UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

SECRETARIAT RECORD COPY

Title: BRIEFING ON ACTIVITIES OF THE CENTER FOR NUCLEAR WASTE REGULATORY ANALYSIS (CNWRA)

Location: ROCKVILLE, MARYLAND

Date: MARCH 9, 1993

Pages: 56 PAGES

NEAL R. GROSS AND CO., INC.
COURT REPORTERS AND TRANSCRIBERS
1323 Rhode Island Avenue, Northwest
Washington, D.C. 20005
(202) 234-4433

DISCLAIMER

This is an unofficial transcript of a meeting of the United States Nuclear Regulatory Commission held on March 9, 1993, in the Commission's office at One White Flint North, Rockville, Maryland. The meeting was open to public attendance and observation. This transcript has not been reviewed, corrected or edited, and it may contain inaccuracies.

The transcript is intended solely for general informational purposes. As provided by 10 CFR 9.103, it is not part of the formal or informal record of decision of the matters discussed. Expressions of opinion in this transcript do not necessarily reflect final determination or beliefs. No pleading or other paper may be filed with the Commission in any proceeding as the result of, or addressed to, any statement or argument contained herein, except as the Commission may authorize.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

- - - -

BRIEFING ON ACTIVITIES OF THE CENTER FOR NUCLEAR WASTE REGULATORY ANALYSIS (CNWRA)

- - - -

PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Tuesday, March 9, 1993

The Commission met in open session, pursuant to notice, at 10:00 a.m., Ivan Selin, Chairman, presiding.

COMMISSIONERS PRESENT:

IVAN SELIN, Chairman of the Commission
KENNETH C. ROGERS, Commissioner
FORREST J. REMICK, Commissioner
E. GAIL de PLANQUE, Commissioner

STAFF SEATED AT THE COMMISSION TABLE:

SAMUEL J. CHILK, Secretary

MARTIN MALSCH, Deputy General Counsel

JAMES TAYLOR, Executive Director for Operations

ROBERT BERNERO, Director, NMSS

JOE YOUNGBLOOD, Director, Division of HLW Management, NMSS

WES PATRICK, CNWRA

BUDHI SAGAR, CNWRA

P-R-O-C-E-E-D-I-N-G-S

10:00 a.m.

CHAIRMAN SELIN: Good morning, ladies and gentlemen.

Today we're meeting to receive a briefing on the activities of the Center for Nuclear Waste Regulatory Analysis. The Center is operated by the Southwest Research Institute under contract with NRC. It's an NRC federally funded research and development center. Its purpose is to provide the NRC staff and through the staff the Commission with strong and independent technical and scientific support for our high-level waste program.

The nation's high-level waste program is a one of a kind effort which presents enormous challenges, demands knowledge and skills of the highest quality. The Center plays a vital role in this program by assisting the NRC staff in addressing these technical challenges and by doing so with personnel and management who are free from any conflict of interest with NRC licensing matters.

It was initiated with a five year contract awarded in October 1987. Since that time the high-level waste program has changed and matured considerably. The Center has also evolved to its

present form.

The Commission is quite interested in hearing directly from the Center of the current problems and issues being faced and the prospects for resolution. It's especially appropriate that we receive timely information now, just as the DOE site characterization program is gaining real momentum. I assume that the meeting this morning will concentrate on the substantive work of the Center, not administrative and management points.

Commissioners, do you have anything you care to say?

Mr. Taylor?

MR. TAYLOR: Good morning. I'll note that this is the seventh briefing provided to the Commission on Center activities and issues. To present the briefing, Bob Bernero from NMSS and Joe Youngblood are on my right. To my left are Wes Patrick, President of the Center, and Budhi Sagar, the Center's Technical Director.

I would like to note that also here with us but sitting in the audience is John Latz, who has elected to go on a part-time basis with respect to Center activities and has been replaced as the Center President by Wes Patrick.

With those opening remarks, I'll ask Bob Bernero to continue.

MR. BERNERO: As you requested, Mr. Chairman, we will not dwell on the administrative matters. We want to focus this briefing on the current and significant technical issues so that the Center can speak to the Commission on them.

Just in passing, I would like to note that the Center currently has 52 core Center staff on board by the end of this second quarter. They are approaching the 54 projected by the end of the next quarter and things look pretty good in that. In that slide you have summary status. There is also an important note that they are currently underrunning at about 35 percent of the budgeted funding. It basically would indicate that there's a programmatic lag as the staff came up, but also there has been a due amount of caution and there hasn't been full utilization of contractors or subcontractors beyond consultants and the like. We hope to take advantage of this. We're right now exploring in light of the recent budget marks how to best take advantage of this situation for the program.

So, with that, I would like to turn it over to Wes Patrick and Budhi for the technical

issues.

MR. PATRICK: (Slide) Slide 3, please.

I certainly appreciate the opportunity to provide you with this briefing today. What we're going to do in the next few minutes that we have together is first to lay out the basis, the methodology that we use for identifying the issues and we're going to cover that very briefly so that we can get to the heart of the matter and discuss the issues themselves. Then, for each of the five issues that we've identified, we'll give a brief statement of our perception of the issue. We'll then progress to indicate how we are making progress toward the address of that particular issue and finally just make a few brief remarks on what our perspective is on the outlook for resolving that particular issue.

(Slide) Slide 4, please.

We use a five element methodology as indicated in slide 4 to identify what we typically call uncertainties. What might also be characterized as concerns or issues within the program. I would note at the outset that the NRC staff has a role in each one of these five areas. That role varies. In some cases they are the principal technical participant in such things as prelicensing

interactions and the Center has a secondary role in those cases. In other cases such as research activities, we are the lead and they function as project managers. So, there's quite a range of staff interactions between the Center and the NRC in the conduct of these areas of activity which we use to identify and then seek resolution of the particular issues that are arising within the program.

(Slide) Slide 5, please.

Today we're going to focus, as I indicated before, on five broad issues. These are not the only issues that have been identified, but we've selected them because of their potential impact on the full breadth of the program. Budhi and I will be working back and forth to discuss these to set the stage for the issue and describe our progress toward it and resolution as we go through our briefing this morning.

(Slide) Slide 6, please.

The first issue that we've identified deals with the matter of data and models of the processes and conditions that exist at the site. DOE is going to be required to present in their license application a very comprehensive and thorough description of all of those processes and conditions that now exist and that might evolve over the

millennia to come that could affect performance. It's going to take not only a good deal of acquired data, but an exercise of professional judgment and interpretation of the data that have been acquired and to cast those data into the context of what we call conceptual models and then eventually mathematical models.

