

# UNITED STATES OF AMERICA NUCLEAR REGULATORY COMMISSION

Title: PERIODIC BRIEFING ON STATUS OF CENTER FOR  
NUCLEAR WASTE REGULATORY ANALYSES

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NUCLEAR REGULATORY COMMISSION

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PUBLIC MEETING

Nuclear Regulatory Commission  
One White Flint North  
Rockville, Maryland

Friday, March 30, 1990

The Commission met in open session, pursuant  
to notice, at 10:00 a.m., Kenneth M. Carr, Chairman,  
presiding.

COMMISSIONERS PRESENT:

KENNETH M. CARR, Chairman of the Commission  
THOMAS M. ROBERTS, Commissioner  
KENNETH C. ROGERS, Commissioner  
JAMES R. CURTISS, Commissioner  
FORREST J. REMICK, Commissioner

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## STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

SAMUEL J. CHILK, Secretary

WILLIAM C. PARLER, General Counsel

JAMES TAYLOR, Executive Director for Operations

ROBERT BERNERO, NMSS

LAWRENCE SHAO, Office of Research

JOHN LATZ, CNWRA

WES PATRICK, CNWRA

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

10:00 a.m.

CHAIRMAN CARR: Good morning, ladies and gentlemen.

The purpose of today's meeting is to hear from the NRC staff and the President and Technical Director of the Center for Nuclear Waste Regulatory Analyses on the progress of the Center's research and technical assistance activities for the NRC's High Level Waste Program

The Center for Nuclear Waste Regulatory Analyses, a federally-funded research and development center, was established by the Commission through award of a competitive contract to the Southwest Research Institute of San Antonio, Texas, in October of 1987. Establishment of an FFRDC by the Commission provides long-term continuity for high-level waste technical assistance and research and provides a central capability for performing and integrating these activities.

Do my fellow Commissioners have any opening comments?

If not, Mr. Taylor, please proceed.

MR. TAYLOR: Good morning.

This is the fourth briefing provided to the

1 Commission on the status of the Center. And at the  
2 last briefing in April '89, it was noted that the  
3 Center was in a critical stage of hiring additional  
4 key technical staff. We believe this briefing will  
5 demonstrate to you that the Center has successfully  
6 implemented this hiring phase to date and is in a  
7 better position to continue its important work in  
8 support of our staff.

9 The purpose of this briefing is to provide  
10 the Commission a summary of the status of the Center,  
11 and also the results of a recently completed Center  
12 report of regulatory uncertainties.

13 We have both representatives of the NRC at  
14 the table and of the Center staff. And at the table  
15 to my right, of course, is Bob Bernero from NMSS, and  
16 Larry Shao from the Office of Research. And to my  
17 left is Mr. John Latz and Mr. Wes Patrick from the  
18 Center. In addition, I would like to acknowledge the  
19 presence of Mr. Martin Golan, President of the  
20 Southwest Research Institute, who is in the audience.  
21 Mr. Golan has shown a direct and continuing interest  
22 in the success of the Center and we appreciate this  
23 very much.

24 With that, I'll ask Mr. Bernero to continue.

25 MR. BERNERO: Thank you.

(Slide) May I have slide 1, please?

For today's presentation, it's a status and a specific technical presentation, we're going to have three speakers for you. First, I just want to say a few words about the status of the Center staffing and where they stand with the various technical assistance and research activities at the Center. Then, I'll turn it over to John Latz, the President of the Center, who's going to enlarge on that and talk a little bit more about their staff capabilities, training and other status aspects. And lastly, and this is a fairly substantial part of the briefing, Wes Patrick, who is the Center Technical Director, is going to present the findings of the uncertainty analyses report.

And I do want to point out to you that last year, in May of '89, we had part of Part 60 treated, Subparts B and E, as my notes indicate. And now we have the present analysis of uncertainties, regulatory and institutional uncertainties, covering all of Part 60. Now this is very important to us in our current activities for the reevaluation of the rulemaking and technical position strategy. This is the strategy we gave you in SECY-88-285, and you're going to get a substantial revision of that shortly. And we do have,

1 as you know, a staff activity for the five year plan,  
2 a major reevaluation of the program strategy for high-  
3 level waste, and that work is going on right now and  
4 should culminate by the end of April. And so, all of  
5 this fits in very neatly to that and is very useful to  
6 that.

7 (Slide) May I have slide 2?

8 One of the concepts we had in seeking out  
9 the Center, a federally-funded research and  
10 development center to be extremely useful to us in  
11 high-level waste regulation, is to establish centers  
12 of excellence. And the planning included the  
13 identification of eight centers of excellence. And  
14 here, the full-time equivalent staff identified for  
15 the centers of excellence are listed. It's a  
16 technical area in which the Center for Nuclear Waste  
17 Regulatory Analyses should have a high level of  
18 expertise, so that we can turn to them and indeed get  
19 expert advice.

20 Now if you look at this list, the current  
21 and planned staffing, let me cite one example. You  
22 see structural and tectonics as a general center of  
23 excellence, but there would be subdisciplines in that.  
24 For example, in that area there would be geology;  
25 geomorphology; geophysics; seismology, which is



1 something we frequently encounter; and of course,  
2 volcanology is, particular on this site, one where  
3 there would be a subdiscipline expertise that would be  
4 very valuable.

5 In addition, not listed overall, but  
6 certainly present and very valuable to us, is the  
7 expertise in quality assurance. As you know, we've  
8 had very serious activities in quality assurance with  
9 the DOE program, and the Southwest Research Institute  
10 and the Center itself act in very substantial support  
11 and participation in that, so that that is an  
12 additional skill we don't even list as a center of  
13 excellence here.

14 (Slide) May I have slide 3, please?

15 If you look at the core staffing of the  
16 Center, you can see the administrative staff down at  
17 the bottom of that chart. They reached essentially a  
18 plateau of baseline, and then you see the technical  
19 staff growing. And it's very important to make a  
20 couple of comments here. They currently have 10  
21 support staff and 34 technical staff, and I was just  
22 informed this morning that an additional expert in  
23 performance assessment has just accepted. I'm very  
24 pleased with that, because that's a critical skill  
25 area for us.

1 COMMISSIONER ROGERS: So that's one more  
2 than shown on this?

3 MR. BERNERO: Yes, one more. Yes. That's a  
4 completely new piece of data. Just got it moments  
5 before this meeting.

6 By the end of this fiscal year, the  
7 projection is that there would be 11 support staff and  
8 43 technical staff, for a total of 54. That's the  
9 current plan. But I want to emphasize that there's an  
10 uncertainty area shown in there, and there's an  
11 attempt -- and the Center and the NRC both are  
12 concerned -- to maintain some flexibility to adjust  
13 the skill mix here. A little bit of fine-tuning is in  
14 order, because we're right now in the phase of  
15 reevaluating the DOE program. And the DOE program  
16 schedule, depending on how they do what they do and  
17 when they do it, can affect to some degree the various  
18 technical skills we have. So there is a little bit of  
19 flexibility here. We're trying to maintain it as we  
20 go through this year.

21 CHAIRMAN CARR: You mean by that, you're  
22 going to get the most critical skills for doing the  
23 work we need done right away?

24 MR. BERNERO: Yes, that's right.

25 CHAIRMAN CARR: Okay.

1 MR. BERNERO: To shift the emphasis,  
2 maintain that flexibility.

3 (Slide) May I have slide 4?

4 I just want to say a few words about what  
5 the Center is doing now that they have staffed up to a  
6 functional level. The technical assistance tasks,  
7 they've already participated in some of the direct  
8 prelicensing reviews. In the site characterization  
9 plan reviews, they've made a substantial contribution  
10 to that already. I mentioned earlier that they  
11 routinely participate in QA audits. That's a  
12 continuing effort and they have been very valuable to  
13 us in that. And now they are actively working in  
14 support of us and in independent contribution in the  
15 development of technical positions, things like what  
16 should be the design basis accident dose for the  
17 surface facilities. That happens to be a rulemaking  
18 problem. Waste package reliability, very important  
19 area there. What are the proper design criteria or  
20 technical criteria for waste packages?

21 (Slide) May I have slide 5?

22 Some of the other areas -- and I often,  
23 perhaps, emphasize too much -- performance assessment  
24 and technical assessment. This is a crucial area for  
25 us in high-level waste, because this is where we

1 confront this very, very long-range forecast. How do  
2 you predict the activities in a high-level waste  
3 repository out through 10,000 years? And the Center  
4 is involved, not only in performance assessment of the  
5 broad scope, but in the technical assessment  
6 particularly with respect to packaging, the CONVO  
7 code, and looking at the waste package and coming up  
8 with solid technical bases for saying how one can  
9 predict its performance and how it will behave; and of  
10 course, and this will be the substantive part in the  
11 later presentation by Wes Patrick, this regulatory and  
12 technical uncertainty analysis.

