies was to see if, in fact, there was continuing evidence along other parts of the system, and specifically at the dam sites themselves.

A very prominent location that allowed us to make a very critical assessment was down near Sonora, not too far from the New Melones Dam site. This is called the Table Mountain latite. This is a volcanic flow that at about seven million years ago when the Sierra Nevada was being uplifted, the series of volcanic eruptions occurred, and this marked the bottom of a river. So this flow came down the bottom of a river and then solidified in the canyon walls. And since the last seven million years, differential erosion, the volcanic materials being much more durable, we have inverted topography. You can see the sinuous nature of the stream

channel, and that horizon was a good marker to look at whether or not faults that crossed beneath had had any displacement. And you can see a disruption here, and a disruption here, and a disruption here.

So we focused--we had noticed these during the PG & E study--and that seems to be out of focus again for me. We'll need to have someone check that.

So here's a 75-foot vertical disruption, normal type of faulting here, and this was 55 feet.

Well, the next question was, well, that's a lot of displacement, but it's post 700 million years. Let's not get carried away with it. So we decided to follow that fault out into this meadow, and this is the trench that was excavated across that fault. Here's the trench at closeup again, right along strike of that fault.

Looking in the trench, one can see this very well developed, slick insided surface in the paleo soils, showing multiple displacements since the time of formation of that soil, and the youngest that could be is about 100,000 years.

So there had been post 100,000 year multiple displacements on that fault.

And a number of other places where other canyons were the same, we had other displacements and other detailed excavations exposing old soil deposits, showed the same kind of characteristics. So it became very clear that in a number

of places, short segments of this fault had experienced displacement. Not large ones, but this is the cumulative displacement probably over several hundred thousand years.

And during this process--and a very useful process is to have a consulting board. We did have a consulting board on the Auburn Dam project. They were very intent in looking at this evidence. We took them quite regularly to the field. You'll note here there's a characteristic style; when consulting boards are out in the field, they always kind of put their arm under one elbow and supporting the chin. You'll see this characteristic throughout all of these photographs. You can see it here again. You might recognize this distinguished individual here. That's Clarence Allen. This is Lloyd Cluff, two members of the consulting board.

I convened the board for the Bureau of Reclamation, and you were--the Board was reporting to the Bureau of Reclamation, and the Board was convened by both Woodward-Clyde, in terms of the field trips, and the Bureau.

So this is an aerial view of the dam site. You can see the construction that had started, and the foundation was a very soft foundation, and some of the issues here is the difference of opinion between the State of California and the Federal Bureau of Reclamation. There had been a long-term difference of opinion on the adequacy of this site for a thin-arch dam. Some of the State engineers felt this was

more appropriate as an earth and rock fill, or a gravity-type dam, rather than a thin-arch dam. And this debate had been going on for years, and that's important to keep that in mind.

Well, to make a long story short, this comprehensive, regional geologic evaluation of the Foothills Fault evidenced a low degree of fault activity along many of the segments of this fault, indicating probably about a magnitude 6 to 6 1/2, with a small amount of displacement. And it was concluded that there was a very low probability that active faults under the USBR criteria traversed the dam foundation, and that the maximum net slip during a single fault slip event was estimated by the Woodward-Clyde team to be about nine inches.

The U.S. Geological Survey, another reviewer participant in this, estimated the net slip to be 3.3 feet, about a meter.

An estimate by one of the USBR consultants was less than two inches, and the USBR's estimate was zero.

Now, you can see some entrenched warfare starting up here, and it was interesting--and I won't name the consultant. I can say it wasn't Clarence. It was demonstrated by the designers and others that two inches was about the amount of fault displacement that they felt the dam could take without causing any serious safety problem.

Well, the California Division of Dam Safety got their consulting board together. I'm jumping a little bit ahead of me here. Here are some of the detailed fault patterns in the dam foundation itself. It's the excavation over on the right abutment. There are very old deposits down here, Cenozoic deposits, Mesozoic. And then up near the top and over here on the top were much younger, but still Tertiary deposits. So there was intense examination of these features, trying to look at the characteristics of these fault zones, compare them with the characteristics that we had found in other parts of the Foothills fault system, and see if there were similarities and dissimilarities.

Then tracing those same features very close, this was just off of the abutment of the dam, and you can see the younger, still millions of year old latite deposits were displaced.

And another view of Clarence Allen here and one of the other consulting Board members to the Bureau, very carefully examining--see, Clarence has a pencil or a knife in his hand, very carefully examining that fault.

And, of course, we found many other faults like this, and it wasn't known before this that this relatively young deposit had been displaced.

This was very close to the dam. In fact, the site being here, all of these dots--that may not be too visible.

This is the latite flow down near Sonora. A site in here, some sites all up in here and throughout here had characteristics that all are very similar to this site here, as well as the site down at New Melones.

And this is the footprint of the dam, and the fault that I was just showing is this fault over here called the Midu Fault. And there were no younger deposits. The Bureau of Reclamation became literally entrenched in that they brought in huge dosers and started excavating throughout the entire area, and unfortunately, destroyed all of the evidence that could have been useful in assessing the younger paleo soil deposits because they were trying to find conclusive evidence that the faults were not active.

Well, it was concluded that due to the association in the physical and geometrical characteristics, that these fault zones that traversed the foundation of the dam in these locations did have a very low likelihood, but a significant likelihood of a few inches of displacement in the single event.

This is the consulting board from the State of California. This is Bruce Bolt, I think Harry Seed, and I believe George Hausner and others. Clarence was a member of this board, but because he was a consultant to the Bureau, wasn't able to participate.

But the Division of Dam Safety judged that a thin-

arch dam could not accommodate more than two inches of fault displacement without failure. The dam site--or the dam was then terminated, the project was.

Now, the Bureau of Reclamation did not have the flexibility or the foresight to change their dam design, and it took them several years to come around to realizing that that was the only way to build a dam, and they are still working on trying to come up with a design that would be acceptable, but the costs are now so high that it's probably not feasible.

So there's an important issue here of cooperation with the Feds and the State, and there was another element that was very important, in that in 1975, the State of California created the California Seismic Safety Commission. This was the first item of focus for the Seismic Safety Commission. It had a lot of clout, being backed by the legislature and the governor, and they were responsible for giving the State of California and the Division of Dam Safety a great deal of say in whether or not this dam was to be built, as well as the New Melones Dam.

So the dam, if you're to go out there today and fly over it, would look like this. It's a little more grass and trees on it, but essentially, it's an abandoned site where hundreds of millions of dollars was spent and a needed dam was not constructed.

This is a view of the New Melones Site along the Stanislaus River just at the beginning of the construction. This is the old dam. This is being built downstream. So this is a massive earth and rock-filled dam, about the same size, 625 feet high, 2,650 thick at its base, and 40 feet thick at its crest, and it also sits on part of the fault zone.

Now, a couple of photographs of a fault that was discovered. We name this the Powerhouse Fault because it did strike right through the powerhouse that was under construction, and we found it was an indeterminate fault in terms of being able to classify it, and it didn't have all of the characteristics that we found in the Auburn case. So we weren't sure about that one.

Here's another view of the dam as it's under construction, and the consulting board, field trips and so forth, and then the dam as it's about three-quarters built--well, maybe not even three-quarters, about a half. The crest of the dam is now up here.

Now, the New Melones Dam, the closest active fault, according to their criteria, which was slightly different, but practically the same, was 2.6 miles away and had the potential for about .8 feet of surface rupture along what we judged was a 10-mile segment. We felt that would be associated with a 6 1/2 magnitude earthquake, and the

recurrence of that kind of event on that segment would be about 10 to 30,000 years; so a very unlikely event.

The New Melones Dam was judged by the California Division of Dam Safety to be safe under those seismic conditions, and the dam was completed as designed.

Now, there's a dramatic difference between these two facilities, and I would say the big difference was the attitude of the designers and the chosen type of dam. Now, it was argued by many in the state of California that this was a site more suited to an arch dam rather than the other, and that they should have gotten their sites traded. But nevertheless, this project was completed, a very important needed dam, and there was controversy over it, but nowhere near the controversy of the Auburn Dam.

Let me turn now to two sites on the coast of California, LNG and Diablo Canyon. LNG Site, due to the Arab oil embargo in the early '70s, California passed in 1977 a Liquefied Natural Gas Terminal Act. This required California to recommend to the Public Utilities Commission where there should be an LNG receiving terminal, multiple sites, it was thought to be necessary along the coast, and this terminal was to receive LNG from Indonesia and Alaska. The purpose of the project was to augment the gas supply in California, which was very short. Here's the sources of gas that were to come into this facility.

And the LNG site selection process considered 50 sites, a very preliminary evaluation, and the Point Conception Site was selected after using these criteria, and safety included seismic safety.

The Point Conception, Little Cojo Base Site was selected based on these specific criteria, and they wanted to make sure that this facility would be receiving natural gas, liquefied natural gas by 1983. So the site was chosen at this location.

This is an artist of this conception of this project as it was conceived, and some construction efforts started in looking to meet the criteria when an active fault was discovered by a geologist hired by landowner opponents to the facility. You can see here these young alluvial deposits displaced. You can see minor displacements, and this started entrenched warfare that lasted for several years.

After years of this entrenched warfare, seismic issues were the ones that were causing all of the problems, and after some period of time, the CPUC Commissioners came to this conclusion: Who should we believe? There were experts on both sides. There were enraged hearings based on the legal adversarial, confrontational style of conducting those to discredit the witnesses and so forth.

And so they convened a panel of independent experts to assist the Commission in judging the adequacy of the

seismic safety of this facility.

And this is the list of the panel of experts. Clarence Allen, again, shows up. Most of you probably know many of these individuals, and there was a long screening process to make this selection. All sides had to agree, and this group had to agree to be cross-examined at the end as a panel. That was an important conclusion.

Now, also, the CPUC and the FERC Commissioners all agreed that this would be a useful thing to do. And the purpose of the panel was to obtain an unbiased, independent advice whether or not this terminal could be designed and constructed in a manner to be consistent with public safety using the LNG criteria.

Here's a view of some of the trenches, another view of those saying this is literally entrenched warfare, and I don't have the time to go through all of the details here, but it's the same as a lot of other facilities that many of you have been involved in.

But the LNG Seismic Review Panel, because of the workshops that we convened, without the involvement of attorneys--I'll talk about that later--we were actually able and given the authority to exclude the attorneys from any participation whatsoever. They can sit in the room.

After several workshops, we found that this process allowed us to focus on the critical few scientific and

engineering issues that really had a direct bearing on the seismic safety of the proposed facility. Therefore, the stymied process resulted in a satisfactory solution after this innovative technique of impaneling this group in the decision-making process.

So the warfare had lasted so long, however. This is the last photograph here. Here's the three members of the panel. There's Clarence again, Roy Johnston and Paul Jennings. We concluded that this facility could be built at this site, and it was not a threat to the public safety.

But the warfare had lasted so long that the economic climate had changed about gas. Canadian gas had been discovered, and other gas was available, and the economics were such that even though the facility was cleared by both the CPUC and the FERC, the facility was never built.

The last case history I'm going to talk about is Diablo Canyon, but before I get into Diablo Canyon, let me just say, and I have to preface this to say that I've been an employee of PG & E for nine years, almost to the month. So I was not involved in a lot of the early PG & E studies in the late '50s, up into the '60s, where they attempted the famous Vadaga (phonetic) Head Site and at this angle, I can't tell right where it is, but it's somewhere up in here, where a nuclear plant was proposed to be very close to the San Andreas Fault. Of course, that was rejected. This was

before there was any criteria at the Point Arena Site farther to the north, then the Half Moon Base Site and several other sites along the California coast, that one after another, because of the way they were studied or the evolving regulatory procedures were rejected.

They finally got agreement from a number of participants, including a lot of intervenors, that the California coast down near Diablo Canyon in this wave cut terrace would be an ideal location to build the Diablo Canyon nuclear power facility.

So the Diablo Canyon project was sited at this location, that dot right there. Now, all of the faults that are shown on here--this is a recent, a new I should say, geologic map. It was not known when PG & E started the design and started construction that this big fault system off coast existed, the Hosgri Fault. And I'm sure you all know the story behind that.

And so it was a number of faults, the San Andreas, the Hosgri and the continuation of the zone of faults along the coastline that became a lot of issues that got involved in entrenched warfare for more than a decade, and the expenditure of $5.8 billion.

Another element in this in 1971 was the occurrence of the San Fernando earthquake of 1971, where at Pacoima Dam, recording a strong motion recording site located on this

ridge top recorded the highest acceleration that had ever been recorded at that time, in excess of 1.2g acceleration.

Many engineers and designers had concluded that the maximum acceleration for engineering, free-field acceleration, would probably not exceed 50 per cent g.

Well, this recording of this event and the ensuing debate about it stopped every major project, at least in California and elsewhere. The Trans-Alaska Pipeline was shut. The progress on that design and construction was stopped. Diablo Canyon was thrown into a tizzy, and a number of other projects, because of this recording site.

It was argued by a number of individuals, Nate Newmark and John Blume and others and PG & E, that this free-field motion was anomalous because of the steep rock ridge and that Nate came up with what he called the Tau factor, in that this dam would have been subjected to a much lower value, and that this was amplified due to being on the sharp ridge.

Well, eventually for Diablo Canyon, the value was negotiated down to .75g. That was the design prefield PGA used in creating a design spectrum, and a number of other projects also adopted that lower value.

I want to briefly go through the approval of the operating license. The operating license was approved for Diablo Canyon in 1984, November of 1984, with a condition on

it, and it reflected back a letter from the ACRS that approved the design of the facility in 1978, that there should be a re-look at all of the seismic issues because of the lack of data in about 10 years. And so when PG & E finally approached for final full-operating license, the NRC granted them an operating license with the condition that this comprehensive study would be done. This was called the long-term seismic program, and this is when I joined PG & E to manage this project for them.

The license condition had four elements. I won't spend a lot of time on these. There was to review all of the existing geologic and seismic and geophysics data and gather new information if it was required to assess the tectonic environment and the earthquake potential of the region. With that information, then to estimate the maximum earthquake magnitude that should be considered for the re-evaluation of the design. Given that information, then evaluate the ground motions from all relevant data that was available. There was a very lack of close-in earthquakes in 1978. And then taking all of this collective information to make a seismic margin evaluation of the safety of the facility, both deterministic and probabilistic.

Now, there are a lot of people in this room that had some involvement in some part of this process. So I'm going to go very quickly.

The long-term seismic program had three phases. I added these phases once I came on board because in Phase 1, I came on board just after Phase 1 had been submitted to the NRC staff for approval, and my conclusion to PG & E was that the Phase 1 report had been written by a whole stable of consultants, the ones that had been working on Diablo Canyon for more than a decade or so. And while it was a very comprehensive scope of work, it had everyone's wish list that they could ever imagine of things they wanted to do.

Having been in the consulting environment, it didn't take too long to recognize some things that may not be as important as others.

So I created this scoping study that allowed us to stop everything until we were clear and the NRC staff was clear and we were in agreement on the scope of work, and by doing some preliminary assumptions and an analysis, to focus on the issues that really would make a difference.

So these are some milestones that we went through; the letter, the license condition. The plan approved in 1985 in July, and the scoping study, of course, was continued until early in 1986.

Now, let me mention again that we chose--PG & E chose to convene a consulting board. Again, you notice names that you are all very familiar with. Clarence shows up on all of these. And this was convened to report to the highest

levels of management in PG & E, and they were directly involved not only as a consulting board collectively, but as individual technical advisors in all aspects of the program.

Now, this was done in full concurrence with the NRC staff, and the scoping study, as I was talking about later, made some assumptions because all of this work had to be done in series because we had to come to a decision within three years. And so we had a very hard deadline to meet, and so we focused on the scope. It was a balanced program. It was well-integrated, and we set this priorities. And this took some time because we needed a consensus among all the players on this project. These were all, of course, public hearings and meetings.

And we used a simple logic tree approach to start out with, and that expanded into a detailed event tree for our probabilistic assessment. But this is an example of some of the things we did in terms of looking at different parameters and to keep track of them and to help us think about them and their relative importance.

This is a simple diagram of how one can adopt different points, decision points in the logic tree with different options, and this allows you to think about how important are some things and how they are as they feed into the next decision point. It's a very effective tool in looking at the whole range of options that one might consider

and helping choose what studies are necessary to resolve the uncertainties if it was really an important factor.

Phase 3 was the implementation in that our consulting board was very much involved. The NRC staff was very much involved. They reviewed--they had independent studies made of all aspects of this long-term seismic program, and during the period of the study up until the report was finished, there was 65 workshops or meetings or hearings during this period.

And, of course, this is more complex. This is the logic tree where we looked at the sense of slip, whether it be strike slip or oblique slip or thrust, and then we could look and follow out to see what the end result would be and to make assessments of the likelihood of each one of these. And we kept this in front of us all the time in terms of gathering data to see what difference the data would make, and then this fed into the event trees that was the full event trees through the probabilistic assessment.

Again, we had a lot of field trips with a lot of people, including the intervenors. Many of the meetings intervenors attended; in fact, most of them, field trips included.

And this is just one example of the wealth of data that was available after 1978 when the ACRS wrote their letter and in 1990 when we were doing the ground motion. The

critical area that we were concerned with is the area right in here, close in. You can see there were only a couple of events, but by the time 1990 came around, we had a lot of data of magnitude, 6 1/2 or greater in the near field, as well as a lot of far field data. This database was very useful.