Recognizing that there's no prior experience with the 10,000 year licensing period that is of interest to us here for the repository program, we recognize that there's a need for objective criteria for determining how much is enough. Have you acquired enough data? Have you analyzed it thoroughly enough so that you have some degree of assurance that you understand both the current conditions of the site and also how those conditions might evolve with time in what we call scenarios, the future states of the repository setting.

Delays in the site characterization process to date have raised some concerns and some issue that there may not be sufficient time for certain of these data to be acquired and analyzed and used in the design process and in the performance assessment process as time goes on. In particular, our concern goes to those coupled processes that take

place in the near field of the repository which, by the very nature of the materials involved, take very long periods of time. I speak, for example, of things such as heat flow and moisture migration in the unsaturated zone of the repository.

There are difficulties that are fundamental or inherent in forecasting the evolution of these systems and those are at the very heart of this particular issue that we're dealing with. One of the concepts in geological investigation that comes into play here is the notion of alternative conceptual models where any given set of data could be interpreted in a host of ways. Those are some of the elements of this issue that we're addressing, the key being how does one obtain reasonable assurance with regard to the performance of the geological repository.

DOCTOR SAGAR: I'll talk very briefly about the progress that we are making at the Center in resolving this issue. Very briefly I'll talk about the three examples listed on slide 6.

The very first one deals with the field experiment that is NRC sponsored near Las Cruces, New Mexico. The experiment was designed to investigate the effect of alternating perceptual models and also

to judge the worth of data for forecasting the shape of a contaminant plume in the unsaturated soils.

In the analysis of the data that we performed over the last two years, we found that even when we used the state-of-the-art mathematical models to predict the shape of the plume, that the exact shape could not be predicted. However, the news wasn't all that bad because we were able to reproduce certain integrated characteristics such as we were able to reproduce the central height of the plume reasonably well and we were able to reproduce the dispersion about the central height of the plume. This study is continuing to evaluate the effects of data density. That is to try to sensor the large amount of data that's available at the site to see how much is enough. This would be a site specific study, obviously, and I'm not quite sure if we would be able to answer the generic question how much is enough at the end of the study.

The second study I want to briefly talk about is about the nickel alloy A-25, which is a candidate waste container material that DOE has selected. The particular concept we wanted to test in the lab was the sensitization of this particular alloy. When we did the experiments we observed the

sensitization at 600 to 800 degrees C. However, the conclusion we came to was that if we wanted to study the same process at realistic temperatures of the repository that a much longer test, such as ten years or longer, would be required, which pertains to --

CHAIRMAN SELIN: Wait. Say that again, Doctor Sagar?

DOCTOR SAGAR: If we wanted to study the sensitization issue at temperatures that would be prevalent in the repository, which is 200, 250 degrees C, that a much longer time test, such as ten years or longer, would be needed.

CHAIRMAN SELIN: We were briefed last week by the Department of Energy's own advisory committee and they were discussing some possibilities of, in fact, storing the materials at higher temperatures than had previously been considered. How would that affect your analysis?

DOCTOR SAGAR: For this particular phenomenon, the higher the temperature the shorter would be the test.

CHAIRMAN SELIN: Sort of a conservation of energy?

DOCTOR SAGAR: Right.

MR. PATRICK: But also the greater the

impact is the implication of that, sensitization occurring much more rapidly in the real repository conditions.

DOCTOR SAGAR: I guess the point we are trying to make is that depending on the design and whether this is going to be hot repository versus cold repository, the test span, the length of time that you need would vary. Therefore, if the site characterization of the design phase delays, you would have to add more time to carry out the test.

CHAIRMAN SELIN: But let me go to the next step. If this is not known to us which approach the Department of Energy is going to take, would you have to do both experiments? Could you do the one and extrapolate to the other or would you need to have both a hot and a cold temperature experiment to answer your questions in advance?

DOCTOR SAGAR: I think the only way we could extrapolate would be if we understood the phenomenon. If it was empirical, you have to do both tests. And there's quite a distance between those two concepts, just extrapolating based on experimental data versus mechanistic understanding of the phenomena which you could then extrapolate. But both would require considerable amount of experimentation, in my

view.

CHAIRMAN SELIN: So that would suggest that we try to get an authoritative answer from the Department of Energy about which approach before we enter into fairly expensive experimentation which, if I understand you correctly, when you said, "Unless we really understand the phenomena," I understand the implications. We're not going to really understand the phenomenon and therefore we would have to repeat the test if the temperature basis switched.

DOCTOR SAGAR: That's correct.

CHAIRMAN SELIN: Is that correct?

COMMISSIONER REMICK: Would you see the NRC doing confirmatory tests in this area or would you expect DOE to carry out the tests?

MR. PATRICK: Well, I think the phenomena are poorly enough understood with current state-of-the-art that the NRC would have an interest in an area as fundamental as this. We're dealing with the issue of containment of the waste and the lifetime of the container that at least some limited confirmatory testing would be in order.

CHAIRMAN SELIN: So, are you answering Commissioner Remick to say both, you would expect DOE to do the test and that we would also do a

confirmatory test?

MR. PATRICK: Yes, sir. Our view has always been that NRC and the Center and serving them should not be in the role of developing any major component of the database, that the role there is to both confirm those studies which the Department has conducted and carried forward in their license application, and second to explore some of the fringes of performance which perhaps DOE has not investigated but which, in fulfilling its safety responsibilities the NRC would have a vested interest in making some assessments.

CHAIRMAN SELIN: Without putting you on the spot, Mr. Bernero, do you basically agree with --

MR. BERNERO: Yes, indeed.

CHAIRMAN SELIN: I'm putting you on the spot.

MR. BERNERO: Yes, indeed. Wes is reflecting the view that we have of the role of the NRC and the role of the Center. We want to select those crucial points. Systematic independent performance assessment has been one of them. Then going into the database, selecting those crucial points where to have an independent opinion we have to be sure that DOE has done a thorough job and getting

on the edges, looking for key uncertainties that could contribute.

But again, I think Wes put it and we have discussed this many times, the burden of proof is DOE's. So, the body of the database, the fullest range of what is needed is DOE's responsibility and we're here to affirm that or to deny it and we need a certain degree of independence to do that.

CHAIRMAN SELIN: To accept somebody's description in a different -- they can deal the cards, but we want to make sure we cut them before.