13 (Slide) May I have slide 6?

14 The research tasks are manifold and they're  
15 now operating with a very strong program in the  
16 research. Just to single out some of the examples,  
17 unsaturated mass transport and stochastic analyses,  
18 both relate very strongly to our ability to review and  
19 evaluate independently a site like Yucca Mountain,  
20 because it is an unsaturated medium; and the  
21 stochastic analyses, where we're trying to simulate  
22 unsaturated flow and transport over these very long  
23 time scales. And we're already doing some analysis  
24 within the staff that indicates some of the technical  
25 problems that come up for mass transport within the

1       unsaturated medium.

2               In addition, the thermal effects, the  
3 thermohydraulics, this is a significant part of the  
4 research program; and seismic rock mechanics; and the  
5 waste package. And of course, there has been some  
6 concern about matching the waste package program  
7 specifics to the changes in the DOE program.

8               (Slide) May I have slide 7?

9               CHAIRMAN CARR: What percentage would you  
10 say they're doing research, as opposed to technical  
11 assistance? Do you have a feel for that? We can ask  
12 them when they --

13              MR. BERNERO: Yes. Well, perhaps you can--

14              MR. LATZ: We are progressing with an  
15 increasing percentage or increasing proportion in  
16 research. Research has been slower to start, later to  
17 get underway. The earlier months of our operation  
18 have been highly weighted towards the technical  
19 assistance/regulatory analyses side. The research  
20 program really is now getting underway. At this time,  
21 I would say it probably comprises something like 25  
22 percent of our endeavors.

23              MR. SHAO: The research budget for fiscal  
24 year '90 is \$2.8 million.

25              CHAIRMAN CARR: Thank you.

1 MR. BERNERO: Well, if I take slide 7, let  
2 me use that as a wrap-up of my part of this  
3 presentation.

4 These are some of the research tasks that  
5 are more recent, just getting underway: the  
6 geochemical analogues, where we're trying to get data  
7 from actual circumstances in nature, the Rainier Mesa,  
8 the Calico Hills, Santorini Island. There are a  
9 variety of analogues. We're looking to that to get  
10 data for performance assessment, as benchmarks for our  
11 performance assessment. And all of these new areas,  
12 as John Latz' response to the Chairman's question  
13 indicated, these are areas that are just getting  
14 underway now as the Center has now reached the  
15 substantial staff level.

16 So let me turn it over to John at this --

17 CHAIRMAN CARR: Which of those have already  
18 been initiated, versus --

19 MR. BERNERO: Well, geochemical analogues I  
20 think has been initiated. Performance assessment is  
21 very, very early. But the key persons, one was hired  
22 about a month ago, a little over a month ago, I think,  
23 and then we just got this second acceptance. So I  
24 would say that's just getting started right now. And  
25 all of these, I think the asterisks on the slide will

1 be removed in a matter of months, I would say, just a  
2 relatively few months.

3 MR. SHAO: In the performance assessment  
4 area, we have -- Sandia has done quite a lot of work  
5 for us, and the work is being transferred to the  
6 Center right now.

7 CHAIRMAN CARR: How is that transfer coming  
8 along?

9 MR. SHAO: It's coming very well right now.

10 MR. BERNERO: And you know the staff has an  
11 independent activity. Research and NMSS together have  
12 been doing performance assessment in-house, and this  
13 is being dove-tailed with this so that we have genuine  
14 expertise and a full bench of capability in this.

15 COMMISSIONER REMICK: Bob, a question. I'll  
16 ask Mr. Latz later on, but for right now I'd like to  
17 have the staff's viewpoint.

18 What are you doing within the staff to make  
19 sure the research effort at the University of Arizona,  
20 which touches on some of these research efforts, and  
21 that at the Center are in tune so that one clearly  
22 knows what the other is --

23 MR. BERNERO: Well, we have considered that  
24 carefully. I'll let Larry answer the question,  
25 because in looking at the University of Arizona

1 research effort, which is very germane to this  
2 particular siting for the high-level waste repository,  
3 we considered that very carefully about letting that  
4 contract, the substantial resources and to coordinate  
5 it with the Center.

6 MR. SHAO: We still have some work outside  
7 the Center. For instance, we are retaining the  
8 University of Arizona work.

9 COMMISSIONER REMICK: Sure.

10 MR. SHAO: And the University of Arizona  
11 people are working very closely with the Center on  
12 some of the research work.

13 CHAIRMAN CARR: So that interaction is  
14 effective there between the Center?

15 MR. SHAO: Very effective.

16 COMMISSIONER REMICK: And the research  
17 complements one another and so forth?

18 MR. SHAO: Yes, yes. The University of  
19 Arizona has experts in this thermohydrolic area.

20 MR. BERNERO: So let me turn it over to John  
21 Latz.

22 MR. LATZ: Thank you, Mr. Bernero.

23 (Slide) Slide 8 indicates that we will be  
24 discussing the status of the Center. And following  
25 that discussion, we will move to a discussion of the



1       uncertainty report that was recently submitted.

2               Since our last visit, I'd like simply to  
3       place the development of the Center in context under  
4       the vision of the contract. When the Center was first  
5       formed, we existed with a staff of ten people totally.  
6       We are now at 46 people, with a great deliberate  
7       effort to obtain quality in staff, as opposed to early  
8       quantity or numbers of staff. We think we've been  
9       eminently successful. We've acquired a staff of  
10      professionals, for the most part nationally renowned  
11      and many internationally renowned in their  
12      disciplines. We're extremely proud of them.

13             You have among the handouts that have been  
14      given to you a roster of the Center staff giving their  
15      credentials and their background. I think you'll find  
16      that to be a very impressive summation of the  
17      capabilities of our staff.

18             The question is often asked, how have we  
19      been able to attract such a staff. There are lots of  
20      reasons that might please our ego to state, but the  
21      dominant reason is intellectual challenge that this  
22      program represents. It is a very unique combination  
23      of high discipline areas of investigation brought  
24      together with interactions, interdisciplinary actions,  
25      that the staff finds to be extremely challenging and

1 stimulating.

2 (Slide) You'll notice from slide 9 that we  
3 have a highly favorable ratio of advanced degrees,  
4 especially among those performing research and  
5 technical assistance work.

6 (Slide) Slide 10 indicates efforts that we  
7 undertake to assure that our staff functions  
8 effectively at the earliest possible time.

9 COMMISSIONER ROGERS: Excuse me. If I can  
10 just go back to --

11 MR. LATZ: Yes.

12 COMMISSIONER ROGERS: -- that slide, I see  
13 that you don't have in research any people at the  
14 bachelors level. What does that say about your  
15 technical assistance for the professionals? Where is  
16 that coming from? Is that coming from people who do  
17 not have any kind of degree program at all, or -- I'm  
18 curious.

19 MR. LATZ: I miss your point, Commissioner.  
20 You'll notice that column is headed research  
21 and technical assistance work. All right?

22 COMMISSIONER ROGERS: Yes. And there's no  
23 one in there at a bachelors level.

24 MR. LATZ: And your question, then, is?

25 COMMISSIONER ROGERS: Well, does that create

1 a gap there between your PhDs and the technical  
2 support, which is perhaps not at as high a level as it  
3 might be in some cases? I mean, there are very  
4 valuable technical support people at the bachelors  
5 level. They're not researchers, but they're technical  
6 support people. I'm just curious how you --

7 MR. LATZ: I don't see the manifestations of  
8 any problems or difficulties.

9 One of the things that is necessary -- I'll  
10 speak to it in a moment -- is the difference of our  
11 organization, as opposed to your organization with  
12 which we must interface. We are a small matrix  
13 organization. While we indicate that this is the  
14 character of the staff that does research and  
15 technical assistance work, the same staff does all the  
16 work. No one person, no one body has a stamp on him  
17 that says "Research and Research Only." He'll be  
18 involved in technical assistance work and analytical  
19 work as well. That tends to create a collegiality  
20 across the spectrum, Commissioner.

21 COMMISSIONER ROGERS: Yes. Well, I  
22 understand that. But I think the question is not -- I  
23 don't want to pursue it at great length, but very  
24 often you find that you have a very strong technical  
25 support for your doctoral level people coming from

1 individuals who are led by someone with a bachelors  
2 degree.

3 DOCTOR PATRICK: If I may further comment on  
4 that, we have been able to, using the same matrix  
5 concept that Mr. Latz is referring to, reach out into  
6 the divisions of the Institute. And we do that very  
7 heavily for technician level support, as well as the  
8 lower professional level support. Analytical  
9 services, for instance --

10 COMMISSIONER ROGERS: Called on from that  
11 source?

12 DOCTOR PATRICK: Very much so. Very heavily  
13 so.

14 COMMISSIONER ROGERS: All right. Fine.

15 DOCTOR PATRICK: These are only our core  
16 full-time staff.

17 COMMISSIONER ROGERS: Yes.

18 DOCTOR PATRICK: And with our smallness, as  
19 John says, we've reached out in a matrix fashion to  
20 get that help from other divisions of the Institute.