This is a conceptual slide that shows all of the involvement of all of the parties; the program, PG & E staff and our consultants, our consulting board, our technical advisors, the Nuclear Regulatory Commission staff and their consultants, and then their independent studies that were done totally parallel to, but independent of PG & E.

So this is just to show you the process from 1984 through when the final report--each one of these lines was an important meeting or workshop or field trip. And then after the report was delivered here, then this was the review process, again with important meetings or field trips, and the ACRS was updated or briefed yearly.

So the plant was finally cleared, and it was concluded that the license condition had been met, and I'd like to quote from a couple of statements in the safety evaluation report that the NRC released in 1991. And back a decade or so ago, or even a few years ago prior to the start of this study, the U.S. Geological Survey was considered one of the enemies of PG & E by many. Not all of the individuals

in the U.S. Geological Survey, but I'd like to quote from the USGS, who is an official reviewer, and many of their scientists were directly involved.

They stated that "This brief summary," their brief summary, "of the long-terms seismic program only hints at the large amount of data acquired and the number of new discoveries. The long-term seismic program was planned and implemented to address a set of predefined geologic issues, but considerable flexibility was demonstrated in responding to new and unexpected findings. The broad range of earth science methods used, the areal extent of the study, and the depth to which critical issues were probed, marks this as an unusually comprehensive site study of earthquake hazards. Much of the credit for this effort belongs to the able and highly professional team assembled by PG & E management."

Quite a shift in attitude in terms of working together on trying to resolve issues.

The NRC concluded that the license condition had been met, and they summarized their approval as follows: "The NRC staff finds that the geological, seismological, and geophysical investigations and analyses conducted by PG & E and its consultants for the LTSP are the most extensive, thorough, and complete ever conducted for a nuclear facility in the United States, and have advanced the state of knowledge in these disciplines significantly. The PG & E

soil/structure interaction analyses were comprehensive, thorough and acceptable. The LTSP has served as a useful check on the adequacy of the seismic margins and has confirmed that the margins are acceptable."

Now, where do we go from here? These projects were all plagued by inept handling of seismic issues by everyone; the applicant, the regulators and all of their consultants. The conflicting agenda of scientists and engineers provided an opportunity of social reformers to get involved and to compound the programs. To avoid entrenched warfare, the process of managing the siting, design and construction of critical facilities must plan for the egos and emotions out of control, surprise earthquakes and the discovery of new faults and other important data, vested interests and jealous competition, technical issues that are emphasized without considering social issues, arrogance of experts and management and regulators, adversarial environment imposed by a legal precedent, attempts to stonewall the entire process, addition of extra conservatism in every step of the process, hidden agenda, ignoring the facts and focusing on the desired outcome and the provincial attitude that does not allow independent review and oversight.

The entrenched warfare is extremely time consuming and expensive. Billions have been spent in defending positions that may not have been--have any direct influence

on the solution. The atmosphere of controversy provides the opportunity for entrepreneurial enhancement of the controversy.

Lawyers, consultants and regulators have all been known to--excuse me, this is the cow that's being pulled in every direction--and that lawyers and consultants and everybody have all been known to "milk" the situation.

To avoid entrenched warfare, projects need to be based on win/win attitude, mutual respect and trust based on competence and integrity, an open seeking of the facts, multi-disciplinary team effort involving the very best talent, approximate identification--appropriate identification of the problems and issues that truly make a difference, appropriate scopes of work using simple logic tree approaches to assist in identifying the tasks and setting priorities to address the issues, team work based on objectivity, anticipation of regulatory evolution, a plan to manage social conflicts, as well as political bombshells, flexibility and a vision of the range of options, workshops, field trips, briefings and publications to keep all interested parties informed, and independent panels of experts to assist in the critical decision-making.

Managing of critical safety projects with an open, positive and cooperative attitude results in a project in which safety is properly addressed, regulatory approval is

achieved, the owner's investment is secure, social issues are adequately addressed, and the appropriate facilities get built.

Thank you.

DR. ALLEN: Thank you, Lloyd.

I think we simply must move on here because we're getting a little bit behind in time, but let me just ask, Leon Reiter, you saw this whole Diablo Canyon thing from a somewhat different perspective from that of the regulator. Do you have any comments on this at all?

DR. REITER: Not really. Maybe later on.

DR. ALLEN: No, please, think about it. Again, we can talk about this in the question and answer session.

The next speaker on this afternoon's program is Jim Devine, who is Assistant Director for Engineering Geology of the United States Geological Survey, a position he's been in for some time. He's had a direct review role or a coordinating role in more than 100 nuclear power plant applications that the U.S. Geological Survey was asked to review mainly on behalf of the Nuclear Regulatory Commission.

So, Jim, your perspective?

MR. DEVINE: Thank you, Clarence. Thank you again.

Lloyd Cluff is a hard act to follow. Not only did he steal the two best projects to discuss, he then had the nerve to present them in a far fuller, richer and more

articulate manner than I could have done. So I'm left to sweep up behind him.

I'm going to speak from a different perspective than virtually anyone who has up to now today. Even though the subjects are very similar, the points are going to be much the same. But I come from a somewhat different perspective in that I'm with a research organization who frequently finds itself either voluntarily or dragged into a controversy usually after it's well underway and major decisions have already been made. So we see things from a somewhat different perspective.

Secondly, we are here for the long haul. We don't see things in terms of finishing one project and it's over. Our research is a continuing program, and so we try to have a long-term prospective when we get involved. And that somewhat changes the view, I think. At least from our perspective, we think it changes the view.

USGS has had a long history of involvement with major science applications, certainly as far back as during the second World War when many of our geologists participated directly with the military departments in classifying their mapping and defining various harbors and beaches and lands in the Pacific Southwest to support the war effort. We had a major activity throughout that time and had a very large branch called Military Geology which went on for many years

to provide that background.

So we come from a long tradition of being involved with direct issues, not just need our retired research in Menloe Park in Denver.

In the 1960s, I don't know whether it was voluntary or mutually coax and voluntary, we began to get more involved with the Atomic Energy Commission in providing them geologic advice on proposed nuclear power sites. Since Lloyd described that process very fully from his perspective, I have chosen not to discuss them, at least not in the same way that he has. I will mention one later, as I think it applies very directly--lessons learned from that one applies so directly to what this Board is dealing with that I am going to trod some of the same trenches that Lloyd described, but on a different site.

The first site I'd like to describe is the Teton Dam that, as all of you know, failed shortly after it was built. That's the first one, of the dam site. It's an aerial view of the dam site in Idaho. And as in any of these projects, there are so many factors that get involved in the whole picture that there's no way one person, certainly not me, could describe all the factors that went into various aspects. But there's one sliver of this activity that I wish to discuss here because I think it has carry-on applicability.

And as you know, this is a Bureau of Rec dam, a large earth-filled dam, that was started back in about the early '70s. And in about 1972, some of our field geologists, some of USGS geologists doing reconnaissance mapping in the area, noticed things in the right abutment of this dam that they thought did not match with what they had been hearing being described by the Bureau of Reclamation.

As you can see, the dam eventually failed along this right abutment. But prior to the construction of the dam, our reconnaissance work indicated that there really were some weak, friable and--weak and friable rocks showing along that exposure, that it looked to us as if it would require a considerable amount of work to make them work satisfactory to support this dam under earthquake loading.

Now, our geologists put together a report. We presented it to the Bureau of Rec, and they accepted what we gave them in the manner, similar to what Lloyd described earlier, in that they put it on the shelf and ignored it.

In our judgment, a failure on their part and in the judgment of Congress, and the post-failure review castigated the Bureau very severely for not having heeded the words of our report. So we looked good to that degree.

But in reviewing what happened at that time, there are a couple of other points I would like to bring out. One is, we didn't quite have it right. We tied our failure mode

to earthquake excitation, not just static load, and the dam actually failed under static load, as I'm sure most of you know.

Secondly, there developed in-house and inter-agency a controversy that I think is worth describing briefly here, and that is our field geologists got very emotional about what they had seen. That's been described earlier by several speakers. This happens to people in the field and on the front line. And they wrote a very hot report describing a dire of things that we're going to be seeing there. And when they submitted it to our standard review process that USGS has, the peer reviewers and the managerial reviewers cut out a lot of that emotion, and there was a sincere effort to leave the science in and take the emotion out.

Well, after the failure, our field geologists claimed that having removed that emotion also removed a sense of urgency of what they were saying. Therefore, they weren't all that surprised that the Bureau felt that they could take this, what appeared to them then to be a mundane report and ignore it.

In retrospect, the words were still there, but the sense of urgency had been muted. So in the process of peer review, which all of us support and support strongly, one can look back at this case and say, well, maybe we should have left a little of that emotion in there because the Bureau

felt fully capable of ignoring the suggestions.

May I have the other slide, please? I've put in a blank view so you can get a little bit of picture of what the site looked like, sideways.

I won't go into the detailed geology for two reasons: One, there's no time, and two, I don't know it that well. So I'm going to let you take a look at it yourself. You can see on the surface it's a very logical engineering site for a dam. Everything was in place except, again, for this poor material along on this abutment that they didn't recognize would be a source of major piping.

Now, the eventual failure was a combination of both piping at the boundary between the abutment and the dam itself and through parts of the dam also. So there were many causes here for this whole thing to happen. There were also many causes for why this whole picture would not have been identified sooner prior to its filling. Communication between and within the Bureau of Rec, communications between all the reviewers and officials was not as formalized as it is now is after they've learned these lessons.

Other factors, the dam due to an engineering miscalculation was allowed to be filled more rapidly than planned due to a scheduling change on removing of the Cauffer Dam.

Other aspects fit into this, but the one part that

I know about most and wanted to describe to you was this controversy of how difficult or how strenuous should an outsider--in this case we were an intervenor, we had no direct involvement in this site--based on reconnaissance geology go forward challenging the detailed site work that had been done by the ground experts, the dam experts. We were not in any way skilled at dam construction. We were looking at reconnaissance geology.

So we can justify having been relatively mild in our presentation of our facts and say that it was up to them to recognize how strongly, how much significance that data should have had.

On the other hand, as Lloyd mentioned earlier about Auburn, that succeeded Teton Dam, and while the Bureau didn't seem to have learned a lot, many others did, and we were very, very vocal in the Auburn Dam when our geologists agreed with much of what was being described by Lloyd, and even more so, in many instances they felt even stronger. We pursued that with great vigor and did not walk away as we did at the Teton.

So I think there is a lesson here on how does one deal with outside intervenors who really don't have access to the same amount of data as the people who are doing the work have.

Having spent years on this side of watching the

intervenors struggle to gather the information, this is an example of where we were the outsider trying to deal with the reconnaissance data versus huge amounts of site specific data.

Well, enough on Teton. Let me move on. If I could have the next slide, the next overhead?

I'd like to speak briefly about one component of the Trans-Alaska Pipeline system. Again, Lloyd mentioned the fact that it came to a halt in terms of seismic matters in the midst of its construction after some more earthquakes in California.

I'd like to speak to just one aspect of it, not dealing with seismology, and that is after the oil was discovered at Prudhoe and they decided they needed an overland access to an ice-free port for the delivery of the petroleum, there developed by all the companies that had spent years building pipelines through Texas and the Midwest and all through the Middle East--of course, were brought on board. That was the experienced community to design and build the 800-mile pipeline from Prudhoe Bay to Valdez. And they designed it in the manner in which they were skilled in doing so, which would have looked largely like the upper left-hand picture for you folks, this one. That was the original design.

Some questions began to be raised, and the when and

how is more detailed, and I'm going to take time to go through, because the whole manner of which this pipeline was regulated and inspected and so forth is a case in itself that I'd leave to the lawyers. I'm going to speak only to one technical aspect.

Some of our permafrost experts began to speak out both in papers and publicly that burying a pipeline carrying hot petroleum would indeed melt the nearby permafrost and cause differential settlement, which would lead, of course, to cracking, breaking of the pipes wherever that differential settlement occurred.

There ensued a very, very vocal disagreement between our folks and the designers of this pipeline because of the consequences of having to design an elevated pipeline everywhere where there was permafrost.

Well, eventually the elevated arguers won out, and, in fact, much of the pipeline today is built either in this manner or this manner, so that now 47 per cent of the pipeline is actually elevated, and the rest of it is buried.

And the cost implications of that were tremendous. It more than doubled the cost of the pipeline, and that's now 20 years ago, and I believe it exceeded nine billion dollars. So it's a very large price to be paid for avoiding breaks in the line.

In addition to elevating the pipeline, in order to

keep the footings from melting permafrost, they are, indeed, a cooling system that carries the heat out to dissipators so that there is no differential settlement.

And I'm happy to report that after about--let's see, the first oil went through in June of '77, it's 17 years now roughly, there have been no significant leakage in any of the elevated portions of the pipeline.

So I think certainly the results so far say that that was worthwhile.

On the other side of the scale, there was one mountain pass where the burying types went out, and in an area where we recommended elevation, they actually buried it, and that pipeline has now been replaced three times due to cracking and leaks in that pipe. So I think the other side of the scale gets mentioned, too.

There was a case where research done in permafrost, which at the time was being done had no direct engineering application, proved to be a major contributor to the safety of that pipeline.

I would only argue that--I would only point out that this case did not come easy for us. A spokesman for that group--there were five of our geologists formed for the team to present these arguments--were even subjected to clandestine psychologic observations by the other side, and we discovered, and actually reports written on how each of

these scientists when challenged and addressed, how they should go about which one should be treated in a hostile manner, which one should be lulled into complacency and so on.

That was kind of a shock. We were kind of naive in those days. We thought we could present facts and they'd fly alone. But we learned a lot about how one presents your arguments, not just the fact that you have them. That was mentioned this morning, too, the manner in which the experts were treated, and how their credibility survived through cross-examination becomes a major component. That was our first significant experience at that.

If you'll go to the--turn the light off for a moment.

I would like to describe briefly one proposed nuclear power site that was not built that is a slightly different story than Lloyd's, but I think really worth discussing, and that's the proposed Skagit Site in Washington.

Skagit was to be--was a site, or is a site, about 100 miles or so north of Seattle in the Cascades, and the issues that developed on that site I think tell us a great lesson that we need to remember today, and that is the original--it was the basic question of thinking you knew all you needed to know before you went out and looked, and the

more you looked, the more you learned, the less you knew.

And as arguments developed over Skagit, two sides became deeply entrenched and bitterly split on what the evidence made, and that is it had to do with the earthquake potential. And in the end, what really came out was the fact that there just was not enough consensus of opinion on the potential for earthquakes in the Pacific Northwest to be able to demonstrate the level of confidence that one needs to site a nuclear power plant. That was the simple end product after a long bitter harangue.

A second aspect about it that I regret even today, having been deeply involved with it, and that is in the effort to develop and describe and bring about experts, one side would grab one expert, one grab another, and the University of Washington was the seat of much of the local geologic expertise. And the two sides, both the proposed applicant and the regulators, took that geologic department of that university and split it assunder, just literally split that department apart.

And talk about--I just don't--even today, it bothers me to think about the manner in which in an effort to get that site resolved, we took a university department and just ripped its heart out.

And so this is something I would point out that we need to avoid in our effort to get to the right answer. It

was all well-meaning, all right for the right causes, but boy, the end result was, I thought, very, very destructive. And the Pacific Northwest geology and seismology is still revolving today, and I'm glad we're not going to go back to Skagit on that one. A very bitter experience for anyone who's been involved with it.

I would like to give a brief description of a different kind of a radiological problem. This has to do with a site in northwest Alaska, near Cape Thompson. About a year ago, a very seemingly benign situation to those who knew about it burst on to the scene with smoke and commotion far beyond that which it deserved. This resulted from the disclosure by a University of Alaska professor, that he had discovered documents that indicated that the Atomic Energy Commission had placed nuclear material in an environment near Cape Thompson, Alaska, with no licenses, no permits and no nothing.

This Cape Thompson Site was a site for those gray hairs, remember, under the Plowshare Program that was to be-- Project Chariot it was called. It was to be a harbor constructed by the use of five nuclear explosives to develop a very large all-weather port, hopefully to bring the oil that was going to be discovered from NPRA, none of which was. But this was to be one of the Plowshare uses of nuclear energy to build this site.

Well, in 1962, the USGS was heavily involved in the mapping of that area, proposed to AEC that they should have some idea of what would happen to the radioactive material as these shots were put off so that they would have some understanding of how the environment would deal with that radioactive material.

The AEC agreed and authorized us to run a tracer test using minute amounts of radioactive material to put on the site, discover how it would run off, how it would be absorbed in the tundra--little was known at that time about tundra radioisotopes--and write a report about it.

Well, for three days we put a grand total of 26 millicuries of material from the Nevada test site, the Project Sedan. We gathered up some material from Sedan, flew to Alaska, put it on the ground, ran some hoses and water over to simulate rain, measured the runoff, completed our studies in three days, moved the stuff into one spot, all 26 millicuries of material, and buried it in the tundra in a plot of about 10 foot wide, 40 foot long of all the tundra that had touched this radioactive material. Wrote our final report and went home.

The site was eventually canceled, and for 30 years no one thought any more of it. Yet, last year when a university professor discovered documents that discusses this use of radioactive material, he sites it--do I have one more

slide there? Sorry, I've lost it. It's just a headline that says, "Radioactive material discovered in northwest Alaska." And there were dozens and dozens of headlines like it. And "Radioactive dump found."