COMMISSIONER ROGERS: On this question of understanding the phenomena, how much will the possibility of understanding will depend upon the physical and chemical characteristics of where the waste packages are being emplaced? Not just temperature environment, but the actual material that's adjacent to the packages. Presumably that's an issue here.

DOCTOR SAGAR: If you're talking about the environmental conditions, that strong waste package, those are exceedingly important and they are heterogenous because of the geology in which they reside. In fact, the recent work we did shows that even in a hot repository the containers can stay wet.

It can be aqueous conditions even at very high temperatures because of the way pressure, depression and so on, some other phenomenon that occurs. So, yes, that's indeed an issue that needs to be studied.

COMMISSIONER ROGERS: Well, I guess the question I have is whether you can do an experiment that's meaningful, either hot or cold, without having data as to exactly what the environment is in which the packages are going to be placed.

MR. PATRICK: Commissioner Rogers, one of the things that we have done in what we call our integrated waste package experimental program is to take a very careful approach to experimental design using some of the factorial experimentation concepts to test a range of high and low values of each of the parameters that we believe would be present in a Yucca Mountain-like repository. We know enough about the chemistry of the rock that using some geochemical modeling techniques we can develop a range of geochemical conditions for the water that is likely to come in contact with the packages. We've taken that factorial approach to in this interim period to try to bound the range of conditions that might eventually be of interest, depending on which design is, in fact, selected.

COMMISSIONER ROGERS: Okay.

MR. PATRICK: That's about the best you can do at this stage of thinking and development of the repository.

COMMISSIONER ROGERS: Yes.

DOCTOR SAGAR: The third example, the last example regarding this particular issue relates to the iterative performance assessment which is jointly undertaken by the NRC staff, Research and NMSS, as well as the Center, to study what particular data is more critical than some other set of data. For example, in the iterative performance assessment phase 2, which is continuing at this time, we find that if there was one single parameter that was driving the performance of the repository, that was the infiltration rate. That was the depercolation rate. That is the most uncertain at this moment. That needs to be studied both in the field as well as in a numerical sense.

The NRC idea team plans to do an analysis in the phase 3 on that particular issue. We believe that the two major programmatic documents which are being developed by the NRC staff, with some assistance from the Center, would make significant contributions towards resolution of this particular issue. Those

two documents are the format and content regulatory guide and the licensing application review plan. These documents, together with the prelicensing interactions with the DOE and their contractors, we believe would provide some definition of what data models and interpretations are to expected from DOE at the licensing time.

Ultimately the resolution of this concern, we believe, would be to focus on the impacts of various phenomena and models and data on performance. That is the only test we can identify that would tell us how much is enough.

(Slide) Slide 7, please.

The second issue we selected for discussion is the validation issue, validation of models and validation of submodels. The models would be used in the predictive performance in the long-term and we believe that the space scales and the time scales in the repository are so large that there would be no true validation in the scientific sense. Yet we do require some sort of testing, some sort of confidence building to arrive at a reasonable assurance during the licensing process. That, we believe, is an issue that would be there when we review the license application.

The Center and the NRC staff and the other countries that are involved in the high-level waste management have designed international programs. The Center and the NRC staff are participating in at least two of them, the INTRAVAL program, whose aim it is to validate the models of hydrologic flow and transport, and the DECOVALEX program which is dealing with decoupled models of terminal mechanical and hydrologic processes. We have selected two analog sites and we believe natural analogs do provide an opportunity to study the phenomena at the scales of the repository, both space and time, and that they could be helpful in the model validation exercise.

The fourth site is Chihuahua, Northern Mexico, which is the host rock there is tuff and the climate and the hydrologic regime and other factors are remarkably similar to those at Yucca Mountain. Further, the site hosts a uranium ore body which contains uraninite, which we believe could be a very good analog to the spent nuclear fuel. The uranium migration is being studied, is being measured. It's a fractured tuff rock, so we could try to figure out the partition between the fractures and the matrix as to how migration occurs in such a medium. And the project is about a year old and we expect a

considerable amount of information to come out in the future.

The second site is on the --

MR. PATRICK: Commissioner de Planque?

COMMISSIONER de PLANQUE: I think you're going to answer it. I didn't hear where.

DOCTOR SAGAR: The second site is in Santorini, an island in Greece, and that's under investigation as a potential natural analog site. This is an archeological site. It has been excavated since about 1967. The attraction on the site is that the dates on which a particular geologic event happened, which is a volcanic eruption, is quite well known. It's about 3600 years old. So, we have the initial conditions sort of fixed in this particular site, which is the hardest thing in natural analog projects. There are some metal artifacts that had been discovered and there are plumes that one could study what happened in the last 3600 years.

A variety of further lab and field studies are also in progress on model validation. Again, we believe that the resolution of this particular issue is both in the DOE's hands and NRC's hands in the sense of NRC trying to define what the expectation would be regarding the validation of models as they

are presented by DOE.

(Slide) Slide 7, please.

CHAIRMAN SELIN: Did you get your question answered?

COMMISSIONER de PLANQUE: Yes.

MR. PATRICK: Slide 8.

The next issue deals with the use of early site characterization data. As the Chairman indicated, the momentum has begun. DOE has now obtained all the necessary permits. They've launched their field studies. They are preparing their ramp areas to begin tunneling at the site and we believe now that that portion of the program is behind them, getting ready, that it's now time to turn some additional attention toward the sequential use of the acquired data as these excavations take place and as the studies are themselves conducted. This is true not only of the subsurface investigations, but the surface investigations as well.

And here again, both DOE and NRC have a need and role to play in the sequential use of this data as it begins to be acquired. I've noted there on the slide just a few of the uses that that data needs to be put to, some of the early designs, the early decision making processes that will be taking place,

use of that data and iterative performance assessment so that NRC can begin to make some judgments, targeting back to one of the earlier issues, as to whether the program that DOE is conducting is heading in the right direction, whether they are, in fact, launching a program that is providing data that is adequate to the task from a regulator's point of view. Those early sequential decision making processes, we feel, are very important and need to be given considerable attention at this point.

We feel also that as the excavations begin, as the surface and subsurface data begin to be acquired that things will be learned that could lead to changes in testing strategies as well as changes in design activities. Those are things that need to be done in a sequential basis. Our own experiences on projects has been that one gets so wrapped up in the acquisition of the data that sometimes one forgets that there's an analysis process and a utilization of that data that needs to be taking place as well and we need to turn our attentions to that.