21 COMMISSIONER ROGERS: All right. Fine.

22 DOCTOR PATRICK: And I think it works very  
23 well.

24 MR. LATZ: (Slide) On slide 10, we would  
25 like to speak to a couple of specific areas.

1           The first is a key area where staff can  
2 develop by learning what others are doing and achieve  
3 recognition as they convey their own findings through  
4 symposia, conferences, workshops and technical  
5 exchanges, as noted in the fifth bullet.

6           The second handout among the materials that  
7 are provided to you is a listing of papers and  
8 presentations that our staff has given in recent  
9 months. Workshops are planned presently in the areas  
10 of geochemistry, materials, hydrogeology and ground  
11 water travel time, and the like.

12           The second aspect of staff development, and  
13 one of which we and the Institute is especially proud,  
14 is the focused internal research and development area  
15 of the Institute. The Institute runs an internal  
16 research and development program that is funded out of  
17 the net proceeds of the Institute. As a commitment to  
18 the NRC, Mr. Golan, the President of the Institute,  
19 contractually bound the Institute to commit up to 35  
20 percent of the Center's net revenues from our contract  
21 with the NRC to the Institute's internal research and  
22 development program, focused to work that is  
23 programmatically relevant to the Nuclear Waste Policy  
24 Act.

25           COMMISSIONER REMICK: A question. What do

1       you do on indoctrination, if anything, to -- and I  
2       hesitate to use indoctrinate -- but teach people the  
3       regulatory environment, in other words, that are  
4       supporting the NRC? It is a different environment  
5       than an R&D environment. Do you do anything at all to  
6       help them become familiar with the organization  
7       they're working with?

8               MR. LATZ: Recognize that we are small in  
9       size and we will always be relatively small in size.  
10      We use every opportunity. One of the opportunities--  
11      well, first comment I'll make is that fully half, if  
12      not more, of our staff acquisitions have been  
13      programmatically knowledgeable, have come from other  
14      areas. Many came from other site investigation  
15      exercises before they were terminated. So they're  
16      programmatically knowledgeable and somewhat  
17      knowledgeable of the regulations.

18             Two areas that I would mention are that we  
19      have availed ourselves of the opportunities of the  
20      many frequent visitations of groups such as the ACNW  
21      and the Nuclear Safety Research Review Committee and  
22      others as they've come to the Center to expose the  
23      newly-acquired staff to their briefings, and their  
24      discussions have been highly informative.

25             We then also immerse them into detailed

1 analysis of the regulations, this systematic  
2 regulatory analysis activity that we've been  
3 undertaking. We get them involved at an early stage.

4 So to some extent, Commissioner, it's on the  
5 job training. But they're quick learners and they  
6 come up to speed pretty well as to the regulatory  
7 character of our work.

8 COMMISSIONER REMICK: The reason I raise  
9 that, there's certainly a different approach than one  
10 would use necessarily in a research environment, say  
11 at a university or an engineering environment, in  
12 their regulatory viewpoint and how things must be done  
13 and so forth. I was just curious if you did anything  
14 specific. But it's on the job training or past  
15 experience, you say?

16 MR. LATZ: Yes, for the most part.

17 (Slide) On staff 11, I would like to allude  
18 to the physical side of the Center. Our contract with  
19 the NRC precludes direct purchases of facilities and  
20 equipment. The Institute contractually is bound and  
21 committed to the provision of those facilities, and I  
22 can report to you today that we are wanting for no  
23 facilities. We are not only well-staffed, we're well-  
24 equipped.

25 (Slide) Slide 12 indicates the character of

1       our work. As I've alluded to earlier, the distinctive  
2       difference between our organization and the Center--  
3       between the organization of the Center and the  
4       counterparts within the NRC, we're basically a matrix  
5       organization.

6               I would like at this point to make an  
7       observation that considering the grass roots start-up  
8       of the Center, the growth of organization, the  
9       indoctrination that Commissioner Remick has alluded  
10      to, that the Center has matured to quite a high level.  
11      And in recent months, there has been great maturity in  
12      the collegial relationship of our staff and the staff  
13      of the NRC. That comes about by exercise, and I must  
14      report to you this morning that the past four, five,  
15      six months, that that has arrived at a rather high  
16      level of operation, the collegial interaction between  
17      staffs, with the Center at the same time maintaining  
18      its independence in order to serve you properly.

19             COMMISSIONER REMICK: I think that's  
20      noteworthy. I detected, during my visit there a few  
21      months ago, that there was some lack in communication  
22      on different type of individuals, different type of  
23      responsibilities, different type of environments that  
24      I was alluding to. So I'm happy to hear that.

25             MR. LATZ: You're very sensitive to what has



1       been probably the largest single challenge, and I'm  
2       reporting to you this morning that I think we've made  
3       substantial progress --

4               COMMISSIONER REMICK:   Good.

5               MR. LATZ:     -- both before and since your  
6       visit, Commissioner.

7               COMMISSIONER REMICK:   Good.

8               MR. LATZ:   (Slide) Slide 13 alludes to some  
9       of the technical assistance accomplishments that the  
10      Center has had during the past months. Both this  
11      slide and the next one summarize some of the more  
12      important contributions of the Center in technical  
13      assistance.

14              As an example, the Center is developing the  
15      technical basis that will be used to evaluate the need  
16      for and feasibility of undertaking a rulemaking on the  
17      matter of substantially complete containment. As a  
18      matter of fact, we have a workshop at the Center of a  
19      peer group from many areas, including the public--  
20      the state of Nevada has been invited -- and DOE  
21      observers that we think will be a very productive  
22      exercise next week. We think that process would  
23      probably serve well in the addressing of many other  
24      issues as well as substantially complete containment.

25              Two major topical reports have been produced

1 in draft form, one on technical considerations that  
2 should be factored into a determination of  
3 substantially complete containment. This is the  
4 process that I alluded to that will play out next  
5 week. The other is an evaluation of methods for  
6 assessing uncertainties relating to performance  
7 measures.

8 We intend to use processes similar to the  
9 workshop method we're using on the substantially  
10 complete containment issue for the address of  
11 groundwater travel time, natural resource assessment  
12 methodologies, and similar difficult issues.

13 (Slide) Slide 14 continues a tabulation of  
14 our technical assistance accomplishments. The  
15 potential rulemaking on substantially complete  
16 containment is tied closely to the development of an  
17 engineered barrier system's performance assessment  
18 code. This code will be used by the NRC and Center  
19 staff to evaluate compliance with the engineered  
20 barrier system's subsystem performance objectives for  
21 containment and fractional release of radionuclides.

22 (Slide) Slide 15 alludes to the  
23 accomplishments of the Center under the Transportation  
24 Risk Study task. This has recently been terminated by  
25 the NRC based upon DOE's decision to stretch out their

1 NWPA program. It is being brought to an orderly close  
2 with technical results being documented in such a  
3 manner as to permit its efficient readdress when  
4 programmatically appropriate.

5 (Slide) Slide 16 states some of the  
6 research accomplishments of the Center. The state of  
7 the art is not well-developed in matters related to  
8 flow and transport in unsaturated rocks, such as occur  
9 at the proposed Yucca Mountain repository site. The  
10 term thermohydrology, as Mr. Bernero alluded to  
11 earlier, refers to the combined or coupled heat and  
12 fluid flow processes that will occur in the vicinity  
13 of the repository. Such phenomena will occur both in  
14 the near field waste canister region and in a larger  
15 repository scale.

16 Introduction of a Raley gas fractionation  
17 model and a geochemistry computer code EQ-6, and a  
18 laboratory evaluation of vapor phase flow in fracture  
19 porous media are aimed at providing staff with the  
20 knowledge base needed to evaluate DOE's prelicensing  
21 submittals and the licensing application.

22 COMMISSIONER REMICK: In the area of  
23 thermohydrolics, how much of this would have been done  
24 in the oil industry with the injection of steam and so  
25 forth for oil recovery? Is that --

1 MR. LATZ: It's very analogous, very  
2 similar, but we're looking at probably a different  
3 order level of thermal pulse than anything that would  
4 be encountered in an enhanced oil recovery.

5 COMMISSIONER REMICK: Much longer term.

6 MR. LATZ: Longer term and higher  
7 temperature.

8 (Slide) Slide 17 continues the statement of  
9 research accomplishments. The Center is nearing  
10 completion of negotiations with a mine in Idaho which  
11 has the distinction of experiencing many rock bursts.  
12 Since these look much like small-scale earthquakes in  
13 veneer field, they provide us with a means to study  
14 the effects of seismic events on both the integrity of  
15 underground excavations and the local ground water  
16 levels. These issues are of utmost importance in  
17 determining retrievability in the period before  
18 repository closure.