And before any facts were out on this factor, two or three of the Federal, Local--State and Federal politicians from the area quickly flew to the site, stood at the dump site and said, "We will remove this hazardous material away from you natives." And the nearest native community is at Cape Thompson, which is about 20 miles away from this site, that's buried in permafrost, so there's no migration through the hydrology because it's all in permafrost. It's buried four feet below the surface, so there's no way to get to it. There are no roads. There is no access to it. So even caribou hunters are very unlikely to come to that spot.

But they announced publicly that that material would be removed.

We protested as best we could, saying there was--by now, since most of the material was short-lived stuff, there was by our best calculations two millicuries of radioactive material left in that burial site.

That did not phase the system one bit. Colleagues at the Department of Defense under pressure from Congress, announced that even though it was not a technical problem, the material would be removed.

So this past summer, a team was mobilized by DOE. They moved into the site, removed all that soil, put it into barrels, and it's now sitting at Hanford, Washington.

Now, from a technical standpoint, the level of absurdity is just hard to exaggerate. Just we rang our hands as to why people wouldn't listen to what the scientists were saying.

And so there was, in our judgment, an unnecessary action taken to satisfy a Congressional need and to make the natives feel as if, indeed, we were concerned about their health, and, therefore, we removed it. That's on the surface.

But underneath that, in my judgment, and this is my own personal judgement, we've done a far greater disservice to those natives, and that is in the midst of doing this, we have convinced each and every one of them that that, indeed, is or was a hazardous site. And consequently, their high rate of cancer that the people in Cape Thompson, in fact, throughout the north slope, must, indeed, be associated with this burial site.

So now we have a whole community of well-meaning local people who are convinced that it's not their diet or their three packs a day cigarettes they smoke or any of the other factors; it's that burial site 20 miles away that's caused all their cancers and other illnesses.

So I think in the end, in an effort to show sensitivity to the natives by removing this site, which one could say was an admirable thing to show sensitivity to them, I think instead we have convinced them all the wrong reasons, all the wrong factors, and this will come to haunt us, I think, for many years to come.

The lesson in this, if there is one, is that I think anytime you say nuclear and scientist in the same sentence, the credibility in the outside world just drops two orders of magnitude, and I think part of that comes from all the years of us repeatedly saying back in the early days that nuclear energy was a panacea and it was actually risk-free, zero risk. I think our credibility in the radiation nuclear world has suffered from those early days of enthusiasm where we were going to have electricity so cheap that it would be-- they wouldn't bother metering it, it would be free, and it was absolutely risk-free.

Well, you know, we know that's not, of course, was the case. But I think what happens is when we tried to describe to people the radioactivity there, there was just nobody who cared. Nobody wanted to listen to the fact of two millicuries. At the same time they were hearing about millions of curies being put into the Arctic Ocean by the former Soviet Union. A curie is a curie of radioactivities-- radioactivity to most people.

So, consequently, we stand here now looking at a scar in the tundra that I think was totally unnecessary, but that's one of the lessons we need to learn.

I'd like to finish with a couple quick comments about some other sites.

Once in a while, you can have a success site. A couple years ago, the Bureau of Rec got themselves into a jam in Utah in the construction of the Jordan Nell Dam. After it was about three-quarters, or two-thirds of the way completed, they finally yielded to public concern that an adequate review had not been done about the geologic safety of that site and the availability awarded to fill it.

And so the Congressional delegation came to the Survey to do an independent review. And this is one instance I bring up only because this one is one that worked and worked well. With the team we put together that went out there, we were able to ascertain, I think, in a reasonably convincing fashion that what the Bureau had done and what their experts had provided to them was, indeed, an adequate demonstration of safety for that site, and we presented our case at a public hearing. And after that, the public accepted it, and the site was completed.

So once in a while, you can bring in outside intervenors, outside experts and have it reach the end that you had in mind.

I'll do a quick and final comment, and pick up the time that you need, Clarence, in that you forced me to say a few words about Ward Valley, and it will be only a few.

For those who don't know, it's a proposed low-level nuclear waste site in southeast California, licensed by the State of California under the provisions of the Low-Level Nuclear Waste Policy Act. The only hitch in that whole process is the fact that it's on BLM land, and, therefore, the land needs to be transferred from the Bureau to the State in order for the construction to proceed.

And we heard from Wendell this morning about WIPP. It's somewhat the same situation. The previous Secretary was quite ready to sign that, but prior to the completion of the licensing process in the state, there was a change in administration and a change of Secretary of Interior. The new Secretary comes in and announces that he needs to know a little more before he would agree to sign the transfer of factors.

He made an agreement with the governor of the State of California to hold some quick and easy hearings to satisfy those questions and get on with it. But after that, things began to unravel. Three of our geologists acting on their own voted to report raising issues that they felt were not adequately discussed in the licensing process. The Secretary, before understanding the provisions, agreed to

look at those, and so now we stand in a delay.

The Secretary has now gone to the Academy of Science, National Resource Council Board on Nuclear Waste, and asked them to please put together a team to review the seven aspects raised by our geologists in order to provide the Secretary with the basis he will need to go forward.

That's where it stands now. The Board on Nuclear Waste has agreed to provide their report to him by December 1 of this year.

Beyond that, I don't care to say any more on Ward Valley.

I'll stop there and let you get on with your next speaker.

DR. ALLEN: Thank you very much, Jim.

I think, indeed, we simply must proceed. The next talk in the afternoon's program is by Larry Chandler, who is Assistant General Counsel for hearings and enforcement in the Office of the General Counsel of the U.S. Nuclear Regulatory Commission. He's responsible for providing legal advice and counsel for all administrative litigation in connection with the licensing of nuclear reactors, and he's been involved in many of the--since 1972, in many of the cases that have come before the Nuclear Regulatory Commission.

So, Larry?

MR. CHANDLER: Thank you very much. I appreciate the

opportunity to be here. I'll tell you whether I'm happy to be here later.

My last speech was to a group of dignitaries from the former Soviet Union, from about seven different countries, and we had eight different interpreters. If there's a need for your benefit to have one, I'll ask Leon Reiter if he'd be kind enough to translate. He and I have done business in the past.

I'd like to give you a brief perspective of what our licensing process is, and then you can decide whether Lloyd's view is correct or not. After twenty some odd years of doing it myself, I often ask whether it is really the most effective and efficient way to elicit the kind of information that's necessary to make the kinds of decisions that have to be made.

It's a workable process. It may contribute to some additional time. It may contribute to some additional cost. But it's a process that's recognized throughout the government as a result of the Administrative Procedure Act which goes back to 1947. It's a process that's been used effectively to resolve conflict and reach decisions throughout the government and by the NRC and its predecessor for many years.

I think part of the thing we need to do, though, is keep in mind what the regulatory objective is in a way. And,

by the way, I don't have any prepared slides or statements, but if it will help, I'll use the pointer from time to time just to keep people's attention going, I guess.

The objective, and I'll point to the objective that's set out for the high level waste repository in Part 60 of the Commission's regulations, I'll paraphrase a bit. The applicant must establish by a preponderance of the evidence that there is "reasonable assurance that there will not be an unreasonable risk to the health and safety of the public, that the activities will not be inimical to the common defense and security, and that from an environmental standpoint, the action called for is the issuance of the construction authorization." And there's subsequent findings that need to be made before a facility actually goes into operation.

There's several phrases in there that I guess are very, very significant. One, of course, the burden is on the applicant. The Department of Energy will have to sustain the burden of satisfying everyone that the standards have been met.

Two, there has to be preponderance of the evidence, and I promise I'm going to try to avoid legal jargon, and preponderance I guess is one of those ponderous words. But more or less it means that it's more likely than not that it

is the way the proponent says it is. People try to come up with percentages. That may mean it's 50.1 per cent as opposed to 49.9, and that may be sufficient. But I don't think we need to dwell on that all that long.

Reasonable assurance is also a very loaded term. It's a term that doesn't have very clear definition. But one thing is very certain; it doesn't require absolute assurance. Zero release or zero likelihood is not the standard against which the Commission has measured the applications that are presented to it for review.

What I think underlies the success or the possibility of success before the Nuclear Regulatory Commission in the licensing process, whether it's a reactor licensee or a high level waste repository licensee, will be overall credibility. That's a term that's been used repeatedly today.

It's a word that has very many aspects to it. It goes to the overall process and it goes to the individuals as well who make the presentation of the overall application to the staff for its review, to boards for their review through the adjudicatory process.

The adjudicatory process is a trial type environment. I guess it's sort of like Perry Mason. We call witnesses, witnesses present testimony, that can be in

writing. Typically in licensing proceedings, it is presented in writing. And then individuals are subject to cross-examination. You can have documentary evidence offered and received, and it is upon that evidence that the board will make a decision.

And I understand what Bill Hall was talking about earlier today in referring to his experience. He's not authorized to look beyond the record and draw on his own experience to reach a decision. He's confined to looking at the record that's provided by each of the parties, or adduced by each of the parties in the proceeding.

For the high level waste facility, the basic ground rules are laid out, that is, the procedural ground rules for the hearing process are laid out in the Commission's rules of practice. That's 10 CFR, Part 2. Two particular sections of that are pertinent. First, there are the rules of general applicability in Subpart G. Those govern virtually all of our licensing proceedings.

And then there's special rules laid out for the high level waste repository in Subpart J. Those, in general, pertain to the licensing support system, the LSS, and hopefully are designed to facilitate the overall process to expedite the process and to prevent it from becoming bogged down in an absolute deluge of paper and information.

The many millions of pieces of paper and time that's potentially spent on this, I can assure you will make some of the experiences you heard of earlier today pale. We're talking many, many millions of documents, pages of documents, that will be involved in the potential for many, many hundreds of days of hearing if it all plays out in certain ways. Hopefully, it can work out more efficiently and effectively than that.

The staff review, as I'm sure most of you know, is conducted on the basis of both the submittal of an application, a written application, but I think as important as its review of paper, is the interchange of information through public meetings and other opportunities for back and forth between staff of the Commission as well as the staff of the applicant.

Critical again, and some words of great significance, and again they're going to go back to credibility, is the public accessibility to this whole process. Meetings between applicants and staff are public meetings. Information that's relied on by the staff as part of its review is public information. It's placed in local public document rooms, in the Commission's public document room, and for the high level waste facility, it's going to be placed in the LSS.

The adjudicatory process, as I said, is basically a trial type process. There are basically structured rules by which it is conducted. But at the same time, there's a great deal of flexibility. Key to the process is the right of each of the parties to present evidence, including testimony and cross-examine witnesses presented by the other parties to test the evidence.

Now, the NRC's evidentiary standard is a very liberal standard, I think. It basically provides that only relevant, material and reliable evidence which is not unduly repetitious will be admitted. Central to that statement, there again we come back to they use the word reliable, I'll substitute the word credible.

The basic rules, the Federal Rules of Evidence which govern court proceedings, are not strictly applicable to NRC proceedings, and the board have a great deal of latitude in the way in which they deal with what information is presented by the respective parties. They recognize, for example, that intervenors, when they participate, may not have the resources available to develop the sophistication that applicants possess or that perhaps the staff possesses. So very often, evidence is admitted with a recognition that the trier of fact, the board, will have to decide how much weight to give it. Another time we're going to get back to

the issue of credibility.

Both the documentary and the oral evidence, testimony that is presented, may be challenged, cross-examined. Largely again it's to test the credibility. First, a party has a right to test the credibility of a witness. That's done through a process known as voir dire. That's always a very nice term for the phrase by which people get grilled about their past. Where were you on Thursday night?

But basically it's an opportunity for the parties to understand what an individual, a sponsoring witness's background is, what's his education or her education and experience. Where were they previously employed? How much are they getting paid? Issues that seem rather extraneous perhaps, but really go to possible biases.

How many times have you testified in support of the licensing of a nuclear power plant? Well, I always testify in support. No one will pay me not to. Well, how credible are you? I'll have you know that Clarence Allen has testified on behalf of an intervenor. That's a true statement. He was subpoenaed to testify in the San Onofre II and III proceeding. I don't think his testimony was particularly helpful to the intervenors, but he testified on behalf of an intervenor.

Evidence is going to be tested through this process of cross-examination. They can be tested by attorneys and they can be tested by the use of expert interrogators. The Commission's rules of practice specifically authorize people to cross-examine witnesses, cross-examine experts presented by other parties on the grounds that that individual, that expert interrogator, is qualified by his or her own education or experience to undertake that cross-examination.

Now, it's not a free for all. That person just doesn't walk into the room and say, gee, I'm in the neighborhood and I'd like to cross-examine so and so. But an intervenor, for example, could have an expert assist in the cross-examination of another party's witness.

Let's make no bones about it. As tremendously brilliant as attorneys are, there are many subjects which are raised by people like you which we have some difficulty understanding, or maybe it's just that we don't have enough time to understand it. But whatever it is, there are times when we're tempted also to rely on experts to do the interrogation, and I assure you that during the hearing process, we have readily available to us plenty of experts to assist us in the cross-examination.

It really isn't a trial by ambush. The process is intended to work to elicit information to help the decision

maker make the decision that has to be made, not to avoid making the decision.

Now, if I can in the brief time that is available, let me try and give you a few instances which come to mind where scientific/technical issues really were at the forefront. I think, like Cluff mentioned Diablo Canyon, I think that was one of the most successful, in certain ways, albeit perhaps frustrating experiences, in dealing with technical issues.

The Hosgri fault discovered in 1973, I happened to have been the attorney on the case at the time and I remember getting a call about the discovery of that. And after I took my suit to the cleaners the next day and you start to deal with the issue, you see how complex and confounding something like that can be. Where is this fault? Who saw it? Where does it go? What evidence do you have of it? How sure are you that it's really there and what its implications are? All great issues, especially for a situation where this comes up years after the plant is initially--its construction is initially licensed.

Equally interesting in Diablo Canyon, and Lloyd did not speak to this, was a different kind of technical issue. It had to do with quality assurance. It had to do with the fact that in September of 1981, after Unit 1 was authorized

to operate at low power, an engineer discovers the so-called mirror image problem. Oops, the design layout seems to be backwards, or maybe the facility is backwards. What does that mean?

Well, the license was suspended and several years are now spent while people regroup and try to understand the implications. What does it say about the utility's quality assurance? What does it say when at San Onofre II and III, one of the vessels is in fact installed in an opposing direction from that which it was supposed to be installed, where Camanche Peak, the vessel pedestal for one of the units, is not quite the way it was supposed to be, when at Camanche Peak, after years of construction and assurances that it was ready to operate in 1984, the quality assurance records are found to be rather significantly wanting, and a multi-year effort is necessary to reconstruct the records and assure that in fact the facility was constructed in compliance with the Commission's requirements and the application.

But what's very interesting about some of these cases is the level of participation by the parties. I think if you look at Diablo Canyon and, for example, San Onofre Units II and III, expert witnesses were presented by all the parties, including the intervenors. If you look at Diablo

Canyon, a related issue on quality assurance was construction quality assurance, and the intervenor there presented an individual who was perhaps marginally qualified, expert in one field, but being offered to testify in an area beyond that individual's expertise, a difficult situation.

Another situation, Three Mile Island Unit 2, before the accident--actually, literally after the accident, the hearing started before, but was concluded after--had to do with aircraft crash probabilities and the location of Harrisburg International Airport about two miles from the site. The facilities had been designed to withstand the crash of an aircraft of up to 200,000 pounds, but it turns out that aircraft such as the C5-A from time to time would take off and land at Harrisburg International Airport. There were some nearby military facilities that they would support.

What are the implications for that? A couple of interesting issues are raised there. In that case, the intervenors did not offer a qualified expert. They chose, rather, to rely on cross-examination of other parties' witnesses, the staff and the licensee's witnesses to make their case. But technically what was very interesting was the way in which the applicant and the staff went about doing their analyses, a great deal of uncertainty. Trying to gather aircraft data was tremendously difficult. It's not

retained for long periods of time at Harrisburg International Airport.

The staff used air traffic controllers and the FAA and CAB records to determine what kind of aircraft used the facility. The licensee, the applicant, used similar sources and, of course, the licensee's number and the staff's number are at some variance.

Then mathematically, when the statisticians got involved in this whole process, we were confronted with an absolutely fantastic--I guess maybe some of you will consider it fantastic--debate between classical and Bayesian statisticians. I'm sure that's got some profound significance or religious aura to it to some of you, but frankly, I was happy to flip my penny and see how many--but this meant something. It was very significant in the whole process.

What I think you can find very interesting, and what I would commend to people's reading are a couple of decisions the Commission has written which really show how they balance conflicting scientific information, expert testimony. The Commission's decisions in Diablo Canyon on the seismic issues, A Lab 644, which is June, 1981, is really a very well developed, well thought out analysis of the scientific issues that were involved, starting from the

Hosgri fault and going through the TAO effect like Cluff alluded to. These are really well explained.

How is the intervenors' testimony balanced? How do you judge credibility? The individual's demeanor, very well presented. A Lab 692, another decision. That had to do with the Three Mile Island aircraft crash issues, very good examples I think of how the process gets worked through in the adjudication of a particular issue.

The need really for the decision maker, and you see it in these decisions, is to consider all of the evidence of record and reach a balanced, fair decision. How well did each party present the evidence? How confident were the individuals? That's demeanor. How did they look on the stand? How qualified were they? Do they have the requisite--strike the word requisite--did they have sufficient education and experience to sponsor that kind of evidence? Do they have that kind of skill? What kind of reputation do they enjoy in the professional community? How consistent is the methodology that they use with accepted community standards? Now, that refers to a standard some of you may have heard about, it's like the Frye standard, it's a court decision in which basically the court said to be accepted expert testimony, must comport with accepted community standards.