Interestingly, this isn't really an area where NRC staff can be particularly proactive and forceful in terms of driving the availability of the data. But the data are becoming available through the

normal prelicensing process. The semi-annual updates to the site characterization plan, for instance, the participation that DOE is very good about and the various public fora dealing with high-level waste as well as the broader scientific agenda, those give us access to a significant quantity of their data. Using that, we have begun to exploit some of the data that are currently available and Budhi will speak to three particular areas that we feel are noteworthy at this particular stage.

CHAIRMAN SELIN: Before you move on, Mr. Patrick --

MR. PATRICK: Yes, Mr. Chairman.

CHAIRMAN SELIN: I'm pleased to hear you saying -- noting the limitation in our role here. I'm sure everybody understands this, but just in case I'd like to be quite clear. Our considerations, on the one hand, are not to sandbag DOE, to let them know well in advance what we think we'll need to do our job when it comes up, but not to run their program or take charge of their program. It's up to them to decide how to gather the data. It's up to them to decide what they need for their own purposes. The amount of cooperation is not to clear things in advance, but just to make sure that there are no technical

surprises. So, your statement of restraint about what we can and should do is highly desireable.

MR. PATRICK: Thank you.

DOCTOR SAGAR: The first example I want to talk about is the capability of geometrically modeling the geological structures and stratigraphy at Yucca Mountain. We acquired that capability and then acquired as much of the early site data as we could and tried to model that to see what kind of stratigraphy do we expect. This one you go back to the beginning of time and try to see if we could reproduce the structure as we see it today.

One of the results of this particular study was that we expected, given the geometry as we know it today, that there should be a fault in the 40 mile wash at the site, which is not in the present maps. The recent earthquake at the Little Skull Mountain seems to confirm that, but that needs to be further investigated if indeed it is such. Our understanding is that DOE would indeed undertake some studies to examine this particular issue.

We have undertaken some studies in the geochemical area. We want to explain the sorption processes mechanistically through ion exchange studies and so on, and we have undertaken some basic

experiments to try to verify existing thermodynamic databases and fill in some gaps that we see in those particular databases. We have made a study of the C-14 transport issue recently and we have found that partitioning of C-14, carbon-14 in the gas and the liquid and the solid phases causes a significant amount of retardation that needs to be studied.

The third example I want to talk about is the volcanism issue. We have research projects undergoing in this particular topic. The most recent study on this issue was to study the probability of a volcanic event happening in the vicinity of the site. The issue was whether the Poisson kind of probability distribution used by DOE was appropriate or the non-homogeneous Poisson process will relate varied with the space, with the distance from the center was the more appropriate model to be used.

The conclusion that we reached from this preliminary study was that a non-homogeneous Poisson process was more appropriate to study the probability and we did estimate the probabilities of a volcanic event.

Again, the --

CHAIRMAN SELIN: How does the parameter vary with distance of the center? Is there an

equation or is it just a set of values that you determined --

DOCTOR SAGAR: It's a set of values that you determine based on what you know about the number of events that had happened at different points in space, and you find that as you go away from a certain central location, a crater or a cone, that the probability decreases as you move away. The greater the distance, the lesser is the probability which would create a non-homogenous Poisson process in space.

CHAIRMAN SELIN: Are you just fitting a curve to a bunch of data?

DOCTOR SAGAR: Yes. Yes, we are fitting a curve. It's not a mechanistic model, if that's the question.

MR. PATRICK: But this is one of those early areas where you can use some of the early data to begin to get some notion of spacial distribution and it's important because it begins to address the matter of where are the trends in these volcanic processes. If you begin to couple the first area that he spoke about, the structural geology, with the third area that he spoke about, these trends in volcanism, you begin to work mechanism into the basic

observations of where volcanic events seem to be trending. You begin to address a little more the issue of why might they be trending there based on structural geological considerations.

CHAIRMAN SELIN: Next time you get a tremor, do you get a violently different distribution? How stable is this equation as a predictor of what happens?

DOCTOR SAGAR: Well, the stability of the equation is dependent upon how many data points from the past did you use. Now, some of the past data itself may be suspected, maybe meaning something different and the equation will change. The question was the project that we were doing was to take so-called accepted data from the past that has been accepted by most of the investigators and reinterpreted it through a different model. So, the equation will probably change in the future.

CHAIRMAN SELIN: I was very leery about fitting curves when you don't understand the underlying mechanism to try to estimate both the form of the distribution and the parameters within the distribution.

DOCTOR SAGAR: Right.

CHAIRMAN SELIN: You can always fit a

curve to any number of figures, but how good a predictor it is is the -- okay.

DOCTOR SAGAR: I accept the comments. I cannot say that this equation is the ultimate equation that will give you the probably, but it's an attempt to try to understand the data again.

The key element of resolution for this particular issue is the timely release and utilization of data both by DOE and by NRC and the Center in making decisions.

(Slide) Slide 9.

CHAIRMAN SELIN: Before you get off that, what is DOE doing on these questions? Again, we're doing confirmatory research. Are we taking their models and testing to see if they're okay or are we going off independently and we're going to have two different models of how the earth behaves? What's our role compared to DOE's role?

DOCTOR SAGAR: In any research project that we have undertaken at the Center, the very first step has been to review all the literature, including DOE's models. So, it's not independent in the sense that we don't know what DOE has done. It's independent in the sense that we try to look for alternative interpretation of modeling aspect to see

that it's not -- as you said, if you don't understand mechanistically what's going on, then there are more changes of interpreting it alternatively. The idea is to see which one maybe --

CHAIRMAN SELIN: Do we have a process five years from now when we sit down with our results and DOE sits down with theirs and we try to reconcile them? Where does this come together?

MR. PATRICK: One of the things that takes place as part of an ongoing dialogue, there are provisions for the NRC Center staff to meet with the Department of Energy staff. In this particular area, two weeks ago we were in the field with the leading volcanologist on the Department of Energy's team, Bruce Crowe and others, with our own volcanologist, to address early on some of these differences and interpretation at the staff level. Not to try to resolve issues in any ultimate sense, but to address them at the staff level to try to understand why our interpretations of those same data might be different. So, in addition to the formal published literature, there's this informal dialogue that continues to go on.

CHAIRMAN SELIN: Are these dialogues available to the State of Nevada's volcanist?

MR. PATRICK: Yes, sir.

COMMISSIONER de PLANQUE: Question about the data that DOE is acquiring. If my understanding is correct, the core samples that are being taken are not being totally archived. Do you anticipate that that's going to present any problem down the road?