19 The integrated waste package experiments  
20 research activities are linked to user needs within  
21 the Division of High-Level Waste here in the NRC. We  
22 see here the relationship to the technical concerns of  
23 the matter of substantially complete containment.  
24 Identification and evaluation of material degradation  
25 mechanisms, some of which are poorly understood, are

1 essential to the technical evaluation of substantially  
2 complete containment.

3 With that, absent any questions, I will turn  
4 you over to Doctor Patrick, who will give you a brief  
5 summary of our recent major submittal to the NRC on  
6 regulatory uncertainties.

7 CHAIRMAN CARR: Let me ask you if the Center  
8 has reviewed draft 2 of the EPA's High-Level Waste  
9 Standard. Are you all getting into the review of  
10 those standards?

11 MR. LATZ: We are working with NRC staff as  
12 you monitor the development of the recrafting of the  
13 EPA rule.

14 CHAIRMAN CARR: Okay.

15 MR. LATZ: Wes?

16 DOCTOR PATRICK: Okay. Thank you.

17 (Slide) If we could, go to slide 18,  
18 please.

19 For the next few minutes, we're going to be  
20 covering the part of the program that deals with the  
21 systematic approach to licensing. We'll be going  
22 through a very brief overview of the systems  
23 engineering approach to give a foundation for the  
24 discussion of the document that was submitted to the  
25 Commission about one month ago, the uncertainties

1 analysis report for 10 CFR, Part 60; also touch  
2 briefly on some other accomplishments to date, and  
3 review for you the approach that we use, the  
4 regulatory analysis method that we have found useful  
5 in systematically evaluating 10 CFR, Part 60, which of  
6 course is the primary regulation governing the  
7 licensing of a repository.

8 (Slide) Slide 19 and the three backup  
9 slides that follow it outline the basic approach that  
10 we are using in the analysis. The systems engineering  
11 approach has five key parts to it, and I'd like to  
12 focus on two of those, the second and the fourth  
13 bullets that are indicated there.

14 (Slide) If we could turn to the backup  
15 slides in your briefing packet, you'll see that those  
16 are basically the same chart and we have provided  
17 screening in three different fashions just to focus  
18 our discussion this morning.

19 The first stage of the analysis process is  
20 to dissect the regulation into the individual  
21 regulatory requirements that exist within it. And as  
22 it turns out, there are some 100 such separate  
23 requirements within 10 CFR, Part 60. Those can be  
24 further segmented into what we would call elements of  
25 proof, the fundamental pieces of those regulatory

1 requirements which must be satisfied by the license  
2 applicant and which NRC must evaluate as it reviews  
3 the license application for the repository.

4 We found in that analysis that there is yet  
5 another level below what is written in the regulation,  
6 which serves the staff well, both our staff and the  
7 NRC staff. Those are the more detailed components  
8 that need to be reviewed by the technical people as  
9 they assess the license application. Those are what  
10 we call technical review components, and they comprise  
11 that third level of the diagram that's shown there in  
12 the white part of the briefing chart.

13 Now if you take that entire set together,  
14 all of the information that includes the regulatory  
15 requirement itself, logically organized into separate  
16 elements of proof, and then the technical information  
17 that must be brought to address those regulatory  
18 requirements, you have basically the content of the  
19 format and content regulatory guide which the staff  
20 will prepare and provide to the DOE and has done so,  
21 in fact, in draft form to be able to guide DOE in the  
22 preparation of their license application.

23 Turning to the second backup sheet --

24 COMMISSIONER REMICK: Wes, before you leave  
25 that --

1 DOCTOR PATRICK: Yes, sir.

2 COMMISSIONER REMICK: -- on the technical  
3 review components, has any thought been given yet or  
4 is it premature on when that technical review would be  
5 done? And what I have in mind here, I know that DOE  
6 has a lot of experience on hold points and operational  
7 readiness reviews, and I think they plan to use this  
8 in their repository. And has there been any thought  
9 from the standpoint -- and perhaps this should be just  
10 as well addressed to the staff -- of what the NRC--  
11 you're telling them basically the components that need  
12 to be reviewed, but is anybody thinking about when, so  
13 that we know that if DOE is independently planning  
14 hold points and things we would say, at that point,  
15 this is what we need to review and say --

16 MR. BERNERO: Yes. Yes, we are. But I  
17 would emphasize a point here. One of the underlying  
18 recommendations, very broad recommendations to DOE in  
19 this entire program, is that they look at the  
20 regulatory requirements at the objectives and assess  
21 with the information at hand what they need to do to  
22 develop or to characterize the site, and at the same  
23 time what results they expect from such  
24 characterization, and to have an integral feedback  
25 mechanism so that as they proceed towards site



1        characterization they are constantly analyzing it to  
2        see whether they are getting the necessary and  
3        sufficient information and at the same time seeing  
4        that they will still be proceeding toward an  
5        acceptable site.

6                It is not the same, not quite the same as  
7        one would do in, let's say, a construction project  
8        where much of their experience is I'm going to go have  
9        this project and I have a PERT chart, you know, I have  
10       critical information, critical steps in the procedure.  
11       Many of these things -- and that's why we have put  
12       them out in draft form -- many of them are needed for  
13       an interactive process where we set down elements of  
14       proof or technical guidance to forecast, to predict  
15       what we expect to be the result or the requirement,  
16       the resulting requirement. And DOE needs to take  
17       those into account and if need be see whether that's  
18       going to change their strategy or their approach.

19               So we are doing it, but we're doing it in a  
20       very broad way, and it's not in any rigidly milestoned  
21       effect.

22               COMMISSIONER REMICK: But NRC is interacting  
23       and playing a role in that.

24               MR. BERNERO: Very much so.

25               COMMISSIONER REMICK: I would hate to have

1 us sit back and DOE do something, and then later we  
2 say, "Oh, we should have looked at this at that time,"  
3 and so forth.

4 MR. BERNERO: Yes. That would be -- and if  
5 you look at our comments on the site characterization  
6 plan, we make this point very strongly to them.

7 COMMISSIONER REMICK: Good. Thank you.

8 DOCTOR PATRICK: If I could add to that just  
9 briefly, if I may, one of the ways in which what is  
10 being done from the more systematic broad top down  
11 analysis that Mr. Bernero was referring to and how we  
12 factor that into the normal ongoing interactions with  
13 the DOE is a very important point. And if we were to  
14 take that bottom line which you've asked your question  
15 about, there's a very good example developing right  
16 now among the NRC staff and the Center's been asked to  
17 review certain documents in the SEP review.

18 And in fact, before the SEP was reviewed and  
19 the exploratory shaft facility documentations, your  
20 staff and ours raised several questions regarding how  
21 DOE was approaching their design of facilities,  
22 specifically the integration of exploratory shaft  
23 facilities with the repository facilities, and more  
24 broadly the need to establish criteria before they  
25 began their design process. That concern, which was

1 expressed in the SCA and exists as an open item now,  
2 is beginning to be addressed in a white paper that the  
3 engineering staff has developed within NMSS in the  
4 Division of High-Level Waste. The building blocks for  
5 that become technical review components. It is a way  
6 of guiding DOE into what kinds of things they need to  
7 concern. The timing is dictated by when we identify  
8 the problem area, in that case.

9 COMMISSIONER REMICK: Thank you.

10 DOCTOR PATRICK: If we may turn, then, to  
11 that second briefing chart, the backup chart, the part  
12 that is in white in this diagram, is a set of  
13 information -- compliance determination methods, as  
14 they are called -- and information requirements to  
15 execute those compliance determination methods, which  
16 taken together will form the license application  
17 review plan, which is NRC staff's self-guidance on how  
18 they are going to conduct the review of the license  
19 application. Being a public document, it also gives  
20 the DOE very keen insights into how that review is  
21 going to be conducted.

22 The third of the backup sheets gets to that  
23 portion of the systematic regulatory analysis where we  
24 begin to see the identification and the dispensing  
25 with, the reducing of uncertainties. Regulatory

1       uncertainty and institutional uncertainty are the two  
2       types of uncertainties which the document you received  
3       one month ago address and which we'll be addressing  
4       further in the briefing today.     We will not be  
5       addressing technical uncertainties.

6               Now this chart, for simplification, shows  
7       regulatory uncertainties leading to a rulemaking.  
8       That is only one of a number of different ways that  
9       regulatory uncertainties can be addressed.     Many of  
10       these regulatory uncertainties are such that merely a  
11       letter of clarification or a DOE staff interaction via  
12       a technical exchange will clarify the language that  
13       exists within the regulation.     We'll focus on that top  
14       part of that third briefing chart.