But how consistent with it is the methodology with the other views of other experts which are put forward in the proceeding? I think, for example, if you look at the San Onofre II and III proceeding, there were some very good examples over there. The intervenors sponsored two witnesses, one who presented what I think was described as a speculative analysis of the geology of the area, and another who tried to present evidence to demonstrate the location of some capable faults. But it was demeanor on the stand and it was expertise and involvement in this was so tangential as to really persuade the board that his testimony simply wasn't entitled to much weight. So weight is given to these things.

The bigger question I think in many ways is one that's alluded to by Lloyd earlier, and that is whether the process works. It's a different kind of process for testing scientific information. Leon Reiter used the terms when he and I were talking several weeks ago, what's the difference between science and regulatory science. And I'm not sure there's a real difference. There's a difference in the way it's presented. There's a difference in the way it may be analyzed, critiqued and received by the audience. It's different when you go through a peer review process than if you are on a stand and are asked probing questions about the way in which you present your testimony, about your

testimony, about your qualifications. But I'm not sure that overall you come up with a different end result.

I think in sum then, the process works well and can work well, but I think central to it, and in the context of the high level waste, as it is in any other situation in which we're dealing with controversial and complex issues, complex and controversial in a technical nature, a legal nature and policy nature, central will be the credibility of the presentation that is made, the oral presentation, the written presentation, the quality assurance, the ability to track the integrity of the process all the way through. And I think time will tell as we go through the review of the high level waste application just how well it's going to work and play out.

Thank you.

DR. ALLEN: Thank you very much. We have time for a couple of questions if the Board or staff have any.

If not, then let's get on with the next two talks. We're going to depart a little bit from the theme of today for the DOE to present some new materials. And, first, Lake Barrett and then Steve Brocoum will be speaking on the DOE Scenario A initiative and OCRWM's new approach to site characterization. Lake has been together with the Board on many occasions. Welcome once again.

MR. BARRETT: Thank you very much, Clarence. It's a pleasure to be here this afternoon. It's always nice to come out here in nice fresh mountain air out here in Reno.

What I would like to do is give you a little bit of background about where we are in restructuring the program and how that ties in with the Department's activities supporting President Clinton's change, Vice President Gore's restructuring the federal work force, Secretary O'Leary's strong views about TQM [total quality management] and strategic planning, and bring that on down to where we are in what we call the administration's proposal for collaboration and dialogue. That's also known as Scenario A.

What we basically did is we started off with a classical strategic planning, which I'll go through quickly, and brought that down to several scenarios. We discussed those internally and we decided that we had a situation and proposal that was now basically ripe for a constructive dialogue with all the constituents that are all very interested in this program. We're starting this process. We discussed this last Friday with the affected units of government in Nevada by television. We will be with the NRC staff next month, and I believe we have an NRC commission meeting I believe it's June 6th, or the date changes around all the time.

So let me kind of go through quickly what we did do. The simple version of strategic planning is you first decide where it is you want to go, and that's kind of what we have on here with out goals, and I'll go through that. Then a self-analysis, situation analysis of where we are, and then sort of our plans on how do we get to where we want to go. That becomes basically our proposal or scenario for discussion amongst everybody.

So we have a mission statement, we have a vision and we develop these goals, and I thought I'd take a moment and tell you a little bit about the eight goals that we have here.

Starting in the lower left-hand corner, one of our goals is to lead the Department and the nation on waste disposal policies. Clearly, this includes power reactor spent fuel, defense high level waste, taking care of the end of the cold war and the cleanup of DOE sites, and also looking at other what we call DOE cats and dogs spent fuel. This would be fuel from research reactors, non-proliferation returns, medical reactor fuels, also Naval reactor fuels, you know, spent plutonium and all of these issues are things that we feel that we need to bring a long-term view to it in those discussions.

The next area is the waste acceptance expectation.

We've had ten years of experience with the Nuclear Waste Policy Act. It was always planned that we were going to find an MRS site somehow and we would be able to meet the '98 date and a truck would back up to reactors and start taking fuel. I think as you all know the siting process has been a very difficult one. It appears now that it's unlikely that the negotiator will bring in a voluntary site such that we could make that date and time. It's still possible, but we say it's unlikely. And we've basically told the various stakeholders about that and have people's attention, and this is going to be a very national debate I believe in the halls of Congress starting this year and probably culminate very much next year on what to do with those contracts and the expectations with our customers, the utilities.

Also, the next one is to provide interim waste management compatible with disposal. Given the reality that fuel will be at reactors much longer than was originally envisioned, that we ought to look at that, face that reality and see what we can apply as far as any advance technologies into a flexible system that can accommodate a lot of the uncertainties that are there. We don't know when material will be leaving, we don't know where it will be going to, and a lot of those issues. So that's another main goal we have.

Moving on up, Yucca Mountain site suitability,

Steve will go into a lot more of that afterwards, but that is fairly straightforward as to what are the conditions in the mountain and is that truly a suitable site, yes or no.

Provide for timely waste disposal, we have it sort of independent of Yucca Mountain. If it turns out that Yucca Mountain is suitable, after we go through that part, then we need to have the NEPA process taken care of, the licensing, the design, construction and all those issues that go with that. If Yucca Mountain is not suitable, we then go back to Congress and talk about finding another site.

The only thing we know for sure is the fuel will not stay forever at reactors. It can't. Reactors were never sited that way for very long-term disposal for millennium type situations. So we need to find something because 30,000 tons of the fuel exists and more is being generated.

Strengthening the management and fiscal controls, we've taken a lot of justified criticism from many bodies, including this one. We need to do some internal improvements. We need to make the program economically viable. We've learned lessons from the super collider discussions that went on in the halls of Congress that this is not a work project for scientists, for engineers, for managers, for contractors. It can't be that and it is not. This is not just research science. This is applied science

to determine, you know, safe environmentally sound methods to dispose of material.

Help resolve nuclear material disposal issues. This again gets tied in that we're not in one little thing that you can isolate out, either Yucca Mountain or utility contracts. It's part of the overall waste scheme in this nation. You've got spent fuel, you've got high level waste, you've got TRU [transuranic] waste, you've got surplus plutonium, you've got low level waste. There are RCRA concerns that go with that. Transportation cuts across everything, so it's not just in isolation can you look at it.

And last but certainly not least, you know, enhancing the organizational and human resources aspects of things, get focused on what you're trying to do, get your people to be capable of doing it, empower them and then hold them accountable and responsible. And that's sort of the last leg, but probably one of the more important legs.

So these were the goals that we used to formulate the program.

Then we went and looked at what the current situation is. You all know that fairly well because you give us good advice on the situation. One of the key things we found in the first bullet was there was an inconsistency between the expectations that everybody expected of the

program and the funding reality. The whole program every year said next year, we'll get double the money, that the next year, we'll have double the money, and people planned and tried to operate the program that way. You heard about being schedule driven and all the others, and there's a complete fundamental mismatch, and that had to be rectified and that was the first thing we started to do. You cannot have an inconsistent program with what the available funds are. So either you bring or scale the program back to match the funds, or you increase the funds to something where you have the program.

So we had an iterative process on that and we basically started within the administration over a year ago with OMB, and this is a very difficult task, as you can imagine, in the federal bureaucracy and the budget, to basically come up with a proposal for what we felt the funding would be, and then we would plan a program to that funding level.

Congress will determine our funding over the next several months and we will then adjust the program to whatever funding level that they tell us.

The Congressional expectations, streamline the program, they want us to move out on this. You've urged many of these issues, the state has, others have, and we're trying

to take that all into account as we basically restructure the program.

Basically, the program, as we kind of look forward to it, we're trying to address two main areas. One is the waste acceptance and near term storage issues dealing with the contracts and utilities, the now at hand decisions that are being made at many of the sites concerning management of their spent fuel, and then also focusing on the site characterization at Yucca Mountain to determine the suitability, and if it's suitable, then proceed with the site recommendation. And Steve will go into more details on this in a moment.

Very quickly on this, but the new funding approach, if you want to go into budgetary and special accounts and the federal budget process, you know, we can do that at the round table, but again, the main issues are emphasizing on scientific suitability at Yucca Mountain and developing advanced technologies as part of the process for resolving the near-term reactor storage problems.

Again, just graphically, the '95 budget, there is a $150 million increase in that, and the bulk of the money all goes to the Yucca Mountain site characterization activities.

Now, I'd like to touch base again, the three main areas, first of all, on the Yucca Mountain as we go forward,

it's increase the funding in the scientific and engineering activities. We'll focus on the site, technical site suitability. We'll also run in parallel the necessary NEPA support activities, the licensing resolution process for many of the issues that need to be resolved with the Commission and take advantage of the pre-licensing interaction between the DOE and the NRC. We will expedite as quickly as we can underground, start the tunnel boring machine. We should be in full production with the tunnel boring machine around the clock this fall. We'll continue the surface based drilling. We will, you know, accelerate around the clock drilling there if Congress approves our proposal on the funding request. We'll continue to analyze the scientific processes and models so we can use the data that we'll be getting out of the tunnel and out of the drilling so we can determine, you know, suitability factors.

What we are expecting is that with the program, we have not assumed there are any changes to the statutes, there are no major--there are no regulatory changes, that we will be performing the scientific work that needs to be done so that we can make the proper determinations and submittals and showings before the independent regulatory bodies.

This is a summary of the proposal. Key dates on this one is that we'd make a technical suitability of the

mountain basically in the '98, '99 time frame. The technical work would be basically done in '98. When you put in the peer review process and all that, it may spill over into '99. We're still putting the details together on that.

The NEPA EIS work would need to proceed along. Then we would have the final EIS and recommendation leading to a license application around 2001 to the NRC. And if all goes as we think it may go, depending on what we find at the mountain and don't find any new faults and new things like that, receiving waste somewhere around the 2010 time frame.

If we had done it along the same lines as we had in the SCP with the same showings, given that we've missed many years at the lower funding levels, the schedule slips way out to the right, and that's if we received all the monies. We tried to bound this. We also have a contingency plan that Congress may not give us any additional money, as to what would happen if we had to basically scale the program back to meet basically constant funding.

Now, in the waste acceptance in the storage area, what we're going to do is, you know, work with the utilities on the '98 waste expectation. I wouldn't be surprised if we're not sued here in the next couple of months, just to add a little more confusion to it when you have the lawyers telling you what you can and can't say, is you try to work

some of these dialogues. But we are working in the advance technology area in the multi-purpose canister concept. We believe this has some advantages in economics for the nation. It wasn't so important years ago, if you really believed that a truck was going to back up in '98, but the reality of how difficult siting is, we're working more with the utilities, as a lot more fuel will be at storage at reactors than certainly had been envisioned back in 1982.

We will continue to support the negotiator and the MRS voluntary siting process. We wish him luck and hope he's successful, no matter when he could bring a site in. We also need to maintain a transportation capability. It's been referred to as the Achilles heel of the program. It's still there. Some day it's going to move and there are a great many complex difficult issues that we're all going to have to deal with, and it becomes a significant part of the NEPA process when you start to back up what needs to be done when.

We're also hard at work on actions to improve our internal processes within RW [the Office of Civilian Radioactive Waste Management]. We're starting basically at home with the federal staff. We've restructured the Yucca Mountain project to get, you know, a simpler, more direct responsive alignment of our federal people. We're also in the process of doing that now in Washington as well. We

also, in parallel, are working with the contractors to get the contractors aligned, to get them focused, to deliver the products when it's needed and to hold them accountable for doing that. Again, we need to do the necessary work that needs to be done and not do some of the superfluous work that people tend to always like to try to fit in there.

We're working very hard to improve our program management systems. We avow we will never again let things get out of sync to where the work you say you're going to do and the available funds are disconnected and inconsistent. We will track the work. It will be resource loaded and we'll expect the schedules to be met.

That schedule we had on the previous page was not-- we did not put dates up and say let's see what dates we can make. We said what funding will be available. That will tell you how much work you could do. Then we went to the scientists and said what can we do and how can we do it within the constraints, and those are the dates that came out. If the funding is less, as we've shown in that third scenario, you know, how would it slide further out into the future. But that is an area that we need to improve.

Develop teamwork across the program. We have been a disjointed program. I hate to say it, but it's true. The Yucca Mountain folks don't know much about the waste

acceptance aspects of the program, and the waste acceptance folks don't know that much about Yucca Mountain. We are struggling with that in the MPC as we go through that, and I think we're making strides in there, but we still have a ways to go. So the overall program integration is still a challenge, it remains a challenger. We're really looking to ignite the empowerment that you can get from teams and some of the TQM concepts where people will cut across on various tasks.

We want to further encourage constructive relationships with oversight groups. The proposal that we're going through at this stage is only a proposal. It has much work yet to be done. We think we needed to bring some things to the table so we could talk intelligently about it. I think through a constructive dialogue process with the TRB, with the State of Nevada, with the units of local government and with the utilities, with the NRC, this will be a much better program. It will change. I expect it to change. And it will change for the better as we go through this dialogue process.

So this is not one of these classic, you know, decide, announce, defend operations here at all. This will change and we're now just starting to flush out, you know, the testimony that Dan Dreyfus talked about, you know, in the hearings.

So with that, let me turn it over to Steve who will give you more of the details about what it is we're doing at Yucca Mountain. But I thought it would probably be important to put it sort of in perspective of where the other parts of the program are. And we'll be here, you know, to answer questions whenever you would like.

DR. ALLEN: Questions, the two of you when you're through, okay?

MR. BROUCOM: First I want to say, as Lake tried to say, this is all work in progress. It's all, you know, of a preliminary nature, and it's all subject to change. We're trying to avoid the decide, announce, defend syndrome.

Dan Dreyfus asked us to evaluate two alternatives in terms of scenario development, and we had several, four or five or six off sites with senior managers who went away for three or four days. We had one last week, and it started sometime last year.

The first one was to improve the program efficiency, but to operate within existing legislative and regulatory framework and assuming availability of increased, or maybe a better word would be adequate, funding for the long term. In other words, getting away from this bow-away effect we've had all these years.

The second was a resource-constrained program, operating again within existing legislative and regulatory framework, and this assumes a level profile that we've had for the last several years.

So we are moving forward, and this is, again, work in progress. This is what we commonly refer to as Scenario A, the title I think on the agenda. This is Scenario A. We now call it the Administration Funding Proposal.

This proposes a new direction for DOE to carry out the policy set by Congress in the Nuclear Waste Policy Act. It proposes a funding profile that will support the restructured--I'm reluctant to call it a new site characterization program because we're building on all the work we've done in the past, and we're evolving and improving on the SCP. We're not abandoning the SCP, we're not abandoning all the work that's been done to date.

And we're intending to address two issues; I think Lake addressed first near-term management. I won't say anything about that. And second is assuring efficient progress toward determination of suitability of Yucca Mountain, and if the site is suitable, to proceed with the site recommendation and licensing.

You'll notice of the eight goals Lake put up earlier, one of them was to determine site suitability. This

is the first time that the program has identified site suitability as a major goal in and of itself. Over the last several years, the way we handled site suitability was we usually considered it a part of a licensing process, and somehow in the development of the license application, we were going to reach the conclusion the site was suitable.

And, of course, we're assuming, again, as Lake said, that we will have increased and assured funding over the next several years.

One of the things we're trying to be responsive to Congress' expectations is to show demonstrable progress at reduced cost. Progress can be measured in many different ways. You can drill a number of drill holes. You can build an ESF. You can assemble a TBM [tunnel boring machine]. You can dig trenches. But the real key that measures the progress in this program are really three: One is you've got to evaluate the suitability of the site. If the site's not suitable, you can't go on. Second is you've got to implement NEPA. And third, you've got to write your license and submit your license application.

Those are the three key areas. So the new program, or the restructure, emphasizes these areas, and the first one we emphasize is suitability. This is, we think, consistent with the original intent of the Nuclear Waste Policy Act and

60, and we're trying also to do it in a step wise, or step-by-step manner where we increase the confidence on all sides, and we think that's consistent with the sequencing of DOE, NRC decisions that are required.

We feel that our program reflects the recommendations of the National Academy of Sciences report, "Rethinking High-Level Waste," where they argue you shouldn't make all your decisions up front right at the beginning.

And finally, we think about responding to some of the suggestions we've gotten from the TRB and others for more effective management and a well-focused technical program.

Our basic assumptions: No legislative and regulatory changes, assured funding. Lake talked about this: MPCs to cover the near-term waste acceptance and storage issues. Restructuring the site characterization program based on available information, this is the information we've gained over the last 10 years, to focus on the most significant issues for suitability and licensing. And we're proposing to increase the period of retrievability from 50 to 100 years to give us more time to see the impacts on the site of emplacing waste.

So the milestones that we have on our schedule are milestones--for example, the notice of intent starting the EIS process, the site suitability evaluation '96, a technical

site suitability evaluation '98, which is kind of a statement by the Secretary of Energy in the 1998 time frame that from a technical perspective the site looks or does not look good, and it's worth either going on or not going on.

The draft Environmental Impact Statement, the final site recommendation report, these are all in those three key areas; suitability, NEPA and license application.

Of course, to do all this, you need to have an ESF, you need to drill holes, you need to do trenches, you need to to performance assessments, you need to make models. That all flows from this.