DOCTOR SAGAR: My understanding is that since they started a recent QA program and approval was approved, that they are indeed archiving all of the core. That's my understanding, that in the past, the core that they had collected would probably not be qualified and that the information will not be used in licensing arena.

COMMISSIONER de PLANQUE: At what point in time did you see that change?

DOCTOR SAGAR: Wesley might know better, but my understanding is about two years ago.

MR. YOUNGBLOOD: For sure they're archiving the cores. The samples they are, but not the --

COMMISSIONER de PLANQUE: It's my understanding that when they take a core and a researcher uses that core for his or her work, that there is not necessarily a quarter or an eighth or whatever of each core section that's archived. It can

be destroyed or used up in the process, although it wasn't quite clear to me what was and what was not being done in archiving.

CHAIRMAN SELIN: Mr. Bernero, will you go and --

MR. BERNERO: Yes.

CHAIRMAN SELIN: Not necessarily by lunch time, but will you check that out?

MR. TAYLOR: Get the answer.

COMMISSIONER de PLANQUE: By dinner.

MR. BERNERO: Yes. This is something -- my understanding from the origin of what they call the sample management facility was that a segment of the core was to be archived as well as samples.

COMMISSIONER de PLANQUE: We don't need to debate it here.

CHAIRMAN SELIN: Calculating what reality is, but try to --

MR. BERNERO: Yes. We need to track that down.

COMMISSIONER de PLANQUE: And my question is, if that's not being done, does that present a problem for us later down the line?

MR. PATRICK: Yes. Without the practice of doing core splits, as they're called, in place,

then the issue of being able to replicate --

COMMISSIONER de PLANQUE: Right.

MR. PATRICK: -- previous results becomes moot because without additional drilling that could be a programmatic issue.

Anything else on that?

(Slide) Turning then to the slide 9, the next issue that we'd like to discuss with you is also a very interesting one for the repository program because of some of its peculiarities. That issue is the use of expert judgment in the licensing process, in the regulatory arena. Certainly the future performance of the repository is going to be greatly dependent upon not only an understanding of the current conditions, which we spoke to earlier, but also the evolutionary changes in those conditions which would define the boundary conditions and the forcing functions that exist on the repository. Those would include not only the normal natural processes that are playing out, but some of the more disruptive things that one might imagine in terms of a scenario developing.

All of those things, tectonics, volcanics, the hydrologic, geochemical, climatic processes and events that are going on will require data

acquisition, but will also require some interpretation of those data and undoubtedly some use of expert judgment in defining what the most likely models are, the appropriate sets of models for defining how those processes, how those conditions are going to play out over time. A large dose of expert judgment should be expected to be used and is a natural part of projects of this sort that deal with the earth.

The question is not so much as to whether to use expert judgment but the way in which that expert judgment should be used, the processes, the procedures for formalizing the use of expert judgment.

Qualification of experts is a particularly interesting issue here because of the long time periods involved. If you take a literal definition, there are no experts because there are no people that have made projections over these kinds of periods of time. So, the skills that we anticipate would be used are much the same as those geological skills that have been used to do what we call post-dicting in the geological environment where you make observations today and you use expert judgments to try to determine based on those observations what must have gone on or what might have gone on in the past.

In this first-of-a-kind effort, we've

taken a three prong approach to begin to try to get our arms around the processes and procedures for using expert judgment in the regulatory environment and possibly addressing the need for some technical guidance in this area.

DOCTOR SAGAR: The first one of those three is an assessment of the current state-of-the-art in the area of expert judgment with the help of academic experts from outside the Center. We undertook the study to see if we could come to some conclusion regarding validity of expert opinion that is based on the past use of expert opinion if we could figure out how well those expert opinions were found to be correct later on.

We found a few things. One is that -- and this is, I think, both of the conclusions we reached are somewhat obvious. The first one is that the expert opinion cannot be, should not be a substitute for real data if that data could be obtained, that you use expert opinion only where such data is either impossible to obtain or it's economic issue sometimes in the industry. The second one is that the selection of the experts is really -- or how we define experts is really the most crucial element in using expert opinions and expert judgments, that consensus is not

really something -- is not really as fruitful as trying to discover why experts differ on a certain issue. That gives us a better understanding of the issue that you are trying to explore through the expert judgments.

We are also undertaking a study to study how, to see how geotechnical experts make judgments since they have been doing that in the industry, for example, for many, many years and there's real money involved in those decision making, that they may have developed some way of how expert judgments are to be used. That study is not complete yet.

Thirdly, we're undertaking an actual elicitation as part of the iterative performance assessment task. We have selected climatology or climate, future climate at Yucca Mountain to be the topic and we are trying to set up an expert panel that we would elicit formally to basically learn what pitfalls there are in doing such an expert elicitation and see if these three studies would eventually lead us to some conclusions as to how -- first if NRC needs to provide guidance to DOE on how to use or what is acceptable to NRC on expert judgments and, secondly, if we do get to the point where indeed NRC ought to provide some guidance, what that guidance should look

like. We hope at the conclusion of these three studies that we might be able to recommend some aspects of this thing to the NRC.

COMMISSIONER ROGERS: Just on this issue of how to use experts, do you think that it makes sense to try to deal with this question once and for all in a generic way or do you think that really the particular issue that arises that can only be addressed through the use of expert judgments has to dictate exactly how you use them? Do you have a feeling about that issue of whether it's wise to try to anticipate beforehand all the ways in which experts might be brought into an issue and come to some conclusions of how they would be used or to allow the flexibility of deciding that issue on a case by case basis because the nature of the question may dictate how you use the experts? Do you have any feelings about that?

DOCTOR SAGAR: From these studies that we have seen in literature, a large part of the expert elicitation issue is generic. How to select experts is more or less independent of what question you're trying to get answered. The way whether you would want to get the consensus or you would want to study the reason for differences of opinion is a generic

issue. Eventually the nature of the -- or how you would use the data and the nature of the data obviously depends on case by case. It depends on what subject matter you're dealing with. But again it's my belief that quite a bit of this issue is generic and can be settled in a generic sense.

MR. BERNERO: Commissioner Rogers, I'd like to interject. There is a good deal of importance to the context of the use of expert judgment. As the Commission is aware, we have looked at seismo-tectonic issues in the past for how one can forecast the next 40 years for reactor integrity. Here it's a substantially different context. We're looking at the same geology, but now we're forecasting for millennia. That's very important. There's very high interest in this and in this context for the use of expert judgment in the international community as well. At the OECD Radioactive Waste Management Committee, very strong interest in this. It's a worldwide perception, I'd say, that we really need to do this because, as Budhi said earlier, you can't really validate the models in the conventional sense of the word.