15              MR. BERNERO:   Excuse me, Wes.

16              DOCTOR PATRICK:   Yes, sir.

17              MR. BERNERO:   I just wanted to emphasize a  
18       point, that in this process there is a judgement line  
19       to be drawn, at what point you stop resolving  
20       regulatory uncertainties with rulemaking or with reg  
21       guides or branch technical positions.     It is that  
22       judgement as to the appropriate level of uncertainty;  
23       or put it another way, the appropriate level of  
24       flexibility in order to make a competent regulatory  
25       judgement in the actual licensing of the repository.

1 And so that's a very, very significant requirement on  
2 us in this whole process is to draw that line as we go  
3 through --

4 COMMISSIONER REMICK: I notice on your chart  
5 under regulatory uncertainties you have technical  
6 uncertainties. You don't have any legal  
7 uncertainties. You anticipate no legal uncertainties?

8 MR. BERNERO: They're always sure.

9 DOCTOR PATRICK: (Slide) Slide 20, please.

10 COMMISSIONER REMICK: Before leaving that,  
11 Wes, is the systematic approach to licensing, is that  
12 new terminology since I visited you?

13 DOCTOR PATRICK: That probably does bear at  
14 least a brief comment or two. From the outset of the  
15 program, we've used a set of words, program  
16 architecture, which refer very broadly to the  
17 application of systems engineering and system  
18 integration techniques to a program, and this program  
19 being the licensing of a high-level waste repository,  
20 any MRS and transportation associated with that. That  
21 term has had associated with it a couple of problems.  
22 One, people have difficulty understanding what program  
23 architecture means, because it also is used in other  
24 contexts, specifically in computer applications, and  
25 it has a specific meaning there. Most people aren't

1 familiar with its systems use from the aerospace  
2 industry.

3 We are currently focusing in on using a new  
4 term to address part of the program architecture, and  
5 that is what we call the systematic regulatory  
6 analysis. But it's important to recognize that that  
7 is only a part of the entire systems approach. There  
8 are functions of integration, broader functions of  
9 systems engineering which are not addressed just in  
10 the analysis of that regulation or any other  
11 regulation.

12 COMMISSIONER REMICK: Personally, I like  
13 this terminology. It communicates more to me than the  
14 program architecture.

15 DOCTOR PATRICK: And that's exactly why  
16 we've tried to go with that enhanced definition for  
17 that part of the work.

18 (Slide) Slide 20, please.

19 This slide just delineates three specific--  
20 what we feel are significant accomplishments in the  
21 systems engineering area.

22 The third bullet is a very important one, we  
23 feel, now that we have in place the basic systems  
24 engineering process and the procedures for systematic  
25 regulatory analysis so that we can now proceed with

1 the activities in this area.

2 Today, we're going to look at a fourth  
3 bullet, which is specifically the address of  
4 regulatory and institutional uncertainties that we  
5 have identified within 10 CFR, Part 60.

6 (Slide) Slide 21 lays out the scope of the  
7 report that you received about one month ago, and the  
8 following slides will be expanding upon the content of  
9 that report.

10 (Slide) If we can turn to slide 22, you  
11 will see outlined there in five bullets the basic  
12 approach that we use in this systematic regulatory  
13 analysis.

14 The first step is the obvious one, to  
15 identify the specific regulatory requirements that  
16 exist within the part of the regulation that's under  
17 analysis, in this case Part 60. As I indicated  
18 earlier, there are about 100 such individual  
19 requirements that we find within the regulation. Most  
20 are directed toward the Department of Energy. There  
21 are ones which are directed toward the NRC itself,  
22 indicating how the NRC shall conduct certain parts of  
23 the review and so forth.

24 The delineation of the relationships between  
25 the pieces of those regulatory requirements we found

1 to be a very important second step in the analysis,  
2 and it enables us to see what specific and/or logical  
3 relationships must be fulfilled within the regulation.  
4 It's very easy to go into a regulation, even as short  
5 as 10 CFR 60 is, and to pick out of context particular  
6 portions of the reg. By establishing a logical  
7 relationship between each portion of the regulation,  
8 we're able to avoid some of those possible pitfalls.

9 Before we proceed, I think this term  
10 "uncertainty" may need a little bit of elucidation.  
11 We're going to give definitions a little bit later in  
12 the briefing packet for regulatory and institutional  
13 uncertainties specifically, but the key use of that  
14 term as we use it in this context is a very broad one  
15 and it encompasses any ambiguities, any lack of  
16 clarity that might exist within the regulation as  
17 written. So it is based on the terminologies present,  
18 rather than with the technical capability to -- when  
19 we get to regulatory and institutional uncertainties,  
20 it deals with those rather than with the technical  
21 capability of implementation. Technical uncertainties  
22 specifically draw themselves to questions of  
23 implementation from a technical perspective.

24 For each of the uncertainties that are  
25 identified, then, the staff developed a rationale



1 pulling in appropriate citations both from NRC's own  
2 documentation and other sources of information which  
3 clarify the presence or later are used to exclude  
4 certain uncertainties that have been identified.

5 (Slide) Slide 23. There are three basic  
6 stages to this process of uncertainty evaluation.  
7 Today's briefing will focus on the first of those, the  
8 identification and some of the early groupings and  
9 categorizations of the uncertainties.

10 (Slide) The backup chart which follows that  
11 lays out the three stages that I just referred to.

12 Stage 1 identification of the systematic  
13 regulatory analysis starts with evaluation of 10 CFR  
14 60, any regulations which may be incorporated by  
15 reference into it, and of course the implementing  
16 statutes.

17 After the uncertainties are identified, we  
18 have found it useful to group them, and those  
19 groupings are used primarily for purposes of aiding  
20 discussion. But as we'll discuss a little bit later,  
21 they also assist us in guiding direction towards stage  
22 2 and stage 3, where we begin to try to understand  
23 what uncertainty reduction methods might be  
24 appropriate for a particular uncertainty.  
25 Categorization serves a similar function, as we'll

1 discuss later.

2 The diamond at the beginning of stage 2 is  
3 the very important aspect which was alluded to  
4 earlier. Some uncertainties may be there on purpose.  
5 They may be there to provide flexibility in the  
6 regulation and in its implementation. And a very key  
7 part of the analysis, then, is to identify which  
8 uncertainties might fall within that category and to  
9 dispense with them, to set them to the side, recognize  
10 that they are there for a purpose. We very dutifully  
11 and systematically avoid making that decision at the  
12 time of identification, because we feel it is very  
13 important to have available the entire sweep of  
14 possible uncertainties so that if a question arises in  
15 the future we will have the evidence in our database,  
16 in our records that says, yes, we recognize that there  
17 is a possible ambiguity there. It is there on  
18 purpose, and we've dispensed with it in the following  
19 fashion.

20 (Slide) Slide 24, please. This reiterates  
21 and hopefully clarifies the three types of  
22 uncertainties which we address in these analyses.  
23 There are very full-blown definitions for each of  
24 these, but these three basically get down to the  
25 fundamentals. A regulatory uncertainty is a question

1 with what must be done, and institutional with who is  
2 responsible for implementing it, and the technical  
3 deals with the how the compliance will either be  
4 demonstrated by the license applicant or determined by  
5 NRC in its licensing review responsibilities.

6 (Slide) Slide 25 and 26 give excerpts of  
7 definitions of regulatory and institutional  
8 uncertainties respectively.

9 (Slide) If we could go to slide 27, I  
10 mentioned earlier the step that follows identification  
11 of uncertainties is to group them. And we find that  
12 this grouping has been very useful to us both to aid  
13 in discussion, because we can talk about uncertainties  
14 which are topically related to one another, and I  
15 think more importantly it also gives insights into  
16 those cases where one uncertainty reduction might be  
17 able to be applied to several uncertainties. So if  
18 the uncertainties are dealing topically with the same  
19 subject, in the future one might be able to dispense  
20 with them in a similar manner.

21 (Slide) Slides 28 and 29 simply list those  
22 groups and I will not discuss them further at this  
23 time, unless there are questions.

24 (Slide) Slide 30 addresses a second action  
25 that we take after we have identified the

1       uncertainties, and that is to group them into  
2       categories to further differentiate among the various  
3       types of regulatory uncertainties and institutional  
4       uncertainties that have been identified. Where the  
5       groups we found to be helpful to show us where an  
6       uncertainty method might address more than one  
7       uncertainty, the categories help us to get some early  
8       insight into uncertainty reduction method. For  
9       instance, those that are categorized as questions of  
10      definition might be able to be dispensed with in a  
11      different manner than those that are fundamental  
12      omissions from the regulation.

13             It's important to point out that those  
14      categorizations don't carry with them, from our  
15      perspective, any implication of importance or lack  
16      thereof or necessity of reduction of those  
17      uncertainties.