But this is an attempt to show, as you can see by the number of milestones, that we could demonstrate we're making progress by meeting or accomplishing these milestones.

The current program, the program that was baselined in 1991 in ESAAB through a license application, would have cost us $9.7 billion dollars. Of that, about $7.2 would have been from the repository program. It was baselined at $6.3 billion, but for the last two years, we haven't been funded what the amount of that baseline would have required, which Lake tried to point out, so it raised the cost of the program.

The proposed restructured program, the Administration Proposal, would cost us approximately $7.3

billion through license application; $4.8 billion of that would be for the repository program.

This is basically a top-bound strategic number. We are working on the investigations and studies to meet this, and this number may be subject to some change.

The Level Funding Program does not get us to the license application, only gets us to the technical site suitability evaluation, and that would cost approximately $6.9 billion; $4.1 billion of that would be for the repository. But remember, that only gets us--this is mixing apples and oranges. You're not getting the license application here.

If I go back to the schedule for one second, you see that this program, the Level Funding Outlook, stops at a technical site suitability evaluation. At that point, we could bank the site, we can go back to Congress and say what do you want us to do? If you want to go on, you need to give us the resources to complete the job. But we're not promising to be able to complete the job on level funding. We're looking at what we think is the most important thing to do at Yucca Mountain, which is to determine its site suitability, and it's not even the formal site suitability determination.

So the summary of this strategy is to make formal

suitability findings in a step wise manner. If you look at our program, the last time DOE said anything about site suitability was in 1986 when it issued the environmental assessments. In 1991, an early site suitability evaluation was conducted. That was a contractor report. That was never adopted by DOE for whatever reasons.

These step wise, or iterative findings, we proposed would be DOE findings. We proposed to initiate the NEPA process as soon as possible in order to actually complete the suitability evaluation. To write a site recommendation report, you need to have a final Environmental Impact Statement. And we proposed to provide enough or sufficient information in the license application to support the finding by the NRC in about 2004 of reasonable assurance.

The key things that go into this is assuring the safety of the operational aspects of the repository. We're proposing to have at the time we submit the license application, a very high confidence in the waste package containment for at least 1,000 years: a substantial requirement.

For releases for radionuclide release and total system performance over the 10,000 year time period, we are proposing bounding and conservative analyses rather than having completed all the investigations. We don't think we

could complete those investigations by that time, but we do feel we can complete enough investigations to provide bounding and conservative analyses.

So we're proposing the testing programs to focus on supporting design and these conservative analyses, and that's the process we're going through right now, evaluating all the investigations in the study. This is going on as we speak.

And then after the license application, we propose to confirm and gather enough additional information to assess long-term performance, using the performance confirmation program. We're kind of elevating or recognizing the performance confirmation program, which will have about 100 years to gather information that will become relatively a more important part of the program.

And we're proposing to better involve the stakeholders and the public prior to finalizing the decision on these things. And that leads me to the meeting that occurred, I guess, last Friday with the--what is it called-- Affected Units of Local Government, where Jane made some presentations and Max presented Scenario A, and a meeting on May 21st, where we've issued a notice of inquiry, or will be issuing in the Federal Register, where we're asking that the people that are interested come in and tell us how they think we should site suitability, how they think we should use 960,

or if we should use something else.

The next few view graphs try to summarize the similarities and the differences of a current program versus the proposed program. Site suitablity: The current program also promises interim evaluations, but it did not have a process in place. The administration funding proposal also proposes interim evaluation, and we have set up a team, and I want to introduce the team leader, Jane Summerson, who's sitting back there, and she will be responsible for coming up and interacting with the public and implementing a process site suitability.

I also want to introduce April Gil, who's sitting next to Jane. She's the team leader who will be responsible for licensing, for the annotated outline, for interaction with the NRC and for the issue resolution process. These two people work very close, are actually sitting together, collaborating as we speak here.

For the current program, we were going to use a Title I design for suitability. We're proposing to use advanced conceptual design in the administration funding proposal.

We are also proposing to have what we call a technical site suitability, which will look at the technical aspects of the site, the status in 1998, and in a sense be an

investment decision, if possible at that time, to the Secretary of Energy, that it's worth going on, it's worth completing the license application, it's worth investing to complete this process.

The EIS originally would have been in 2003 of the draft. Now we're talking about 1998. That's why it's so important to start the scoping in the coming year. The final would have been 2005. Now it's in 1999. The rest is about the same, except that we're using the advanced conceptual design instead of Title I.

In the site recommendation, in the administration funding proposal is the year 2000. In the current program, it's 2005.

In the current program, the license application would have been submitted in 2005. In this current proposal, it's 2001. The design basis would have been a full Title II for the complete repository in the current program. In the current funding proposal, it would be Title I for the whole repository, Title II for the waste packages and the first panels. And so that as you get ready to construct further panels, you would then bring your design up to Title II. Title I would provide you enough information to make the safety issues, the construction issues, the operational issues and the waste isolation issues.

Now, with respect to the extent of the technical and scientific studies, obviously the current program, that's the 7.2 billion Yucca Mountain program, we would have done the full scope of studies proposed in the SCP with possible modifications through time.

In this funding proposal, we are basing the studies on assessment of our current state of knowledge to focus beyond the technical issues that are most important, the suitability and licensing, and we're trying to make the most effective use of performance confirmation in the future.

Retrievability. In the current program it's 50 years. Now we're suggesting it be increased to 100 years.

Another way to look at this, and some people look at it this way, is to use a chart of something of this sorts. If we plot the amount of expected information versus time, when we started writing the SCP, we thought we would have all the information essentially that we needed or that's acquirable by the time we completed the SCP.

I think we've come to the realization that, you know, even after we submit a license application, we have nine years between the license application and the license to receive waste. That's nine years we'll be collecting more information. There will be a performance confirmation program, which will start during site characterization, as

required by 10 CFR 60, and continue through the life of the operating facility. So we will be increasing amounts of information. So that's what this curve is meant to represent.

Also, there's uncertainty in the information, and we hope through time that the uncertainty band will decrease.

But we feel that at the time of the submittal of the license application, we will be able to make an argument that allows the NRC to reach a reasonable assurance finding in the year 2004.

And so between now and 2001, we're in pre-license interactions, in those nine years between the submittal of the license application and the license to receive waste, formal license interactions. We're conducting site characterization now, and in the future we'll be conducting performance confirmation.

Just two quotes or statements out of 10 CFR 60. In our license application, you're supposed to have an application as complete as possible in light of information that is reasonably available at the time they docket it. They don't expect you to have all information. Also, it's not on here, but you are supposed to update your license application as new information becomes available. It's a recognition that you will have a step wise increase in the

amount of information and confidence.

Another quote is that demonstration of compliance may take uncertainties, so you're expected to have uncertainties and gaps in knowledge into account. In other words, you're not expected to have all knowledge because it's unattainable, and there's a recognition of that.

Now, the next view graph is a blow-up of this, which I just want to make a point. For each major step of the technical site suitability evaluation, the EIS, the license application, the construction authorization, the updating of your license application may be around 2007, 2008, and perhaps your license to receive and possess waste, you'll have a certain amount of information. The next view graph gets to that.

On the left we have plotted for the natural barriers, the repository design and the waste package, the key areas, you need to have an understanding to understand how the repository will perform. And the kind of information we think we will have at each step, based on talking to our scientists--this is their--they created this diagram.

So in time for the technical site suitability evaluation, many things will be bounded or many of the designs will be of an advanced conceptual design nature. At the time for the license application, some things will be

bounded, some things will be almost finished, some things--from the advanced conceptual design to Title I. There is an incremental increase in your information.

At the time of the license application, the waste package design, as shown by the substantial complete containment requirement and criticality controls, will be complete. As we said earlier, we were going to have that--a very high confidence in that, part of our logic.

These things will, if necessary, during performance confirmation be updated. New information gives you a reason to update your evaluations.

So as you go through time, you will complete this, and during performance confirmation, you will, of course, finalize everything before you close the repository.

Now, if you take the same chart, and this face, the front face is that chart, and then you project back, those are all the different studies. And that's the work that the scientists are doing right now in several teams. So for each of these key areas, we're looking at all the studies that apply to them and trying to determine how much information we need to have to reach Title I or complete evaluations, and that is determining in a sense, the scope of a site characterization program.

And in many cases--just to make one more point for

each of these studies--if you compare the scope of that study with the scope in the SCP, it varies from say 25 per cent to 150 per cent. In some areas you need more information; for example, in the waste package. In other areas you may need less.

This, again, is all work underway and subject to change.

What are our next steps? The next steps are to complete the identification of the information expected at each key program step. Identify the testing, design and PA activities needed to support each step in the DOE and NRC decision process. Obviously, allocate budgets and determine the schedules. Revise whatever project documentation needs to be revised, and through this whole process, conduct stakeholder interactions, which started last Friday and continues on May 21st.

That's my presentation.

DR. ALLEN: Thank you very much, Steve.

MR. BROCOUM: Oh, I did have one more view graph.

DR. ALLEN: Okay.

MR. BROCOUM: I skipped it because I thought it was out of place.

In terms of site suitability, we're proposing a step wise or interim process for suitability. This, again,

is just a proposal at this time, where you would group like guidelines, using 960 here, and then you would have an evaluation, a peer review and a DOE management evaluation decision by step. And this would all be completed by 1998 for that technical site suitability evaluation.

This, again, is all subject to change, but that's--that's key for the next few years in evaluating suitability of the site.

DR. ALLEN: Let me ask if members of the Board have comments or questions for either Steve or Lake Barrett.

Yeah, Dr. Price?

DR. PRICE: I have two questions I'd like to ask. To what extent has this been developed with an interchange of communications with the NRC?

MR. BROCOUM: Dan Dreyfus at a Commission meeting will present this information to the NRC on June 6th.

MR. BARRETT: June 6th. When we spoke to the Commission back last--a week before Christmas, it's the annual Christmas meeting with the NRC, we told them we were in a process of reviewing the program and restructuring the program. We did not have this developed at that time. Chairman Selin said we'll come back within six months, and, you know, June 5th--apparently the month of May the Commission is pretty well out different places. So June 5th was the first time, and we

really weren't ready for this to start putting this together.

So we discussed with NRC management that we will have a management meeting which everyone will come to. We have not talked this level of detail with the Commission yet. We will following the Commission's processes for meetings.

DR. PRICE: Okay. And the second question--I think that answers the question quite well.

MR. BARRETT: Yeah.

DR. PRICE: The second question, I want to read a statement, or a paragraph, and then follow it with a statement. The paragraph and statement are from a remarks by Commissioner Ronald Russell, the Michigan Public Service Commission, made to the American Nuclear Energy Council in 1994 Congressional Information Program Leadership Workshop. And I'd like to comment on the statement. The paragraph is just for background information.

The paragraph is, "Every mandated date in the Nuclear Waste Policy Act, NWPA, has been violated, and there is no overall game plan, the mission plan, as mandated by the NWPA. There is no operative total life cycle cost analysis. The required date of 1998 to begin to take spent fuel will be violated. There is no defensible date for the opening of the repository, and the mining of 200 yards of a standard tunnel at 10 times the low-cost method is not a nuclear waste

breakthrough."

Now the statement: "The Department of Energy, DOE, has asked the Congress for more money, much more money, but they haven't guaranteed they first will correct the management programs that make all expense to date ineffective."

Could you pleas make your comment?

MR. BROCOUM: I think I should ask the Deputy Director to make that comment.

MR. BARRETT: Yeah, that expresses Mr. Russell's views. They are rather focused on a date 1998, and they are going through, in my opinion, a little shock at reality when we told them that it's very unlikely that an MRS site will come up. If we had an MRS site, you know, we wouldn't have that problem as far as the initial thing with the utilities. But Congress rejected the Oak Ridge Site. They set in process the idealistic voluntary process, and I think that's good, and I wish it well, but it hasn't born fruit yet. I hope that it will.

Regarding the criticism on Yucca Mountain, a lot of that is legitimate. I think it steps like what Dr. Brocoum just described, is to rectify that situation. It's easy to be critical and tell you what's wrong. It's not so easy to fix it. We're in the process, under Dan Dreyfus, to fix it

and go about with a new RW. And I think hopefully that over the next year, Mr. Russell may hopefully change his tune on what the future looks like regarding the 1998 date. You know, I expect we'll probably be seeing Mr. Russell in court before too terribly long.

DR. PRICE: His statement, though, was specifically regarding the management problems that make all the expenses to date ineffective, and what guarantee will there be that actions are going to be taken to correct these management problems.

MR. BARRETT: Well, we are taking steps now to fix the management problems, and the only guarantees are hard to do. The only guarantees I know in life are death and taxes. But, you know, we are moving out. We are restructuring, not just boxology, changing titles. It's not the routine thing we're doing there. It's trying to go along, following TQM concepts of metrics, milestones that are measured. You're accountable for your performance. Look at the dynamics of what you try to do and put these in place.

Part of Mr. Russell's criticism, and it's fair, is that it was a completely disconnected program. I mean, what was said in the dates, and you said it yourself about schedule driven in your reports, need for review. I mean, reality was not the RW program. I think the new

administration is bringing a reality to the program. We did the hard work with OMB before the administration proposal would go up $150 million in a very difficult budget year.

So I believe there is new management, and I believe the steps are being taken, and I hope to demonstrate to Mr. Russell and others that it is different, and it will be different very soon. I look forward to being able to present this to him. The last time we talked with him, we did not have this for our staff, with dates and things like that, like we are now. We didn't have the OMB agreement by the presidents for the proposal of the Congress.

So we hope that with more information, Mr. Russell will feel better about this situation. I know he will never be satisfied concerning the '98 date, but that's something that's sort of beyond our control at this point.

DR. ALLEN: Any other questions from Board members? Warner North

DR. NORTH: I'm very pleased at this step moving toward reality, but I think there's quite a ways to go, and in particular, there are a number of fairly difficult issues that you will need to add as flesh on those bones in the process. And I'd invite your comments. Some of the other Board members may wish to follow up with more detail.

The first is the thermal-loading question. This is

really critical to the question of repository design, and from what we understand at this point, the uncertainties are not going to be resolved for sometime, so you're going to have to carry this along.

If you could share with us what your process will be on the Title I design? Are you going to go with the most conservative approach, a below boiling type design, and if so, what does that mean in terms of the area of the footprint, the pork chop as we've come to affectionately know it.

MR. BROCOUM: Let's see here, thermal loading, let me find that.

DR. NORTH: Okay. Hard issue No.--

MR. BARRETT: Well, let's take them one at a time. These are not easy issues.

Steve, why don't you start with that, and then I'll say how we're going to handle that.

The only near-term decision regarding thermal strategy is any impacts they may have on near-term, multi-purpose canister system development decisions. The rest of it is like much of the other Yucca Mountain design, we don't have it yet, and we're trying to focus first to get the scientific data about the mountain, and then develop design secondly.

I'll let Steve talk about a long-term thermal

strategy, and then I'll come back and talk about APC.

MR. BROCOUM: We're obviously hoping to bound it by the time we do our license application, so no higher than a certain amount. And then we're deferring a decision until near its waste emplacement, and we're reserving the option to reconfigure it later on, based on real impact on the site over the next hundred years, especially if we're using MPCs that are on rails and can be moved closer or further apart.

If the thermal loading is 50 kilowatts per acre or greater, the footprint today we had is about right. If we go lower than that, then we need a larger footprint, and that has to be taken into account in the site characterization program. But, of course, you don't need that whole footprint right up front because you're only loading one or two panels to begin with. So you have some time to decide what your footprint will be.

DR. NORTH: And a second related issue--

DR. CORDING: Well, before you get on to the other, could I follow that one up?

DR. NORTH: Sure.

DR. CORDING: It seems to me, I mean, Steve, the possibility is that you would carry more than one thermal loading strategy or some range--you're carrying that forward through Title I. To me, certainly there's logic there, and

the concern I have is not so much on what your decision is regarding the thermal loading, but will you have enough information at 2001 on thermal effects, regardless of a loading, to be able to say that you have taken care of the site suitability issue? And recognizing that with whatever schedule that you have, you have a very limited amount of time to do any underground thermal--actual in situ thermal work?

MR. BLOCOUM: Well, again, we're hoping to bound it, and when you bound something, you tend to be on the conservative side. So I assume we're going to be conservative when we do this bounding, and then we'll be able to move as we get more information to go closer or, you know, to reassess that. I can't give you a complete answer at this point.

DR. CORDING: It's not so much the bounding it, but will there--and I'm going to be interested in hearing more when we get to some of the more technical discussions regarding thermal loading. But it would seem to me it's going to be a question, what does one need to understand about the thermal conditions further before one can take care--regardless of the bounding that you do to be able to evaluate site suitability.

MR. BROCOUM: In terms of the near field effects, one of the things we've discussed is starting off with two panels,

one relatively cool and one relatively hot, and being able to actually observe the effects over a period of time.

I mean, there's a lot of discussion like this going on. We don't have the answers for you right now.

DR. CORDING: But I'm saying, what do we need before 2001 to be able to go forward with licensing, to be able to understand a phenomenon when we have not had the in situ testing underground since 1988?

MR. BROCOUM: Sure, that's the details. Those are the details. Scientists are really struggling over this, these issues right now. I've been in some of the meetings. We've had a lot of interactions with them.

DR. ALLEN: Warner, do you want to continue?

DR. WARNER: More of these little details related to the first, Items 2 and 3 on my list. One is the size of the waste package. Going to the MPC, we're going to a much larger waste package than previously contemplated, and what local effects there may be from this lumpiness certainly need to be factored in as part of the bounding exercise you described.