COMMISSIONER ROGERS: Well, we'll wait and see how it all comes out.

MR. PATRICK: (Slide) Slide 10, please.

The final issue that we'd like to address with you today is a rather broad one and it deals with the subsystem and total system performance objectives which are delineated in Part 60. In particular, the total system performance objective that's laid out in the EPA standard, which is currently in remand and about to be repromulgated. This is really the most fundamental of issues. It has programmatic aspects to it as well as the technical aspects that we'd like to address.

From a technical perspective, there's really a concern here not only in how these subsystem and total system performance objectives fit together in a licensing context, but there also arises a technical concern regarding the level of detail and modeling these various phenomenon. We know that the processes and conditions are very complex. That would be true of any geological repository site. We feel though that there has to be some additional detail and associated attention paid to some of these near field phenomena which are among the most complex that would be taking place. Therein we see that the need to do some additional detailed modeling with respect to, say, waste package performance, release of radionuclides from the engineered barrier system, may

be appropriate, whereas in a total system performance context one would need to use greatly simplified models just to be able to accommodate the current limitations in one's ability to compute processes such as this.

From the outset, the programmatic issue or the regulatory issue is identified using the technique that we call systematic regulatory analysis. You've been briefed on that area in the past as a Commission. As we did that study, we identified several uncertainties that bore on this particular issue. One of them I've spoken to briefly and that is how do the subsystem requirements fit into the total system performance area. Other ones deal with such issues as the validity, the appropriateness of some of the subsystem requirements such as groundwater travel time, the containment of the nuclides for a substantially complete period, 300 to 1,000 years, and then finally the gradual release of nuclides from that environment.

Although some of those things are regulatory issues, we have been able using iterative performance assessment, two aspects of iterative performance assessment in particular, to begin to address the technical aspects of the problem. We know

from our total system performance assessments, those are assessments done by both the staff at the Center and the staff at the NRC, that we can identify those areas which are most crucial to performance and we can calculate those using models which have been appropriately simplified to be able to handle the range of phenomena, the range of conditions that are of interest. But we've also found in that process that some of these phenomena need greater attention. So, we've done what are called auxiliary analyses in our parlance where we've looked specifically at such things as transport of carbon-14 in the gaseous phase as well as in the liquid phase. These auxiliary analyses have also extended to such matters as the effects of volcanic intrusions here, stepping aside from the issue of whether we can project or predict where those are going to occur and when they are going to occur, but to parametrically evaluate what would happen if they occurred with certain frequencies, spacial distributions and sizes.

So, these auxiliary studies have enabled us to look at some of these particularly important effects of phenomena that could affect groundwater flow or transport of radionuclides.

We feel there are several actions that

need to be taken to bring ultimate resolution to this particular area and that those actions are really going to be taking place against the backdrop of a much larger regulatory issue, and that is specifically whether there is a need, a desire, a regulatory drive to have a unique nexus or connection between the subsystem requirements and the total system performance requirement. At the Center, based on the studies we've conducted so far, it seems to us that if the subsystem performance objectives are viewed strictly as a means to ensure or to mandate that multiple barriers are used and that they are used at particular minimum levels of performance, then there's really no need for there to be a nexus in the sense of a perfect connection between the subsystem requirements and the total system requirements. But it is, at its heart, a policy matter as to whether one feels there needs to be a nexus. What a nexus would bring on the positive side of the ledger is the potential for a single regulatory performance measure to be dealt with in the licensing arena.

NRC staff and ourselves are currently wrestling with that issue. But within that broader backdrop, some of the specific things that we're looking at is to complete some evaluations that we

have ongoing now and to complete those within the next several months with regard to specific rulemakings and staff guidances that we feel may be appropriate to provide some information to the Department of Energy regarding how to treat subsystems and total systems.

Second, we feel that the need for the staged or the phased performance assessments need to continue and they need to continue to get increasingly thorough and increasingly more realistic as time goes on. Again, there is a balance there to be struck between what one can calculate from a total system perspective in some of the more detailed auxiliary analyses that will undoubtedly be needed to enable us to understand some of the particular phenomena that are of regulatory interest.

Once these are available, the results of the performance assessments we feel can be put to timely use both by the regulator and certainly DOE will be putting those to use as part of their performance assessment calculational exercises.

Those conclude our remarks. We'd be pleased to entertain any further questions that you would have.

CHAIRMAN SELIN: Commissioner Rogers?

COMMISSIONER ROGERS: Well, just coming

right back to the point you've just left, this question of subsystem performance, is it possible that our own regulations which focus on subsystem performance can result really in a suboptimal overall performance rather than the best possible performance of a potential repository? It seems to me that it's conceivable that that can be the case. We know that in another context by emphasizing unduly one particular aspect of a complex system you ultimately reduce the performance of the overall rather than improve it. I wonder if there's a similar possibility here that can arise through dictates of our own regulations and whether you have any thoughts on that matter.

MR. PATRICK: Well, we do have some thoughts on it. One, to be able to sit here and assert that it can't possibly be having such an untoward effect of causing a suboptimum solution to be found is not something that I think anybody could do at this point. But I would point out that the history of the development of those subsystem performance objectives, as they're referred to, does give considerable latitude. Going back and looking at the discussions that took place at the time, certainly it would bear examining those again in light of how the

state-of-the-art has moved forward over this last dozen years or so.

But as we go back and look at those, it was very clear that the Commission over and over again would say, "It appears that it may be possible for this level of achievement to be obtained, but we want to set the minimum standard here." We show that the minimum standard will have a positive beneficial effect on total performance. If the applicant wants to drive for the higher level of performance, they're certainly encouraged to do so. We see that in the rulemaking record. We see that in NUREG-0804 specifically that deals with some of these particular issues.

The other thing that we feel very strongly about is the rule already has in place a provision that at a particular site that there could be changes in those subsystem requirements, number one, and in fact there could be additional requirements put in place as might be appropriate.

So, I guess to sum that all up, Commissioner Rogers, I feel if we have a basic rule that sets minimum standards to ensure that the multiple barrier concept is implemented appropriately and then allow those to move that will above that to

drive to an optimum, a best possible performance within the existing technological limitations and site limitations, always being certain to minimally meet the EPA standard, I think we do have very close to if not the best of both worlds in that regard. A personal view on that.