18             (Slide) Slide 31 begins to get to the meat  
19      of the report that you received. It very clearly  
20      shows that by far the preponderance of all the  
21      uncertainties identified to date fall into the first  
22      two categories, the need for clarification in the  
23      definition and omission of some particular feature of  
24      the regulation.

25             And I need to draw a distinction between

1       insufficiency and omission as we're using them here.  
2       Insufficiency would arise if an entire function or an  
3       entire system or component of the repository were not  
4       addressed at all in the regulation. Omissions arise  
5       in a case where the basic function or the basic system  
6       or subsystem is being regulated, but there's some  
7       feature that isn't being properly addressed. One  
8       might address in the regulation the potential design  
9       implications of a fire, but for instance might leave  
10      out the implications of an explosion. That would be  
11      an example of that type of an omission, as opposed to  
12      an insufficiency.

13               I'd like to provide you, just to give you  
14      some insights into the types of categories, an example  
15      or two from each of these.

16               In the area of definitions, we find there's  
17      an uncertainty regarding the dose commitment for  
18      design basis purposes. You have a rulemaking ongoing  
19      in that area.

20               Another area where definitions seem to need  
21      to be clarified is in the area of anticipated  
22      processes and events and unanticipated processes and  
23      events. There's been an ongoing rulemaking in that  
24      area as well for some time and a recent decision to  
25      group that with the rulemaking dealing with

1 implementation of the EPA standard.

2 In the category of emissions, there is currently  
3 no subpart I for the regulation. That will need to be  
4 prepared and there's a rulemaking in place on it.

5 Another case of an emission would be the EPA  
6 Conforming Amendment.

7 Examples of inconsistencies. One that  
8 seemingly is not terribly important is a use of  
9 terminology within Part 60 dealing with environmental  
10 report versus an environmental impact study.

11 A second example might be the treatment of  
12 combinations of potentially adverse conditions.  
13 That's an inconsistency which currently isn't being  
14 addressed by rulemaking or any technical positions.

15 Finally, the last area where we've  
16 identified some potential uncertainties is in question  
17 of agency jurisdiction, dealing with the matter of  
18 responsibility for compliance with the mining  
19 regulations that may have a secondary impact on  
20 nuclear safety or radiological safety.

21 (Slide) If we could turn to slide number  
22 32, we see the results of a series of correlations  
23 which we provide within the report.

24 One of the questions that the staff raised  
25 when we embarked upon this study and were keenly

1 interested in as the study progressed is are you  
2 finding things that are new or do we currently have  
3 all of the bases covered? And slide 32 speaks to that  
4 matter, as does the report.

5 Five of the tentative rulemakings that have  
6 been identified by staff correlated with uncertainties  
7 which we identified in this analysis.

8 Fifteen of the technical positions likewise  
9 correlated.

10 There were 13 uncertainties that we found  
11 for which there was no companion rulemaking or  
12 technical position underway. That does not mean that  
13 a technical position or rulemaking is needed to  
14 address those uncertainties, but the uncertainties do  
15 need to be further examined, further evaluated to  
16 determine if action of that level is appropriate or if  
17 simply a letter of clarification or technical  
18 interaction at the staff level would be all that's  
19 necessary to resolve or sufficiently reduce those  
20 particular uncertainties.

21 (Slide) Slide 33 and 34 list some further  
22 actions which we feel would be appropriate at this  
23 time to take, building upon the analysis that's been  
24 completed and reported to you.

25 The first one addresses the question of

1 sufficiency. And if you recall from the slide on the  
2 categories of uncertainties that had been identified,  
3 there was a little asterisk there that indicated that  
4 we have not yet done a complete test of the  
5 sufficiency of the regulation. We have completed the  
6 tests that deal with necessity, but not those that  
7 deal with sufficiency.

8 We are currently meeting with your staff to  
9 embark upon a study called a functional analysis of  
10 the repository, which would provide the basis upon  
11 which we would be able to conduct the sufficiency  
12 test. In the meantime, any targets of opportunity  
13 that we see where there seems to be an insufficiency  
14 in the regulation we will of course pick up on and  
15 address. But we feel it's important to do that,  
16 again, a top down analysis, a thorough analysis to  
17 make sure that there are no items missing in the  
18 regulation for which the NRC should be providing  
19 review capacity and regulatory responsibilities.

20 The second bullet there speaks to the need  
21 to dig into those uncertainties, particularly those  
22 for which there are no current technical positions or  
23 rulemakings.

24 (Slide) And I direct your attention  
25 particularly in that regard to slide 34. In cases



1 where the uncertainty correlates with a rulemaking or  
2 a technical position that exists, there's still a  
3 potential that the rulemaking or technical position  
4 will not adequately reduce those uncertainties, and we  
5 need to address those. We need to look at the scopes,  
6 the statements of work for those technical positions  
7 and rulemakings to ensure that the uncertainties are  
8 being reduced.

9 The second case would be those where the  
10 uncertainties don't correlate at all with an existing  
11 TP rulemaking or other staff action. It's  
12 appropriate, we feel, to initiate some review of those  
13 so that we can determine if there's any particular  
14 action that the staff needs to take at this point.

15 Those conclude my remarks regarding the  
16 technical report which you've received that analyzes  
17 the regulatory and institutional uncertainties that  
18 are present in 10 CFR 60. And if there are no  
19 questions, I'll turn it over to Mr. Bernero.

20 MR. BERNERO: I'd like to just make a couple  
21 of summary remarks, and that is that we think this is  
22 a very important piece of work in the program and we  
23 are going forward using this, working with the Center  
24 in this activity. And I would remind you again that  
25 our program strategy reevaluation is crucial at this

1 point.

2 You will be seeing in the very near future  
3 the rulemaking technical position strategy paper, in  
4 other words the revision of SECY-88-285. And in  
5 parallel, you will be seeing in the five year plan  
6 budget program that's also ripe for consideration now  
7 you will see the treatment of the same program  
8 strategy in the broadest sense. So it's a very  
9 important factor in this strategy reevaluation.

10 And as far as the Center itself, now that  
11 you see the Center is up to speed, it's functioning  
12 well, they have substantial expertise, we're going to  
13 go forward. I am happy to say and second what was  
14 said earlier about collegiality. We're working  
15 together very well now. I'm very happy to see that  
16 progress. We've got this fine line to walk. We have  
17 to work as a team, but the Center has a responsibility  
18 to maintain their independence to contribute to the  
19 program. That's the very reason we believe the  
20 Commission went out for a Center. So we want to  
21 preserve that independence, but at the same time we  
22 have to work effectively in the regulatory process.

23 So if you have any --

24 COMMISSIONER REMICK: Bob, along that line,  
25 it impresses me as being a very thorough, systematic

1 and analytic look at Part 60, which I think an  
2 independent body can best do. If we were doing it  
3 ourselves, many times we'd say, "Well, we understand  
4 that," or "It's obvious that ..." and so forth. But  
5 to flesh it out, I assume it takes a tremendous amount  
6 of staff participation and interaction to work with  
7 the Center staff. Are we up to date from our  
8 standpoint of helping flesh-out this?

9 MR. BERNERO: I'd say we are. Keep in mind  
10 what the Center is doing is taking an independent look  
11 at a body of regulation and regulatory requirement  
12 that this staff, General Counsel, the technical staff  
13 in Waste, the Research staff, that all of the people  
14 here in staff more or less have fresh in mind. And it  
15 is -- I don't mean to boast -- I'd say a coherent set  
16 of regulation, because it's untried, unused. And  
17 therefore, it's been formulated to be an attempt at a  
18 complete regulatory process.

19 I would say that the staff in Research,  
20 NMSS, and in OGC is able to interact with the Center  
21 in a healthy way. We're getting that independent  
22 shot, but at the same time we can quickly identify  
23 things for why they're like that or why they're not  
24 there.

25 COMMISSIONER REMICK: Are we doing it in a

1       timely fashion?

2               MR. BERNERO:   I'd say we are.

3               COMMISSIONER REMICK:   Gee, I wish you had an  
4       analysis   like   this   for   licensing   an   enrichment  
5       facility.

6               MR. BERNERO:   That's not the one I was  
7       thinking of.   No, actually, an enrichment facility,  
8       we, as you know, put out an advanced notice of  
9       proposed rulemaking.   It would be very nice if we had  
10      such a thing sorted out.   This is, considering the  
11      difficulty of high-level waste regulation and  
12      licensing, this is an effort that is going to just pay  
13      for itself many times over when the time comes.   And  
14      it's a real luxury to have it.

15              COMMISSIONER REMICK:   I agree.   Some day  
16      it'd be nice to have some Part 50.

17              MR. BERNERO:   Please, the EDO can take just  
18      so much.

19              MR. TAYLOR:   I asked -- after I was briefed  
20      on the subject, the thought entered my mind.   It's  
21      still there.