Related to this, even at the level of a cold panel and a hot panel, is the question of ventilation. If we're going to keep it open for 100 years, what are the ventilation requirements? And if we consider going to some fraction of

the amount of waste we've been describing, is that feasible? How well do we understand these ventilation duties?

MR. BROCOUM: I assume the advanced conceptual design for the repository is going to look at all these issues. I mean, that's the purpose of doing that advanced conceptual design. These are some of the things that have to be looked at.

MR. BARRETT: Your ventilation is a fairly straightforward engineering operation. With the state of knowledge we have, today we don't have those answers. You know, we will when it comes time to do that. We can't do everything yesterday. But it's a legitimate thing, and we'll have an answer for that.

And the MPC, given that decisions are being made now at sites for storage, and we need to deal with that now issue there without precluding reasonable options in the disposal process, and that's what we're trying to standardize with an MPC.

There are some, you know, issues that become expensive, commitments. They're reversible. You can always take the fuel out and put them in a small package. But we're trying to make balanced and manage the risk as you go forward and make some decisions, and when you go looking at nominally a 10-ton waste package, 10 tons of fuel in it, but the only

thing you're precluding--you can still do the lower areal kilowatts per acre, but you end up with a non-homogeneous situation. So you need to watch out for heat pipes and those sorts of effects.

But your surface temperature of your metal is probably over 100 degrees C at that point. Now, the rock temperature you can control, and this all ties in with tunnel diameters and drift diameters and ventilation for the 100-year period as we sort out what to do.

We assume that we will gain much more knowledge through the science and the engineering between now and when the final decisions need to be made.

DR. NORTH: Okay. Warner, detail No. 3.

DR. NORTH: Okay. The next detail on my list is the question of managing the risk. As we look into this program with the idea of waste emplaced over time, what's the potential economic risk, if you have to take it back out again? I've never see a calculation of this kind, and I think it would be very useful going through this kind of a learn-as-we-go approach. To look at the economics, supposing at various stages you have to take everything back out again because you have found some kind of a fatal flaw. Are we talking about a trillion dollars? Are we talking about a few tens of billions? It would be nice to have some insight

about that.

MR. BARRETT: Well, it would be nice to have a lot of information. That's something that's not that high on our "To Do" list compared to thermal strategy and other issues. I can say that it's fairly straightforward engineering to do that. If society decided they wanted to put a man on the moon, there are science and technologies there to do it, and the science and technologies there to pull these packages back out.

DR. NORTH: I think one of the issues that people are going to raise is if you go ahead with this kind of a phased approach, are we going to be left holding the bag as society? I recall a presentation made in the society of risk--no, actually this was to a National Academy group that I was on--about why some of the intervenors in the community became very upset about a proposed toxic waste facility in this community. Their concern was that the entity might go bankrupt, leaving a community with lots of toxic waste that they would then have to pay for getting rid of or managing in some fashion. They would be left holding this noxious bag.

If it turns out that it costs a huge amount of money to get the waste back out again, even if it's technically feasible, I think a lot of people are going to question whether or not the promise of the Federal

Government, that in event of a fatal flaw the waste will be retrieved is really credible.

So I think you will help your case a lot if at least that issue gets a good back of the envelope calculation, as opposed to being left far down the agenda and not dealt with at all.

The next element on my list of risks is we have a new standard coming out of the National Academy process. Based on how that might come out, what additional risk does that put into this embryonic new mission plan, if I could call it that that's the objective. Will things switch around dramatically depending on how that standard evolves, and what thinking might you share with us at this time as to how you're going to deal with that risk?

MR. BARRETT: It could make substantial changes. We don't know yet. We'll know a year from now where that is. Between now and a year from now, we need to get underground. We need to start getting the data so we have time to adjust that in. We've made, you know, our thoughts known on that. We will have to weight the process of the Academy and then EPA rule-making process to see what that will truly be. But I don't anticipate that it will make big changes, but if it does, it does, and that will be a society call, and we'll have to adapt to what society tells us we need to do.

MR. BROCOUM: We submitted last Friday to the National Academy DOE's suggestions on how they will approach--their recommendation on the standard. Their report, of course, is due out in December of this year. So in six months or in nine months from now, we'll have a much better idea what they're recommending. And then, of course, EPA has one year to promulgate their standard. They have indicated that they would like to stay as close to 191 as possible.

DR. ALLEN: Okay, let's take two more comments before we quit, one by Pat Domenico and one by Bill Barnard, or questions.

DR. DOMENICO: Domenico, Board. I just have one question. I notice the diagram, Lake's diagram, that shows a proposed budget increase from 380 to 532 million, did I hear correctly that if that comes true, that you will commit at least part of that to around-the-clock tunnel boring and around-the-clock surface-based drilling forever and ever.

MR. BARRETT: No. In FY '95, yes, ever, no. That would--

DR. DOMENICO: On a continual increase to that level, you feel that there will be a commitment to the 24-hour--

MR. BARRETT: If we get the budget request, we will run the tunnel boring machine, you know, basically six days a week, and the seventh for maintenance, 24 hours a day, and

the same with the drilling. It's the effective way to run big pieces of underground equipment. To try to start it and stop it on one shift--it takes a half a shift to start and a half a shift to stop it, so you make no progress. And that's why we had to have balance in the funding. So if Congress gives us the money requested, that's what it will do in '95.

Now, in '96, the tunnel boring machine comes back out the back side, and then we won't be doing that. Now, there'll be other drifts in the main test area, and other underground activities, and the way to efficiently run large construction is to run them 24 hours a day when you have large investments of capital.

DR. ALLEN: I think we said that.

MR. BARRETT: Well, we are trying to follow your good guidance on these issues.

DR. ALLEN: Okay, Bill Barnard.

DR. BARNARD: Bill Barnard, Board, staff. Lake, if the program is restructured according to your proposal, how will that affect the amount of drifting in the SF? Are you still planning on fourteen miles?

MR. BARRETT: We're currently planning on a five-mile loop, a test area and some other drifts to key features. We're also having internal debate on the Calico Hills. There's some discussion on approaching the Calico Hills--a

separate, a totally separate facility in the Calico Hills, coming in from the Solitario Canyon, the west, or perhaps the north or the south side. That's still under debate as to when for the Calico Hills. But the total amount of drifting we foresee right now, at least through suitability, is less than we anticipated earlier.

DR. ALLEN: Okay, we're very nearly on schedule. Let's take a break for twenty minutes now. The tables will be reconfigured, and after that time, there'll be a roundtable here, and I hope all the speakers who've been with us today will be here, plus a few others. And the Board will move somewhere back behind.

(Whereupon, a break was taken.)

DR. ALLEN: We still have a couple of people to get at the head table. Where's Jim Devine, did he skip town?

We have, I think, at the head table, all of the people who spoke today. In addition, there are a couple of others. Let's see, Russ Dyer, who is going to be making an initial presentation for the DOE, and Tom Kerr, who is with EG & G and monitoring low-level waste sites throughout the country, who, if he has any additional comments, is welcome to put them in.

Let me start off, since we asked Russ to make a few statements as to whether anything he's heard today is as

relevant as what the DOE is trying to do or plans to do. To Russ.

MR. DYER: Thank you, Clarence. Leon Reiter asked me if I would essentially give my gut reactions to the presentations today. First off, I must say I've been very impressed by the series of presentations that the Board put together for today. It is somewhat heartening to see that the challenges and frustrations that our program faces are not unique in this country, or even in the world. As I listened to the presentations, I found myself in violent agreement with virtually every one of the presenters. In fact, I think I sprained my neck from bobbing it up and down in the back of the room.

Let me put my comments into two main categories. I heard two themes that came out which cannot be mutually exclusive, but maybe it'll set some of the stage for the discussion that comes later. I have comments or observations, or at least my perceptions from a technical viewpoint, and also from what I'll call a process viewpoint.

From the technical side, I heard from multiple individuals the absolute necessity for early and iterative performance assessment, integrated and tied to the site characterization program, and use this to guide the program to decrease uncertainty. We talked, or we listened--I

listened, some people talked--quite a bit about uncertainty today. And there was a statement made that I hope we will delve into in this panel discussion. I'm personally bothered by an apparent perception, at least in some quarters, that uncertainty equals error. Error would suggest something that was done that should not have been done, or that was not done that should have been done. So perhaps we'll talk about the distinction between uncertainty and error.

Bill Hall made an excellent point about effective quality assurance being critical for establishment of credibility. And we heard about credibility throughout the day also. Credibility on the technical arena and also on the process side, within the hearings and licensing hearings.

Wendell Weart made a very, very good point about continuity of the program, continuity of the technical program, continuity of program management. I would take it even a little further, as to continuity of individual investigations. As individuals leave the program, you must be able to carry on the same level of technical program in spite of the absence or the departure of individuals.

And Klaus Kuhn made a statement that I certainly absolutely agree with, detailed underground site investigation is absolutely necessary. To what level and to what degree, I'll talk about that a little bit later,

whenever we get to process part.

And I believe it was Klaus that also made a very important statement that perhaps was glossed over at the moment, and that was don't oversell or oversimplify the attributes of the site until they're confirmed. Non-issues at one point in time may later become issues.

On the process side, Wendell, I believe it was, raised the point that procedural issues are as important as technical issues.

I was delighted to hear from Mr. Harris that a volunteer siting process can be successful. Perhaps we can talk about what's different about the siting processes that have been used in our program, or have been considered, and how those have not resulted in the same level of success that the Alberta program received.

From Lloyd Cluff, the solution is in the process is the message I got from him. I find the idea of a multi-disciplinary consulting board very intriguing. I am struggling with some of the concepts, and perhaps maybe they'll come out in the panel discussion. Recognizing that there's a hierarchy o decision-makers within any program, all the way from the regulator down to the applicant down to the individual consultants, or participants as we call them, is one board sufficient? Would each one of these entities have

a board? How does one work that out? In particular, I'm curious what the role of the California State Seismic Board--I'm not sure I have the right name for it--had versus the board that he impaneled for PG&E. And from a pragmatic managerial viewpoint, I have a question. Will these boards replace or augment some of the existing oversight bodies that are already in existence?

We talked a lot about public involvement, how to get public involvement, how to get effective public involvement. Certainly the experience that I heard related today would indicate that extensive public hearings are incompatible with a schedule-oriented program. If one has the luxury of dictating your own schedule, perhaps you can incorporate into the schedule accommodations for all these public involvements. That is not always a luxury that we have.

With that, I'd like to just throw that out as my perceptions of what I heard. I listed a few things that I would personally like to here some follow-up on in the panel discussion. And if I misheard anything, I'd like to be corrected.

DR. ALLEN: Okay, thanks, Russ. Perhaps I might do this. Let me ask our foreign visitors first if, now having been through the day's proceedings, if they have any words of

wisdom or comments on situations they've heard about in this country versus their own. Camilla, you started out very first thing this morning, before anyone else had talked. Do you have any comments here on the basis of what you've heard during the day?

DR. ODHNOFF: Well, one comment must be that something of what I've heard seems to be things played out on a technical arena, very far from human beings. While other people have stressed on the cooperation you must have with the people in the neighborhood, that you cannot do things on top of people's heads. Well, it makes me curious, how do you get a more abstract view and deeper down in the soil to meet? Can you really make these programs work which are only determined by technical standards and where you haven't got the human aspect on them? How do you join technical progress and, say, man's ability to make a mistake?

DR. ALLEN: Do you have any words of wisdom for us?

DR. ODHNOFF: No, no, you have the words of wisdom. We are here listening, Harald and I.

DR. ALLEN: Let me ask Klaus. Did you hear anything today that sounded familiar or made you sort of homesick?

DR. KUHN: Not really homesick, but there are very many parallels in the programs, which is treated here in this country, and which we are following at home. But if you ask

me for my general impressions of today's presentation, I would like to make some comments, especially on the DOE presentations, which were last.

I mentioned, by introducing my presentation, that I've been following the United States waste disposal program since the very early days. And I think it sounds very familiar, what I heard today, to several items which I heard before. So when a new director took over, there was a new program, there was a new program structure, there was a reorganization, there was a new approach. So in general, I think you have done this, but taking the consequences, the progress measured against the thoughts you put into the program are not balanced.

One other impression is, coming from a small country, with a limited number of experts available, and with a limited budget, my impression is that there's some danger that your program gets out of control. If I remember correctly, I read a figure that about 2,900 people are working in your program now. That's a number which is unbelievable for European scales. And I have a certain inquired feeling if such a type of program can still be managed.

Another statement which frightened me a little bit was that you were thinking about, if you have not decided

already, to enlarge retrievability from 50 years to 100 years. If you will take this approach, I think you will lose the credibility to construct a repository. Then you should store it on the surface for a longer time, until you have done your homework and are sure that you can construct a repository. For as we have heard today, the definition of disposal is to dispose of radioactive waste in an underground repository, and not taking care of the waste anymore after the disposal has been shut down and closed.

There was on question directly towards me about the limits of underground investigation. I think we are relatively better off investigating a salt dome, for there are natural boundaries of the salt dome, as I showed you on some of my figures, and there's another limitation that we have a criteria to stay at least 150 meters off the natural boundary of the salt dome, to have a safety pillar around the repository of at least 150 meters. So this describes the area into which we have to go with the underground investigation.

And the detail is that we have to find out, in case of the salt dome again, if we have intercalations of another strata, like, for instance, anhydride, water seams or clay layers, which we don't want to use as a disposal area. We have to fix some certain distances from these layers,

intercalations. And we also have figured a certain temperature at the boundary between the waste canister, the high-level waste canister, and the borehole into which the high-level waste canister is to be placed. And this, again, is coming back to the qualities and quantities of salt. And we fix this temperature to be 200 Centigrade.

So, in summary, the details of site investigations underground, should be such that you know where to locate your disposal areas. Of course you have some flexibilities in it, but you have to regard some safety distances, and you have to look for inhomogeneities. And the final target is, within the site investigation programs, to find homogeneous undisturbed areas where you can build your repository panels.

DR. ALLEN: Thank you. Before we just turn it wide open here, let me just ask Walter if he has anything additional to say. For example, is it possible that a successful conclusion could ever be reached in this country on an issue such as yours, or is it just that Canadians are more gentlemanly?

DR. HARRIS: By no means. Well, I guess I could reiterate a little bit of what I said earlier, and that is that we certainly need some technology. But it needs to be recognized that I think the direction of a siting program is largely a sociological deed, and recognized that the problem

to be solved is largely outside the technical arena. Public involvement is not a luxury, by any means.

One thing that does concern me a bit is I think the underlying assumption that nobody has stated that we will have social stability for decade after decade, even in this country. And that's an assumption that may not be valid. And so one thing I'm doing, certainly in Canada, is to say, let's start putting this away with cautious haste. We don't know all the answers, but let's start putting it away.

And the idea of having it with a need of social attention for a century in the future, is an assumption that you're making when you say it will be retrievable over a century. I wonder about that. I think that I'm in concurrence with what you've said.

DR. ALLEN: Okay, thank you. I'm going to turn it wide open here to the panel, but I would like to point out that at a quarter of six, we will open it up to questions or comments from the audience, or anybody who wishes to say anything, State of Nevada or anybody else, is welcome to do so. So let me ask the people who are sitting here, do you have any comments on what you've just heard? Do you wish to defend anything you said during your presentations? Do you wish to deny anything you said during your presentations? Bill Hall.

MR. HALL: I'd like to--is this on?

DR. ALLEN: Yes.

MR. HALL: I'd like to address one point regarding Fred Snider's talk that maybe he or even Tom Kerr could get into, and that was on the zero release comment. As I recall, Fred, you said something about you were frightened by the concept of zero release. I didn't answer that on purpose at that time, because I wanted to go through the report here and see if I could see where you might have found that. And I couldn't find it. I would offer to people who would review our report and the other parts of our documents that they might start by looking at the statutory criteria and the conclusions.

As I understand it, the Management Act reads very clearly. Let me follow through some logic and see if this makes some sense. The Management Act does not require complete elimination of the possibility of radioactive release. I mean, that's in the Management Act itself. And as I look at the train of events, it was felt that the till would lead to a retardation in travel of water for 500 years. But when it was found out that the till was fractured and that there were sand bodies in it, that kind of raised a lot of questions there. And there were also a lot of questions about the coefficient of hydraulic conductivity, if you've read the reports thoroughly, whether this was as low as some

people would claim, and we raised some questions about that.

Then, to compound that, we found out, to our surprise, that only 10 percent of the water was expected to go through the till, and 90 percent of the water was to go by surface, wherever it went. So it was only taking care of ten percent of the water even if the till was acting as a barrier.

At that point, the next argument was that, well, for the surface waters, the argument is that dilution is the solution. You've heard that before. But again, we got into a lot of questions about what happens when the Embarras River is essentially dry, and on and on, and that was not ever answered in any way.

So what you're left with was the facility and the adequacy of the facility, which was the last thing. And I alluded to some of the problems there. And most perplexing of all, which I didn't know when I entered into this process at all, was the matter of walking away, even though it's supposed to be managed--well, it's under institutional management for 160 years, and then just walk away from it and let things drain as they will.

So all of this raises a whole set of questions, and the big factor is, of course, I believe that most of the short-lived radioisotopes will be close enough to background

that there is no problem. The big problem is the long half life isotopes and how much there are, what happens to them and so forth.