MR. BERNERO: Commissioner Rogers, I'd just like to add a thought to that. In one area we have a weaknesses. That is the site geology. The pre-emplacement groundwater travel time is really not that rigorous an index of performance. We don't have a better index of performance. We've struggled for a long time to find one and there is a weakness therein. But I don't think that tends to lead us into suboptimal sites because ultimately the overall performance criterion will ensure site acceptability.

MR. PATRICK: And to tag on to your tag-on, that is an area that the Center is specifically addressing where we have a study underway, a calculational study not a paper study, to examine other ways that one might be able to evaluate the goodness of the geological component of the total system.

COMMISSIONER ROGERS: I guess the area that concerns me the most is one that you didn't dwell

on at any great length, but it seems to me is going to be a difficult -- could be very difficult one, and that is the validation of the process models, either through the use of expert judgments or through the use of data, because it certainly is conceivable that one can challenge a model rather easily with respect to its validity 10,000 years from now in terms of its ability to span that full extension of time.

I don't expect you to give us an answer of how that's all going to be solved, but I have a feeling it's going to be -- it has a potential for being a very sticky issue to settle. I would like to hear more about how you propose to do that as time evolves. I don't know that -- I'm sure we can't do it today, but it does seem to me that that's going to be a very, very important question, I think, although sometimes these things break in a way that everybody agrees that a model is an adequate representation and they feel quite confident. But it does relate to how you select experts and it does seem to me that there is a sticky question of the outlier expert and how you include them in the picture because they have credentials, very often very important credentials and yet their points of view may be quite different from a collection of experts that you may be very

comfortable with.

How to include that possibility of at least those people's views somehow being if not exactly included in the final result, that their views can be used to challenge the experts, the other experts, because it seems to me that that's the important thing in using experts. Not that you can find a collection of people who all agree, but that there is a reasonable challenge to the basis for their agreement that establishes their validity. These are issues that I think are going to be very important in the use of experts. I'm not so sanguine about how they're all going to come out.

CHAIRMAN SELIN: Did you have other comments?

COMMISSIONER ROGERS: No. No.

COMMISSIONER REMICK: In your discussion of expert judgment, I assume you're talking about experts used to develop data where data might not otherwise exist or interpreting the data mathematically and not in the adjudicatory sense of expert witness.

DOCTOR SAGAR: No. We were talking about actually --

COMMISSIONER REMICK: Okay. The

systematic regulatory analysis is something I've had a lot of interest in since you developed that. I was wondering as a result of this -- let me digress a minute and say that certainly one of the more interesting, perhaps more useful use of the probabilistic risk assessment is in the design of, let's say, a power plant or something else where you can look at alternatives and see what effect they have on the risk.

As a result of your study of the systematic regulatory analysis, is there any skeleton that you've developed or a template that might be used as a write regulations in the future of things to check to see that the thing hangs together, that all the pieces are there? Is there anything out of this process that shows -- that one could use in that sense, of a check list or a template in developing future regulations to make sure that all the pieces are there that should be there?

MR. PATRICK: It's not so easy as to put a template together. I guess I should start by remarking that that has not been a charge.

COMMISSIONER REMICK: Yes. I understand.

MR. PATRICK: We've not tried to take that broad a sweeping of a view. But it is not so easy as

putting a template together. But we do feel that the procedures that have been developed and, in fact, are still under development do help one to focus one's attention on some of these most critical and most crucial issues. Our staff had the opportunity to be of some small help to the people in working up the rulemaking for the monitored retrievable storage system. I certainly can't speak for how useful they found the exercise to be, but some of our staff members actually "did the SRA" on those particular modifications that were underway to search for uncertainties that might be introduced as a result of amending a rule or modifying a rule.

We're doing a similar thing with a pending rulemaking that the staff is currently evaluating within Part 60 to look at how 60.122 dealing with the potentially favorable and adverse conditions at the site might be better structured so that they interface with the performance objectives.

COMMISSIONER REMICK: I see. That's what I had in mind.

MR. PATRICK: And that's a specific task that we undertook to be sure that in the process of making a change to resolve one set of uncertainties you don't generate a bunch of other ones.

COMMISSIONER REMICK: That's interesting. Thank you.

COMMISSIONER de PLANQUE: Just to -- were you finished?

COMMISSIONER REMICK: I'm finished, yes. Thank you.

COMMISSIONER de PLANQUE: Just two questions. On the subsystem versus total system concept, you may not have this information at the tip of your fingertips, but couldn't you tell us how other countries, like France, U.K. and Japan, are approaching that from a strategy point of view?

MR. PATRICK: Sure.

DOCTOR SAGAR: As a matter of fact, none of the other countries that we know about how the subsystem quantitative requirements. They all have qualitative requirements, but none of them have -- that's what I know.

MR. BERNERO: Yes. The one exception, for years Sweden has had this hot isostatically pressed copper container. If you ever try and pin them down, it's really not all that definitive as a packaged specification. They have it sometimes and other times don't have it. Their principal focus in the program is binary. They have activity on the package and they

have their principal focus on the rock characterization or site characterization activity. So, they are the closest ones, I'd say, to someone in a national program overseas that has at least one subsystem specified.

COMMISSIONER de PLANQUE: But the others are mainly looking at total system performance.

MR. BERNERO: Yes.

MR. PATRICK: Well, they take an approach that's not -- correct me if I'm wrong, but not too dissimilar from what the EPA standard says. There are numerical criteria in the remanded EPA standard, but then there's a Section 191.14, as I recall, that deals with what are called assurance requirements. So, you say, "Yes, I want to have multiple barriers, but I'm not going to put specific numerical quantitative criteria with regard to their performance. I will feel assured if you've got a good waste package, if you've got a slow groundwater travel time, if you've got good geochemical conditions and so forth, but as a regulator they've not specified those in quantitative terms. They're still there as intrinsic measures that build assurance in the hearts and minds of the regulators and the public, but not to quantify them.

COMMISSIONER de PLANQUE: Okay.

DOCTOR SAGAR: But there are other major differences, like they don't have the 10,000 year time frame either.

COMMISSIONER de PLANQUE: Right.

DOCTOR SAGAR: They are talking of risk, maximum risk whenever that might happen, a million years after the repository is closed and so on and so forth. So, we have quite a bit different regulation.

COMMISSIONER de PLANQUE: Okay. Back on the issue of expert judgment, I don't know how new this concept is to the public, but can you tell us have there been studies done to figure out public reaction to that concept and it being used in a regulatory framework?