22              CHAIRMAN CARR:   Any other questions?

23                      Doctor Remick?

24              COMMISSIONER REMICK:   Not so much questions,  
25      just a comment.   Mr. Bernero started out by saying

1       that the purpose of the Center is to provide expert  
2       advice, and I agree. And I know that to provide  
3       expert advice one has to continue to be an expert. So  
4       its important that, I think, the Center does continue  
5       to have the opportunity for conducting research,  
6       independence, all the things that were addressed here  
7       this morning, because I think if they're going to  
8       retain the excellent talent that they appear to have  
9       obtained, why, it's going to be important for people  
10      to be involved in their profession and so forth.

11             I realize, at the same time, we have lots of  
12      needs for them to provide technical assistance, but we  
13      have to preserve what I think will provide us with  
14      creativity and forward-looking and so forth at an  
15      organization like this who's not engaged in the day to  
16      day crises can provide.

17             I had responsibility for about 23 years for  
18      a laboratory larger than this one that was an FFRDC  
19      for part of its existence, providing independent  
20      advice to a government agency, and I feel very  
21      strongly I know what such an organization can provide  
22      being independent and so forth, yet being involved at  
23      the same time.

24             So I just urge the staff to keep that in  
25      mind, that although we're going to have a lot of

1 crises, we're going to need these people to help, we  
2 also want them to be forward-looking and provide us  
3 with creative thinking. So it's important for them.  
4 They'll be the corporate memory after a while in this  
5 area. So we want to retain very good people over a  
6 period of time. The only way is to treat them as the  
7 type of individuals we want them to have. So, lecture  
8 given.

9 MR. BERNERO: We welcome that.

10 CHAIRMAN CARR: Commissioner Roberts?

11 COMMISSIONER ROBERTS: In these days of  
12 budget cutting, I'd be careful about bragging about  
13 luxuries. Just smile and enjoy it.

14 CHAIRMAN CARR: The thought occurred to me  
15 as he mentioned the word.

16 COMMISSIONER ROGERS: Yes. I think it's not  
17 a luxury. I think it's a necessity. That's not a  
18 good word, I think, luxury.

19 Just a question now on this, where this  
20 process stands. Have you completed the identification  
21 of regulatory and institutional uncertainties now for  
22 Part 60? Do you feel that that's complete?

23 DOCTOR PATRICK: With the exception of the  
24 test on sufficiency that I alluded to.

25 COMMISSIONER ROGERS: That's done, in your

1 view, yes, just for the regulatory and institutional  
2 uncertainties.

3 Is there any additional validation that one  
4 might be able to impose on this system? Can anybody  
5 think of anything that somehow would test how well  
6 it's -- I mean, it's very impressive. It looks  
7 beautiful. It has a sort of marvelous completeness  
8 about it. But one always wonders, in anything of this  
9 sort, is there a test that one could apply to it to  
10 see whether it, in fact, has picked up everything.  
11 Anything you've thought of along those lines?

12 DOCTOR PATRICK: One thing that I didn't  
13 speak to, Commissioner, and is a very important part  
14 of the entire process. If you look at the second  
15 volume of the document that you have, you'll find the  
16 analysts names appearing there, and they are many.  
17 Probably 25 or so people have been involved in the  
18 process.

19 Once an analyst completes his initial work,  
20 and typically that is a team of analysts of two to  
21 three people -- we try to have someone with a legal  
22 background involved in the development of each of  
23 these regulatory uncertainties to bring that  
24 perspective in -- then those are subjected to an  
25 internal review, and that is a very formal process as

1 well, controlled by procedures.

2 The uncertainties then are turned over to  
3 people who are doing the actual analysis and reporting  
4 function: in this case, Doctor Ruth Weiner, Mr. Ted  
5 Romine, both of whom are in the audience this morning,  
6 and myself. We take a third fresh look again at  
7 everything that has been done and try to look at them  
8 as a cohesive whole.

9 The third step of analysis and review is  
10 when that document is turned over to the NRC, which it  
11 was in draft form in the late December time frame. So  
12 many eyes have looked at it from many different  
13 perspectives. And although I'm not going to sit here  
14 and say that there is nothing that has snuck through  
15 in that process, that kind of a review and the very  
16 substantial changes that occurred at each step of that  
17 review gives me confidence that it's pretty close.

18 COMMISSIONER ROGERS: Yes.

19 MR. BERNERO: May I pick up on that? What  
20 Wes describes is an extensive quality assurance and  
21 review, but I think the thrust of your question is  
22 more toward a test, a validation. And it raises an  
23 interesting point that is at least partially  
24 available, and that is a trial use of the regulatory  
25 process.



1 By way of example, right now with the Office  
2 of Research in particular we're working with the  
3 Swedish authorities on the possibility of developing a  
4 trial application of performance assessment to a  
5 repository, a going through the motions of at least  
6 part of the regulatory process to exercise it to see  
7 whether such trial application identifies missing  
8 uncertainties or conflicting uncertainties, things  
9 like that. And that of course is a very sensitive  
10 point, to try to use that without compromising the  
11 whole regulatory process.

12 COMMISSIONER ROGERS: I notice that you have  
13 43 discreet regulatory and institutional uncertainties  
14 identified, and just seven of those were regulatory  
15 uncertainties. Is that correct? On page 11 of volume  
16 1, you pointed out that there were 43 discrete  
17 regulatory and institutional uncertainties that remain  
18 for resolution, and seven of these are regulatory and  
19 36, presumably, are institutional.

20 DOCTOR PATRICK: I'm missing where you're  
21 picking up, sir. One of the --

22 COMMISSIONER ROGERS: Page 11 of volume 1.

23 DOCTOR PATRICK: We've identified two  
24 institutional uncertainties. Let me see if I can  
25 locate --

1 COMMISSIONER ROGERS: Well, I'm just looking  
2 here in your executive summary on page 11, near the  
3 bottom, the fifth paragraph up from the bottom, "A  
4 total of 43 discrete regulatory and institutional  
5 uncertainties remain for further characterization and  
6 consideration." So presumably -- and seven of these  
7 are regulatory uncertainties.

8 DOCTOR PATRICK: Regulatory uncertainties  
9 that are common to the 24 potentially adverse  
10 conditions. In other words, seven of the 43 --

11 COMMISSIONER ROGERS: Yes.

12 DOCTOR PATRICK: -- if one wanted to tally  
13 it up in a different manner, you would have seven  
14 times 24, because the same phraseology that is a  
15 source of uncertainty occurs in all 24.

16 COMMISSIONER ROGERS: Oh, I see. So you  
17 wouldn't -- I can't read that, that of the 43, only  
18 seven are regulatory and 36 are institutional?

19 DOCTOR PATRICK: You cannot read it so, no.

20 COMMISSIONER ROGERS: Okay.

21 DOCTOR PATRICK: There are only two  
22 institutional uncertainties that --

23 COMMISSIONER ROGERS: Two.

24 DOCTOR PATRICK: -- were identified.

25 COMMISSIONER ROGERS: I see.

1 DOCTOR PATRICK: The table 7, I believe,  
2 showing the categorization, elucidates that a little  
3 better. That would be page 38 of volume 1. And in  
4 your briefing packet, it is summarized there as well.

5 COMMISSIONER ROGERS: I see.

6 DOCTOR PATRICK: Only those in category 7,  
7 need for clarification of jurisdiction, would fall  
8 within the category of institutional uncertainty. All  
9 of those in categories 1 through 6, of which only 1,  
10 2, and 3 we found any, would be regulatory in nature.

11 COMMISSIONER ROGERS: I see. Okay. Well,  
12 that's helpful. I didn't understand.

13 Well, it's a very impressive piece of work.  
14 And I must say I haven't had a chance to really digest  
15 it yet, but it certainly has a very substantial ring  
16 to it, impressive.

17 Let me just turn to a couple of other  
18 things. You mentioned that we've suspended the  
19 transportation activities. Are there any other  
20 adjustments that have been made to accommodate to  
21 DOE's changed schedule?

22 MR. BERNERO: So far, there has been some  
23 adjustment of the waste package research tentatively  
24 taken, but nothing so definitive so far as the  
25 transportation. But that's really where we'll be in

1 just a few months, just a very short time, as soon as  
2 we've completed this reevaluation.

3 DOE, as you know, put out the 60 day report,  
4 and then has had further iteration with us. So things  
5 are becoming more clear as we deal with DOE, more  
6 clear than are evidenced by just the report itself.  
7 But to answer your question specifically, aside from  
8 the waste package, I can't think of anything else  
9 that's as definitive as what we did with  
10 transportation risk.

11 COMMISSIONER ROGERS: Where do we stand now  
12 with the question of fellowships between NRC and the  
13 Center? I know that's a matter that's under  
14 discussion.