So that's the way I look at it, and I'm not quite sure where the zero release business came from. I might finish this, and then you can answer. I'm really an optimist that there are solutions to a lot of these problems. And with regard to Russ' comment over there about uncertainties arising from error, there are all kinds of uncertainties that arise normally that don't have to do with errors. But there are certain processes in the engineering field, some of which occurred here at Martinsville, where it does occur by error.

For example, you're drilling a well to look at the quality of water at some depth, and you contaminate the drilling fluids with Clorox, and you're looking for evidence of--we look for tracers quite a bit, that we could put our hands on, tritium, things like this, including agricultural chemicals, ammonia, ammonium products. So here's a place where I think you might say there's some errors made in the process that lead to some uncertainty. That's just one observation.

I'm through, and Fred, maybe you'd like to--

DR. ALLEN: Let me just ask if Fred Snider or Tom Kerr had any particular comments on this. I don't want to spend

the whole time debating Martinsville.

MR. HALL: No, no, and I'm not interested in debating it.

MR. SNIDER: I just may make one comment. I don't think that I meant to use the word "frightened" in the same context as the zero release criterion. I think that where I was using the word "frightening" were the issues that uncertainty became a perception of error, frightened in the concept that people who are technically competent may, because of their inability to perform well under a high stress cross-examination environment, may not, in fact, come across as credible as they should be. Those are the types of issues that have frightened me as a technical individual and a person moving forward.

The zero release really came from comments made by the Commission that after reviewing BEIR-5 and some other documentation that they were not convinced that any amount of radioactivity to any member of the population was safe. And that's really where that came from.

DR. ALLEN: I apologize for a few minutes ago not turning to Harald Ahagen, who, I think, would like to say something.

DR. AHAGEN: I'd like to connect to Russ' point here on processes important as technical. I thought I heard two

things this morning, one thing mainly from Illinois experience, calling for more and clear regulations, and totally different from Alberta. One of the blunders they avoided was not to pass regulations without the means to meet them. And there was a "pressure" always there to pass tough regulations and then assume that the problem has been solved.

I think what might be behind this clearer regulation, isn't that a clearer process? But what's really important is to have a defined process, how this facility will be decided, who the parties are that will be invited, what steps this process will take, what these different parties' roles are, how their involvement should be and, of course, collect the wishes from these parties how they would like to see their involvements and when, and then initiate the implementation. And not initiate implementation and process planning in parallel, which I have a feeling would allow these bad experiences to come out and parallel process planning and implementation.

DR. ALLEN: Any comments. Steve Brocoum.

MR. BROCOUM: We have a concern, just taking off on Harald's comment here, on the 801, on the new standard for Yucca Mountain. One of our biggest concerns is that standard be clear, be implementable, be unambiguous, and to be able to clearly demonstrate when you have met it, or haven't. That's

one of our major concerns in supplying information at National Academy is that their recommendation will lead to such a standard.

DR. ALLEN: Other comments or questions. Larry Chandler.

MR. CHANDLERS: If I could perhaps address a comment made by Fred Snider a moment ago, and I'm not leaping to the defense of my profession in terms of the way in which particular witnesses may fair during any particular hearing. But one of the things that I think should be recognized, and I say perhaps in defense of the process, and certainly the process as it has played out before the Commission and our cease tribunals over the years--it's really, and I tried to make the point very briefly when I spoke that a hearing is not an opportunity for trial by ambush. It's a hearing more than a trial in a sense. And the rules of the process are sufficiently flexible that you shouldn't have a situation in which people's credibility, in terms of competence, suffers because of a process that's manipulated by the attorneys.

There are a couple of things that were to the defense of individuals who participate. First of all, I would expect that if one attorney starts badgering a witness, that individual's attorney will spring to that individual's defense. If that doesn't happen, it's not unusual for boards

themselves to inject themselves and prevent a witness from being destroyed on the stand, if you will.

The process really should enable an individual to fully explain his or her views on a given point without the fear of coming out looking foolish. I mean, we've had instances--I've personally been involved in a situation where we had a witness who was just tremendously competent in a particular area. Yet when he got on the stand to testify and it was under friendly examination by the Board, not even hostile cross-examination, developed a case of stage fright that was unbelievable and could barely recall his name. It was very unfortunate, and the individual was momentarily embarrassed by the situation. But the process enabled us to rectify it the following day through some clarifications.

Those things can be dealt with. It's not a process of intimidation. It shouldn't be a process of intimidation. It really should be a process of exploring the basis for an individual's point of view.

DR. ALLEN: Let me ask Lloyd Cluff, your subject was how to avoid trench warfare, and yet of the four examples you gave, two were successfully built, two were not. All of them involved trench warfare. The Bureau of Reclamation to this day is not happy with the State of California, with Woodward-Clyde, with its own consultants, who didn't tell them what

they hoped they would hear. Although Diablo Canyon is in operation, the interveners, Mothers for Peace and so forth, are no happy with that site than they were when the process started. Why are those projects any more avoiding trench warfare than all the other nuclear plants or dams in this country, some of which have been successful and some of which haven't?

MR. CLUFF: No, they're not. It's a part of the process. I guess the point I was trying to make is that there are unnecessary attempts, whether it be by intimidation through attorneys or otherwise, arrogant scientists or engineers, to try to discredit individuals rather than in a more open fashion to try to exchange ideas and get to the truth of a matter rather than in a very antagonistic mode of operation. And I guess that's the message I was trying to give, is you can accomplish a much more positive result with other techniques. We're all part of every one of these projects. There were parts, as you remember, Clarence, having been involved in all but one, I don't think you were involved in the New Melones project, but--

DR. ALLEN: Or Teton Dam.

MR. CLUFF: Yes. But there were many times on the Auburn project with the Bureau of Reclamation where there was a good common sense of going in a direction until it looked

like the outcome was going to be one that was unacceptable to management. And I think that's often the case with a lot of management, is when all of a sudden the desired outcome isn't going to be achieved, then it becomes a real entrenched battle that I think there are ways of standing back with a little flexible attitude and admitting that there may be other ways of getting to a successful resolution rather than at a preconceived idea.

DR. ALLEN: Well, if you were to suddenly become Chief Scientist for the Yucca Mountain project--and they're looking for someone--do you have any thoughts on how the program might be changed or improved with regard to the issues that you've been talking about?

MR. CLUFF: Well, I don't know the Yucca Mountain project at all. I can't speak with any experience on Yucca Mountain, other than it's a huge scientific engineering sociopolitical decision-making process. I guess I would fall back on my experience of a number of big projects, Auburn, Diablo Canyon probably being one of the most successful ones. I guess I would reflect back to when I first got involved in the long term seismic, there was published a large program that, quite frankly, was, I think, overkill. All good things found things to do. Leon remembers those days, and I'm sure Steve Brocoum and others.

And I was fraught with what to do with this, because I felt that the program would never end. In fact, I told PG&E's management that I, within a week after being there, felt that we were going in a direction that was going to be very time-consuming and extremely costly and would probably raise more questions than it would answer.

And so I proposed a simple technique which we termed the scoping study to kind of put things off for about six months, until our consulting board, the NRC, the panels of consultants, and we had the scope of work pretty well defined by making some assumption on certain potential results that we knew might vary. But it clearly helped us focus on setting priorities. There were a number of things where, to the surprise of some of the individuals on both sides, really, when you did sensitivity studies, didn't make that much difference in the end result. And all of a sudden it became clear what programs were worth funding and what programs were a matter of interest, and we did some of those as well.

So I think it's a matter of having a consensus building process that focuses the priorities. And I think that doing that up front and getting agreement, I think, Clarence, if you remember, we did this in our workshops with the panel on the LNG's process. We entered a very hostile

environment, where the witnesses were even reluctant to talk. But after a couple of workshops, all of a sudden all of the fears and all of the reservations caused the people to enter into a dialogue that we ended up reaching consensus, and the attorneys even said the panel reached a consensus on issues that they had been trying for four years, and we did it in one workshop.

And so I think it's a matter of trying to openly, without intimidation, get to the answer without someone feeding you--the part that I observed in a number of cases where there were advisors, legal advisors, and before a witness can give a question, all of a sudden there's a caucus, and there's language given to an expert witness that wouldn't necessarily be his own that is rather awkward. And I think if we can break through--not that attorneys aren't needed. Larry, I'm not against all attorneys, I'm against the way that attorneys and scientists and engineers and others misuse this whole process to their own benefit.

DR. ALLEN: I do recall in the LNG project that the only way we could get the USGS to participate fully was by guaranteeing them that no one is taking notes, there was no tape recording.

MR. CLUFF: Yeah.

DR. ALLEN: It was not a legal proceeding. And to some

degree, I think our board, Nuclear Waste Technical Review Board, who's been criticized that we're taping all this, in essence, it prohibits some full exchange of ideas. The ACNW handles things quite differently, and I must say I'm impressed that some of their meetings have been much more productive ideas without the formality. Jim. Jim Devine.

MR. DEVINE: May I offer one comment about Diablo? I don't wish to take away one element of the good job that Lloyd has done since he took over that program. I would point two comments that might explain some of the answer to your question, Clarence. And that is, by the time that program was started, they had already been through seventeen years of warfare on that site, so much of the blood had already been shed. And two, the license--

DR. ALLEN: A new generation of blood was being--

MR. DEVINE: Was being generated. But a lot of the trenches were already pretty deep. And secondly, the license had already been granted, and there was a major sigh of relief on one side and a sigh of resignation on the other after the granting of the license. So we entered a new era of science investigation after that.

DR. ALLEN: Leon Reiter.

DR. REITER: Leon Reiter, staff. I sort of relate back to my experience, and I was at the NRC at that time. And

Jim, I think you're right, but I think there's one thing that was really changed when Lloyd and his team took over, was that there was a recognition that the old team was very confrontational with the USGS. That was changed, and as a result of that, I think there was a real change coming out of that.

MR. DEVINE: I agree with that.

DR. REITER: Lloyd, I would like to ask you a question, though, and that is, another thing that we at the NRC staff, and I think everybody, anticipated was that worst scenario, Diablo County was getting its license. Scientists came up, based on geophysical evidence, indicating that this Hosgri fault could possibly dip right underneath the plant and cause much larger ground motion. And that was the trigger that set this whole long-term program in. And a lot of faith was put in the idea that PG&E will go out and do a lot of geophysics to resolve this question. To what extent was that realized? And to what extent did geophysics play the role? And how much was spent on it?

MR. CLUFF: That's a very good question, and geophysics did plat a very key role in those early days in terms of developing issues. The one that you mentioned, it was the Crouch hypothesis of a fault, very close below the plant. And we did do a lot of very innovative geophysics. We

purchased a lot of existing proprietary petroleum company geophysical results that were very helpful, and reprocessed them and so forth. We actually purchased all of the geophysical tract lines that Crouch himself had done and looked at the original process and then did more high-resolution processing.

And what I learned out of that one little reprocessing was that depending upon what you're looking for, you can change the parameters of the processing to get almost any answer you want. Now, geophysics is an indirect tool, and it's highly interpretive. And you have to admit that if you're looking for traps for oil, faults are traps for oil. And geophysicers who are out there trying to get plays on petroleum are fault happy. And they don't know the difference between one fault and another when it comes to being seismogenic.

And we did a lot of deep geophysics. We did some of the profiling that went down to the base of the crust, all the way out to the Continental Shelf. That was very helpful and helped a lot of the university people to get in and give us advice.

But the single thing that I guess I looked at in terms of geophysics, it's one database, highly interpretive. You need to get a number of interpreters from petroleum,

from engineering, geophysics, and look at the variations. And then it has to be integrated with and compared with other databases, onshore geophysics. Sometimes we found the offshore geophysics and the onshore geophysics to be completely out of kilter with one another. The onshore geology didn't meet the offshore geophysics. So we spent a lot of time trying to figure out why there were differences, and running more geophysical profiles until we finally got the answer to some of those.

So we integrated the geophysics with the geology, both offshore and onshore, and the seismology. We had a seismic network operating in the area, plus the broader coverage of the USGS, and we found that a lot of the work done by the USGS and by PG&E seismologists and our consultants, didn't fit the geophysical models that had been developed. So it all had to be integrated, and if something didn't fit, you had to find out why. And what I found was that geophysics wasn't that reliable to resolve the issues. You had to use it as a test, or take a geophysical model and then test it. So I would argue that geophysics is useful, but not to give you the answer. It's just another database that has to be compatible with the other databases.

The question was asked earlier about the role of the Seismic Safety Commission. I'm a commissioner on the

Seismic Safety Commission, and have been for some ten years. The Commission is not a regulatory body. It's a body that advises the governor and the legislature in the State of California on policy matters. And we bring the regulators into our meetings and have workshops and hearings to try to focus the regulatory process on the things that address seismic safety. And the Commission had just been formed during the beginning of the Auburn issue, and they had a lot of clout with a lot of high-level people in the State of California, and they were the ones who assisted the California Department of Water Resources to have more say in the federal versus state issue on seismic safety.

There was another question that someone asked about panels of experts or advisory panels or consulting boards, how do you use them and what kind of responsibility do they have? It depends on a case by case basis, but there's one set of criteria. They have to be of the highest quality, integrity, experienced individuals, and availability to serve. There's nothing worse than to have a person who fits some of those qualities and then comes late and leaves early, and then the next time we get together, the person is off in left field when you come to trying to address issues. So there has to be a commitment to get involved.

I wrote a paper from the experience of the LNG

process. Leon, I don't know whether I ever gave that to you. I've got one in my briefcase. But it's the entire process that set the precedent for both the state and the feds to convene a joint hearing to empower a panel to actually make the value judgment on whether or not the site was safe. And this has all been set legally in the State of California. I would urge you to look at that, and I'll give Leon another copy if I didn't give it to him before. Where I think if they are properly selected and charged in terms of their responsibility, they can be very effective.

DR. ALLEN: I should point out that our Board has been on record ever since the first meeting that the DOE should make more use of expert opinion from outside of the Department of Energy, solely in terms of adding to credibility. It might not change any of their opinions at all, but it might add more to credibility. Steve Brocoum.

MR. BROCOUM: I just want to add one thing to the Diablo Canyon. I was one of the people at the NRC when this Diablo Canyon stuff started on the latest information on the Hosgri fault. That information came to us just before, I think, the Commission was going to make a finding on full power operations. That's what I remember. And we had enough confidence in PG&E that they would handle us properly, look into it. When they hired Lloyd, it gave us even more

confidence. We felt that our advice to the Commission was to allow the plant to operate. That wasn't made clear in Lloyd's presentation, for you who may not know. But the plant was allowed to operate all the years that the long-term seismic reevaluation was conducted. And we felt that the plant was safe during that period, and that was another find we had to make. But it was, in a sense, a win-win situation on all sides. The plant was allowed to operate while they actually finally answered those questions on the Hosgri fault.

DR. ALLEN: Other questions? Yes, Wendell Weart.

MR. WEART: The similarity between the discussion I heard about the Yucca Mountain program and the WIPP program is very striking. We're undergoing a rebirth right now also, in which we're being asked to do things quicker, with no more money, and make this process perfectly credible. Our immediate task is, in fact, to find a way to do that. And the only way to do that that we've found a path to is to do some decision methodology which is probably--I don't want to prejudge it--going to result in some very major changes in concept about how WIPP operates up front, such as phased waste acceptance.

We have a very indiscriminate type of waste. Some of it's very innocuous, some of it's very difficult to deal

with. And we may find that the best way to an early certification of compliance is to purchasing in a phased manner. Now this, in fact, we've presented to a number of people, to the National Academy, to EPA, and they all think this sounds pretty neat. And we think it has some promise, or we wouldn't be doing it. But the problem is, all these people who think it's neat have a desire to get on with the job. And I'm not quite sure how we're going to make this process sound credible to the general public, who will more likely view it as, "Here they go again, trying to get WIPP open early, trying to get Yucca Mountain operating early."

We have to find a way, I think, to explain this process in credible, honest, understandable terms to the public and to the stake holders who are not pro stake holders necessarily, to successfully sell this new approach in both programs.

DR. ALLEN: Camilla Odhnoff.

DR. ODHNOFF: It is very interesting to listen to you, and while the U.S. Government is not the only one in the world that thinks that they just can tell people to do things faster with less money, that's something I think both Klaus and we from Sweden have heard before.

I would like to ask you, is Yucca Mountain still an open question? When I listed to DOE, their presentation, I

understand that this is the one and only possible site and this is it. When I meet politicians from Nevada, and during these few days we have been here, there are surprisingly many politicians that come up and tell you their opinion on these matters. And they imply that singling out Nevada is a political decision connected with the fact that the population is what it is, and so on.

And I would like to ask you, then, is it in your opinion really a good scientific choice to say that Yucca Mountain should be declared a site? And when you do your research and you are surveying these things, do you do it with an open mind or do you do it just to prove what is already decided?

DR. ALLEN: I have a feeling Lake Barrett might like to answer that.

MR. BARRETT: The situation by statute, by law, is that we are authorized to scientifically characterize only one site, and that site is Yucca Mountain. Now, there is a voluntary process if some other potential repository site would be interested in being a repository site, they can talk with the nuclear waste negotiator, who could take a proposal to Congress. That's allowed. But the negotiator hasn't, to my knowledge, had any jurisdictions that have expressed an interest about being a repository site.

Now, the way Yucca Mountain got to be chosen as the only site to characterize, was in a long process where we looked at nine sites, five sites, three sites, and based on the scientific data that was available in the mid-'80's, it was determined to be a good site. I didn't say it was the best site, it was a good site. And United States Congress, in its wisdomly ways, said there's only going to be one site to be characterized.