DOCTOR SAGAR: I think there are very few studies that exist that we could put our hands on that are in the laboratory area. We tried to get to the EPA to see how they handle their air permitting and waste injection kind of processes. Most of the studies we saw were in business area where they were trying to predict what the demand would be 30 years from now. But none of the studies that we came across had the long time frames that we have in the high-level waste. It's very difficult to answer this

question and that's how we started. We wanted to validate expert opinion, see how well people have done in the past.

The conclusion was we could not come to a single conclusion that said under these circumstances it succeeds and under these circumstances it doesn't, which is what we set out to do. So, I don't think I have an answer to your question.

COMMISSIONER de PLANQUE: Well, that addresses whether or not experts believe in expert judgment. I'm more concerned with how will the public react to the use of expert judgment in this context and it sounds like there hasn't been a lot of studies done.

MR. PATRICK: There haven't been, but specifically although there are some beginnings in that area. I think one of the things that's relevant with regard to that is that the public has a bit of a problem with being told to believe someone because they are an expert. I think we touch here on the whole area of public knowledge, public awareness, public perception regarding an entire industry, if you will.

I think personally, not the Center's opinion, I think personally that there has to be a

great deal of work done in that area in the coming years if the public is going to be comfortable, and that's really what it comes down to, to be comfortable with these kinds of decisions made over these long periods of time by experts, by people who have not themselves lived 10,000 years to see whether the performance of their prediction is adequate. So, I think that's an important element, is public awareness, public education.

COMMISSIONER de PLANQUE: Okay. Thank you.

CHAIRMAN SELIN: I'd just like to close with a couple comments.

First of all on the expert opinion, it's important to remember this is a regulatory process and the stress that I think you've laid and I hope you continue to lay on experts making known the process by which they draw their conclusions is a lot more important than just somebody saying, "36" and closing it up at that point.

There's a story I've told a number of times about Norbert Weiner going up to the blackboard and putting up a complicated integral, looking at it and says, "2 pi." Somebody else said, "Well, how did you get that?" and he erased the 2 pi and looked at it

again and he wrote, "2 pi," and he said, "See, I did it a different way." He was an expert but you still have to know the process.

Okay. A couple of -- there's a point in that story. It will take a few weeks to figure it out, but there's a point.

I'm struck by a couple of things. First, in spite of Doctor Patrick's disclaimer, you are clearly taking a look at the overall question and saying, "What other holes are there to fix?" not just what are the answers to the three or four questions that we're doing, and I think that's useful. I believe -- my own personal opinion is that over the five or six years that the Center has been helping us that you have established a reputation for independence and for common sense, for not going off on too many wild goose chases.

That leads to a second observation and that is that we just have a lot more sources of independent advice on the high-level waste question than we did have five or six years ago and perhaps the Commission will have to sit back and figure out how much of this is complementary and how much of this is redundant. But I believe that the breadth and depth of your observations are both salutary for us to

consider as we look at this question.

So, we thank you very much for the presentation and look forward to your continuing work. Thank you.

MR. PATRICK: Thank you.

(Whereupon, at 11:12 a.m., the above-entitled matter was concluded.)

CERTIFICATE OF TRANSCRIBER

This is to certify that the attached events of a meeting of the United States Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING ON ACTIVITIES OF THE CENTER FOR NUCLEAR WASTE REGULATORY ANALYSIS (CNWRA)

PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: MARCH 9, 1993

were transcribed by me. I further certify that said transcription is accurate and complete, to the best of my ability, and that the transcript is a true and accurate record of the foregoing events.

Carol Lynch

Reporter's name: Peter Lynch

CURRENT ISSUES IN THE HIGH-LEVEL WASTE PROGRAM

Center for Nuclear Waste Regulatory Analyses

March 9, 1993

Briefers: R. Bernero, NMSS
W. Patrick, CNWRA
B. Sagar, CNWRA

Contact: M. Knapp, NMSS
Phone: 504-3324

Slide 1

SUMMARY STATUS CNWRA

STAFFING

- Planned Staff of 52
- Current Staff 49 Plus 2 Limited Term
- Ultimate Staff of 54

SPENDING

- Current Underrun of 35% of CNWRA Funding

SCOPE OF BRIEFING

- Basis for Selecting Issues

- Analysis of Issues
  - -Statement of Issues
  - -Progress on Addressing
  - -Outlook for Resolution

Slide 3

BASIS FOR SELECTING ISSUES

- Systematic Regulatory Analyses
- Iterative Performance Assessment
- Development of Analytical Capabilities
- Research
- Prelicensing Interactions

Slide 4

SELECTED ISSUES

- Data and Models of Processes and Conditions
- Submodel and Model Validation
- Use of Early Site Characterization Data
- Use of Expert Judgement
- Subsystem and Total System Performance

Slide 5

DATA AND MODELS OF PROCESSES AND CONDITIONS

ISSUE

- Objective Determination
- Timely Acquisition
- Differing Opinions

PROGRESS

- Unsaturated Flow
- Materials Degradation
- Iterative Performance Assessment

RESOLUTION

- Prelicensing Guidance
- Focus on Performance

Slide 6

SUBMODEL AND MODEL VALIDATION

ISSUE

- Time & Space Scales
- Complexity

PROGRESS

- INTRAVAL
- DECOVALEX
- Natural Analogs
- Laboratory & Field Studies

RESOLUTION

- Control Expectations
- Technical Basis for Guidance

Slide 7

USE OF EARLY SITE CHARACTERIZATION DATA

ISSUE

- Use in:
  - Design
  - Decision-Making
  - Testing Strategies

PROGRESS

- Structural Geology
- Geochemistry
- Volcanism/Tectonism

RESOLUTION

- Timely Release
- Timely Use

Slide 8

USE OF EXPERT JUDGEMENT

ISSUE

- Time & Space Scales
- Complexity of System
- Qualification of Experts

PROGRESS

- Current Practice
- Use in Other Industries
- Trial Use

RESOLUTION

- Technical Basis for Guidance
- Public Confidence in Process

Slide 9

SUBSYSTEM & TOTAL SYSTEM PERFORMANCE

ISSUE

- Relationship of Regulatory Requirements
- Level of Detail in Modelling

PROGRESS

- Systematic Regulatory Analysis
- Proposed Rulemakings
- Iterative Performance Assessment

RESOLUTION

- Complete Rulemakings
- Performance Assessments