DR. ALLEN: But that was purely a political decision.

MR. BARRETT: That was a political decision. It was an economic decision, then it was starting to become obvious to characterize a site and go through the formal suitability process, go through the licensing process, was an expensive undertaking. And when the Congress realized if we were to do this for three sites, which was the plan back in the mid-'80's, that this would be very expensive, and Congress said, "Don't do that, do one site," and they chose Nevada, Yucca Mountain, as the only site to characterize. But they also said, "If it turns out that it is not suitable to be a site, a repository site, come back and tell us." So it is not a foregone conclusion that it will be a repository. So if we find geologic conditions that would make it unsuitable for a site, I wouldn't feel bad to go back and tell Congress, "Well, the choice that was made was not a good one, and we

just found that out. Now what do you want to do to start another siting process to find another site?:

DR. ALLEN: Klaus Kuhn.

DR. KUHN: If I was a little aggressive against you a little earlier, I want to defend you in this case, for we are in a very similar situation at home. During my presentation, I stated this morning that we followed the proper site selection procedure and came out with three proposals. Neither of them was accepted. And by a proposal of the state government of the then acting state government, Gorleben came up in the picture.

But I again would underline my statement from this morning. You first have to look into the qualification of the site. You can't disqualify the site before you have investigated it. And so up to now having done this work for more than ten years in Gorleben, there was really not one perfect knockout criterion available, so of course there are weak parts in the system.

But if you will investigate each site with such a detailed investigation program like you and we do, you will never find an ideal site. You will always have some flaws. And I would like to underline it is not necessary to find the best site, but it's necessary to find a site that can meet the goal.

DR. ALLEN: Well, in about five minutes, I want to turn it open to the audience. But in the meantime, let me ask the board and the board's staff if any of you have comments, questions, that you would like to offer. Yes, Dr. Price?

DR. PRICE: I would just like to ask the counsel from NRC if he has any comment on the feelings of NRC with respect to the question and answer about the development of this Schedule A and the interaction of DOE and the NRC in that process.

MR. CHANDLER: I wouldn't begin to be able to, having just heard it for the first time today. But I'm anxiously awaiting the presentation that they'll be making to the Commission later next month and in June.

DR. ALLEN: Other questions? Where's Warner, did he leave?

MR. CLUFF: Clarence?

DR. ALLEN: Yeah, Lloyd Cluff.

MR. CLUFF: I had another observation to make that had to do with dealing with the public, and particularly intervening bodies that tend to have an agenda that of course is not to help you anyway, to have the project go ahead, and on the long-term seismic program for Diablo Canyon, a turning point with regard to the clout that the interveners had locally and in some circles in scientific areas.

The original program that was proposed was severely criticized by a number of technical people, including a prominent geologist who was a professor of geology at Cal Poly, the State of California University at San Luis Obispo. I'll open this in terms of inviting local geologists and others, openly inviting them in writing and calling them on the phone to come out and observe the field work and so forth. And we had a public forum that was sponsored by the local television station for one Sunday evening from 6:00 to 10:00 at night, where there was a group like this that included local citizens, about 50-50 for and against Diablo Canyon.

I was there and this professor was there, and I was told by the PG&E management and attorneys that he'd been a very tough adversarial individual and that I shouldn't even be seen talking to him and so forth. And I nevertheless took the opportunity, prior to the television starting, to go up and find--because I knew he'd been out in the field with some of our field teams, and he let me in on a secret. He said, "I'm going to startle this group this evening when I make an announcement." Then he just said, "Just stand by."

So when it came his time to speak on live TV, he said that he had realized that over the years in his opposition to the Diablo Canyon Power Plant, he had been

wrong and that he had been working with the scientists, and they'd been very open, they shared all their data, and he looked at their priorities and criteria, and he said, "I've been convinced that on a technical merit of the information and the quality of the work that's being done, I now declare that the Hosgri fault cannot generate an earthquake greater than magnitude 6, and that the Diablo Canyon"--he totally turned around, and the interveners that were in the room were at their wit's end. And from that point on, the local community lost one of their main spokespeople. And it was clear. He admitted that he'd been manipulated and that he'd been fed erroneous information. And now that he was seeing what was being developed, he said he had nothing but admiration for the work that was being done.

DR. ALLEN: Like in a sense he was being bought by someone.

MR. CLUFF: Yes. So, you know, that was a surprise to everyone. And I think it speaks for the open nature of places where you can have open dialogue, at least trying to get to the truth, rather than trying to outwit each other.

DR. ALLEN: In this area of openness, I don't know anyone who's been critical of the DOE, certainly in the efforts of the DOE to get people off of the site, not only scientists, but public citizens, has been really rather

remarkable insofar as I'm aware of.

MR. CHANDLER: Clarence?

DR. ALLEN: Yes? Larry Chandler.

MR. CHANDLER: One observation, if I may. Jim Devine's point regarding Diablo, I think, was a very significant one. I think the environment, post licensing, was very instrumental in permitting the process to work as well as it did. And it did work extremely well, there's no question about it. Lloyd was 100 percent right on that.

I think today the general approach, and certainly the NRC's regulatory approach is also very different. I think generally industry's approach is very different in terms of openness and accessibility to the public, which should contribute.

And just one final observation, the process and vision with respect to the licensing of the high-level waste repository, under the Commission's rules, also should facilitate a process that will be able to hopefully do things in a perhaps less adversarial mode. The establishment of the LSS, which is to include all relevant documents--and that's a very sweeping statement I make, but just to generalize a moment--provide access to all the parties and the recognition that the states and others will enjoy a special process, or access to the process, from the outside, I think will go a

long way in streamlining things, more so than perhaps was true in other more routine licensing cases.

DR. ALLEN: Thank you. Let me now turn it open to anyone in the audience, or the assembled group out there, who has something to say. If so, would you please raise your hand, and would you also identify yourself in the microphone? Yes.

MR. BECHTEL: My name is Dennis Bechtel. I'm with Clark County, Nevada. For those of you who are unfamiliar with Nevada, it's the area around Las Vegas, south of Yucca Mountain. I've got several questions. One I'd like to direct to the representatives from Sweden. I was intrigued by the fact that you have a theologian or on your siting board. I was just curious whether, in fact, this individual has influenced your siting process and whether it's perhaps changed some things that maybe a purely technical committee would have recommended.

DR. ODHNOFF: The reason why we thought we should have a slightly different profile from the state authorities, who are very well equipped on the technical and natural scientists side, we wanted to meet people and take up questions they had which, from the technicians, were pushed away, they're too complicated. "You must trust us, we understand, but it's not possible to explain to you." This

made people very uneasy, to say the least.

And we thought when KASAM was founded that we should have somebody who could understand the uneasiness of ordinary people, of the layman. And also, somebody who was used to thinking in long spans, and with a window open to eternity. So therefore, we proposed to our minister that she should pick a theologian.

And when you ask if she has influenced the thinking of dominantly technical natural scientists, well, she very often speaks about the human being as unfoolproof, rather than foolproof. And to her, it's really the reason why development can be achieved at all, because if everything was perfect, well, you'll come to a standstill. But since it's not perfect, there is always a possibility that things will change.

And therefore, I listen with great interest to the new ideas from DOE that they wanted to have a 100-year repository, open repository. Because this is something that she has suggested, too, that there must be a certain possibility of repairability and there must be also a possibility that you can close it so you should not guard it continuously. But it should not be too difficult to open and to be able to repair if you find that you have made mistakes.

MR. BECHTEL: Thank you. My second question is directed

to Mr. Kuhn from Germany. There's been a considerable amount of discussion today about the siting of repositories. How is Germany handling the transport of the waste, which is of concern to us as well?

DR. KUHN: I mentioned this morning that we went through a very lengthy procedure of public hearing for the planned Konrad repository, which is in a former iron ore mine and which is previewed to serve as a repository for non-heat-generating reactor wastes mainly, but also from the waste from hospitals, like we talked about lunch today.

Frankly enough, during the public hearing, the transportation was a very big issue, in spite of not belonging to the licensing procedure of the repository. So the public hearing should strictly focus on the repository issues themselves. But the public brought up the question of transportation, and the normal answer to those people is that there's a large amount of experiences available for transportation of radioactive material, including transportation of irradiated fuel elements from the nuclear power plants to the reprocessing plants, crossing borders in Europe, and there has never been an accident. And especially there has never been an injury to any person at all. So the records of transporting radioactive material in Europe is excellent, and I think if you continue to develop further the

safety of transportation, at least in my personal opinion, this is one of the least problems.

MR. BECHTEL: Given the fact that humans build things and things go wrong, are you studying it, though? Are you studying the transport of the wastes or are you just using some existing--

DR. KUHN: Not personally. I'm not personally engaged in the transportation business. But there are of course people available who are looking into the problems of transportation, and they're also performing performance assessments for transportation. And we could show up to now that is really one of the negligible problems.

MR. BECHTEL: Okay, thank you.

DR. ALLEN: Thank you. Other comments from the--yes, Senator Hickey.

SENATOR HICKEY: Thank you, Mr. Chairman. I talked earlier about this. I'm interested in the integration of management. You know, we've heard that buzzword here for a number of years. It's been directed--in fact, it's one of the recommendations from the Board. But I, in looking at the presentation, and I think I direct my question to Lake Barrett, for the record, dealing with this integration of management, my concern is with the multiple purpose canister, how it interrelates with the thermal loading and the site

characterization and how that management is going to deliver that package on thermal loading, and actually the integration of the design of the repository. Now, it's a very complicated issue with a very simple man that needs simple explanations. Thank you.

MR. BARRETT: Oh, that's a challenge. Realizing that fuel exists, there's about 500 tons a year. In a couple years, we'll be going into X pool storage. Something's going to have to happen with that fuel, and it'll be going to various different technology. Whatever the cheapest utility cask is is what they put it into. Almost all of those today, you have to take those canisters or casks back into the pools, take them out, more exposure, more handling, and that's not a desirable situation.

So we started looking into advanced technology so that we could do it once in one canister that would be compatible with disposable. And the only place we're looking is Yucca Mountain, but even if it wasn't Yucca Mountain, something that would be compatible. Realizing that no decision was a decision by default, and if we didn't do anything, different storage designs, we still pull the freight, and it would basically be the cheapest ones available because the rate payers and the public utility commissions and all.

So we decided to take this on and do conceptual studies. We realized it was very complex and we had a problem in that they don't make people who, with ten years of geologic setting experience, and ten years of nuclear power fuel storage experience, you get ten of each, but you don't get anybody that's got ten of both.

So what we did, with some troublesome starts, we commissioned TRW to put together teams of folks, and they're doing the repository design work out at Yucca Mountain, as well as they were doing the storage, and as well as they're doing the transportation. They put together an integrated team that did reports on that, and basically came up with a spec, and that went through the final procurement to go out for private industry to bid against it.

As best as we can tell, within human capabilities that we have, if you were to go forward and build it in accordance with those specs, it would meet the storage requirements of the Nuclear Regulatory Commission for reactors, would meet the transportation requirements, would be transportable using existing technology that Klaus talked about, and would be compatible as best we know it with Yucca Mountain if Yucca Mountain turns out to be the repository.

Now, that last part, we got very much into the thermal strategy and how hot's the mountain going to be, and

a lot of unknowns, and we do not know how hot the mountain should be. Some scientists say you should make the mountain very hot, some scientists say you should keep the mountain very cool, and we do not know. We do not have enough scientific data to make a good estimate at this time.

So what we did, is in designing the MPC and designing the specs, we said, where does it matter in the design of the canister and design of an MPC? And we identified certain parameters, like the material that you'd make it out of, that it would be a flexible system, you'd put overpacks on it, because we didn't know about corrosion existence layers or corrosion allowance layers. So it would have to be flexible, it would have to be robust-type of design that could be used at different reactors, different cranes, different handling capabilities. And when it came to the thermal aspects, we knew, based on experience we'd done in Idaho, how hot fuel pins could be and still maintain their integrity. So we set specs as we went through it, and one of the specs was how many kilowatts would be in the can, based on different parametric studies we did for different thermal strategies.

So we bounded it such that it would work for a hot repository, but if it was a very cold repository, it didn't work as well. If you could go down to a lower level, then it

would cost more money if you had to space them all out. And the only thing you made that was irreversible from an economic point of view, not safety, because if safety turns out you had to change it, you change it, would be the middle temperature of the canister would exceed a 100°C. And that was really the only thing that it boiled down to once you specified that.

So that's a long explanation. The Board may wish to have a whole meeting on the MPC and its relationship to the repository so they could bring in the engineers and scientists who worked on that team. And we wrote several reports--I approved those reports--where we looked at the management risks that we were doing and that we were not making unreasonable estimates and decisions, realizing that no decision was a decision and the proliferations between technologies.

It's unfortunate that we don't have all the information before you need it, but that's usually the case of life. You know, when you're older and you know about it, you say, "If I was only seventeen again and I know what I know now." But that's the way it always is. But we believe that we are managing the societal risks as best we can at this point. We don't think we've done anything that's irreversible, and we don't think there are unreasonable

investments of money, and all it is is money at this point.

But it is a complex thing, and like I say, an integrated team worked on it and came up with a report that they all signed. The Yucca Mountain project people signed off on the package when we went forward with the MPC design to the secretary. So we did have that cross integration. We still have other areas to go, and we want to constantly improve it. We're not satisfied with where we are, but we think we've met the basic needs, and we have an adequate integration. It is not the integration that we certainly desire and strive to have, and we will have much better in the future.

DR. ALLEN: Thank you, Lake. We're essentially at the end of our program. We'll take two more comments, one over here, and Harald, you had something you wanted to say.

DR. AHAGEN: The lady.

DR. ALLEN: Okay.

MR. WILLIAMS: I'll try to be brief. I'm Bob Williams of the Electric Power Research Institute. I'm speaking primarily because if the organizers of a meeting provide the opportunity for stakeholders to say something, I think that opportunity should be taken, or the forum will vanish.

I think there's one crucial point that became clear to me. My compliments to Leon Reiter for organizing this

session. I came here thinking, what the heck are we having discussions of site suitability and site selection for? We have gone a good ways down that path. And in the morning session, it started to appear that many of the key decisions and many of the key bridges that were lessons learned from Martinsville had already been crossed at the Yucca Mountain Site. But I think there is an absolutely crucial lesson that hasn't been highlighted so far today.

And first let me inject another caveat. While I'm from the electric power industry, nobody can speak for the electric power industry. Ask them. So I speak for myself. But I think this is a very important conclusion that the industry would support. It goes like this:

We absolutely must go forward with some kind of preliminary safety analysis report to accompany the site suitability determination, or otherwise we'll be into the thicket that the Martinsville people were into when you forced the hearing process that is trying to determine site suitability to obliquely deal with the safety issues. And I think that needs to be said publicly, because I think we're all trying to grapple with the question of how to deal with uncertainty and how to assure the citizens of Nevada that the siting process is safe. Thank you.

DR. ALLEN: There was a comment back here, please.

MS. TREICHEL: My name is Judy Treichel. I'm from the Nevada Nuclear Waste Task Force. And I did want to say that the comments that were made by the representative from Sweden sounded like the questions and comments made by Nevada citizens, and have been for years. Your question about, is Yucca Mountain still an open question, is it the right choice? And many of the times, we don't get answers much better than you did. We often hear, well, it's the law. And a lot of what's gone on through the industry and through the Department of Energy has been to sort of sell inevitability to Nevadans. And that has a sort of chilling effect, and people kind of pull away, because it doesn't make much sense to bang your head against a brick wall. So where you also mentioned that you're told "Trust us," and it gives you an uneasy feeling, I know exactly what that feeling is all about.

But I wanted to also say that we have had a huge change in the policy, or in the program, very recently, and many of us heard a presentation much like what we heard from the DOE each day. We heard it on Friday. They had very different view graphs. But we have been told for years here in Nevada that we were to trust the system, and if it's not safe, it won't be built. And it's very evident from the presentation that came today, and particularly from the view

graphs that we got last Friday, that the intent is to build this, and then check for safety. And that's going to be very difficult to sell to the people of Nevada, who have been assured for a very long time that that would not be the case.

And the other sort of impassioned statement that we've gotten for years and years is that this must not be a problem for future generations, that it was this generation that benefitted, and that future generations should not bear the burden. Well, according to the new plan that's out there and was presented today, it's going to be the future generations who test and see how well we did. And they could very well be in for dreadful surprises. And all of this seems like a pretty awful way to go.

And the last thing I wanted to bring out was that in the examples of successful siting, many of those were not nuclear or radioactive facilities, and there's a big difference. The minute you get into anything having to do with radiation, it's very difficult to draw comparisons. And in many, many of the cases that were cited, they were not forced sitings, which is what you have in Nevada, and that's a whole different ball game. That makes everything change. So, thank you very much.

DR. ALLEN: Thank you. Any other comments?

If not, then, let me thank the speakers today.

Thank you also for the past hour. If one thing comes through loud and clear to me, it is that the Nuclear Waste Technical Review Board, or at least those of us who are scientists and engineers on that board, are not going to solve the Yucca Mountain problem by ourselves. John Cantlon, do you have some final words.

DR. CANTLON: No, just for tomorrow.

DR. ALLEN: Okay, we're adjourned until 8:30 tomorrow morning.

(Whereupon, at 6:05 p.m., the meeting was adjourned.)