15 MR. BERNERO: Well, we have that on our  
16 agenda and we expect to be proceeding with that, but  
17 we're not quite ready for it yet. You know, we're  
18 just early in the stage. This is a very desirable  
19 thing for us, you know, the exchange of staff.

20 COMMISSIONER ROGERS: Yes, right.

21 MR. BERNERO: So I hope that we can be  
22 coming to that in this near-term, but we're not ready.

23 COMMISSIONER ROGERS: You don't have a  
24 schedule for that?

25 MR. BERNERO: No, we don't have a firm

1 schedule yet.

2 COMMISSIONER ROGERS: How does the Center  
3 see the licensing support system as a potential  
4 technical tool?

5 MR. LATZ: Very important.

6 COMMISSIONER ROGERS: How would you use it?

7 MR. LATZ: I think it will be very necessary  
8 that all parties at interest in the proceeding take  
9 cognizance of the material that enters the licensing  
10 support system database. It can't help but be  
11 reflective of the concerns of those who are entering  
12 it. And I think it may well signal or create an  
13 awareness of areas that we've overlooked and perhaps  
14 should be addressing. So I think the monitoring of  
15 the flow of information to the LSS database will be an  
16 extremely important activity.

17 DOCTOR PATRICK: I would second that from  
18 the standpoint of analysis of even the regulatory and  
19 institutional aspects of uncertainties, and it's going  
20 to be even more important in technical uncertainty  
21 analysis. The greatest hampering of that process is  
22 lack of timely information being available, and the  
23 LSS, you know, we're banking on it. We're planning a  
24 system, a software system on our side which will  
25 directly interface with the LSS. We just have to

1 start it.

2 COMMISSIONER ROGERS: Well, I just want to  
3 say that I've been very impressed with the progress  
4 you've made. I know that you started from scratch.

5 I was down to visit you a year or so ago,  
6 and I heard about your approach here, this systems  
7 approach to licensing that I thought looked extremely  
8 interesting. It seemed to me an ideal demonstration  
9 of the way systems engineering can be applied to  
10 analysis, regulatory analysis. But I must say I was  
11 cheering for it, but I was a little skeptical that you  
12 would be able to pull it off. And it really looks  
13 pretty good. I really want to compliment you on your  
14 achievements to date. Good work.

15 CHAIRMAN CARR: Commissioner Curtiss?

16 COMMISSIONER CURTISS: Let me commend you  
17 too for the work that you've done. It's most  
18 impressive and I think at the same time that you've  
19 geared up within a short period time. The work has  
20 been most impressive.

21 Let me ask some -- I have a range of  
22 questions, some general and some specific. On the  
23 validation question that was raised earlier, do we  
24 have -- have we identified any uncertainties that did  
25 not show up in the work that was done, or are we

1 identifying the same uncertainties? I know we looked  
2 at the question in 88-285 and came up with a list of  
3 rules and technical topics. Are the two squaring?

4 MR. BERNERO: I think so. Let me ask. John  
5 Lenahan probably would have a fresh look at that.

6 MR. LENAHAH: Yes. In general, they are  
7 squaring.

8 CHAIRMAN CARR: Would you identify yourself  
9 at the microphone, please?

10 MR. LENAHAH: John Lenahan, NRC staff.

11 In general, it is confirming what we had in  
12 285. There are some differences that we are going to  
13 have to evaluate in the update to the strategy that's  
14 going on right now.

15 COMMISSIONER CURTISS: Okay. On the ones  
16 that have been identified by the Center that cropped-  
17 up, in particular the 13 that are referred to on slide  
18 32 that do not correlate with rulemakings or technical  
19 positions currently underway right now, I think you  
20 indicated somewhere in your volume 1 that you've done  
21 a cursory review of the significance of the issues.  
22 Really, two questions. One, do you have a feel for  
23 how significant those 13 are? And two, from our end,  
24 Bob, do you have any comment on whether those are  
25 intentional or unintentional certainties?

1 MR. BERNERO: Again, let me turn to John,  
2 because I'm not that close. That analysis is going on  
3 right now.

4 MR. LENAHAAN: Yes, that's exactly the  
5 situation. We haven't had a chance to do a good  
6 thorough analysis of the report by the Center.

7 COMMISSIONER CURTISS: Okay.

8 CHAIRMAN CARR: It's my impression the  
9 Center hasn't finished their analysis of those 13.  
10 Have you?

11 DOCTOR PATRICK: Well, from the standpoint  
12 of getting down to the really difficult part of  
13 assessing importance, timeliness, timely need for  
14 review and reduction of those uncertainties, that's  
15 stage 2 and stage 3, and that's work to be done.  
16 You're correct.

17 COMMISSIONER CURTISS: I guess what I had in  
18 mind is the -- somewhere in volume 1 there was a  
19 reference that you had undertaken a cursory review.  
20 Recognizing that the more detailed review still  
21 remains to be done, did anything jump out at you in  
22 terms of significant issues with that cursory look  
23 that we haven't identified already?

24 DOCTOR PATRICK: I would not try to address  
25 it exhaustively, but one which is a subject that I



1 think is going to need some attention, whether  
2 anything -- I don't think anything needs to be done.  
3 Personally, I don't believe anything needs to be done  
4 to the rule. But dealing with the question that I  
5 mentioned earlier, the institutional uncertainty that  
6 we identified associated with who's going to take care  
7 of the mining aspects, mining safety aspects that can  
8 impact radiological safety, I think that's something  
9 that is likely to impact your staffing needs and  
10 possibly our own as well as we get into that.

11 COMMISSIONER CURTISS: Okay. Let me -- I  
12 was intrigued by your discussion in volume 1 on pages  
13 22 and 23 where you spend a good deal of time talking  
14 about your approach to the relationship between 60.112  
15 and 60.122. Can you expand on what you looked at  
16 there? Because, I gather there were two different  
17 ways to look at that issue, and on page 23 in  
18 particular there are four points discussed that led  
19 you to conclude that, as you say here, the  
20 uncertainties listed do not exist -- the school of  
21 thought that you rejected here for the four reasons  
22 that are laid out, can you expand on that?

23 DOCTOR PATRICK: Well, the concern that had  
24 been raised is whether certain uncertainties existed  
25 in and of themselves, and particularly those

1       uncertainties that are in 60.122 dealing with  
2       favorable and potentially adverse conditions.

3               There is terminology which occurs in such a  
4       manner that it trickles down and applies to a number  
5       of technical requirements of the regulation, and we  
6       were trying to address such matters as what does it  
7       mean to not affect significantly, what is an adequate  
8       evaluation or an adequate investigation, and so forth.  
9       How would a technical person doing such an  
10      investigation know when enough was enough, does he  
11      need additional guidance in what those terms mean were  
12      the questions that were arising.

13             There was an argument made that all of those  
14      uncertainties would be addressed by the Hearing Board  
15      when they tried to get to the point of making a  
16      decision as to whether there was reasonable assurance  
17      that the repository would perform as advertized.

18             The argument that we present, in looking at  
19      that, is that there is a separate closure to the issue  
20      that must be had long before the Hearing Board is  
21      seated, unless we're going to run the risk of rather  
22      substantial delays in the licensing process.

23             So if the staff of the DOE has guidance  
24      early on as to what constitutes an adequate  
25      investigation and an adequate evaluation, et cetera,

1 et cetera, that they will be able to come in with a  
2 license application that is complete, that has the  
3 depth and breadth of analysis that properly addresses  
4 technical uncertainty and data uncertainty, modeling  
5 uncertainty, so that when the staff sits and tries to  
6 come up with its evaluation findings, all the  
7 information it needs is there. And then having made  
8 their determinations, their evaluation findings, then  
9 the Board, using adequate information and adequate  
10 evaluation can come to their finding of reasonable  
11 assurance as a separate final step to that process.

12 But to try to build a finding of reasonable  
13 assurance on inadequate data seemed to us to be  
14 fraught with problems. And in fact, if you look at  
15 the SCP comments, you will find that by far the  
16 preponderance of all comment is right at that heart.  
17 DOE and NRC staffs don't agree with one another on  
18 what constitutes an adequate evaluation of that site,  
19 as we currently sit here.

20 COMMISSIONER CURTISS: Okay. I guess two  
21 specific questions of interest to me. We've -- in  
22 December of last year, the Department came before us  
23 and, among other things, raised a question about  
24 whether the regulation was clear from the standpoint  
25 of what trade-off they can strike between the geologic

1 medium and the waste container, in particular on the  
2 1,000 year groundwater travel time. Is that one that  
3 cropped-up in your -- I haven't had a chance to take a  
4 look at volume 2 carefully, but is that one that  
5 popped-up in your analysis?

6 DOCTOR PATRICK: Our analysis shows  
7 groundwater travel time to be a technical uncertainty.  
8 The rule seems to be painfully clear on what it's  
9 asking the applicant to provide. The technical people  
10 haven't the foggiest idea right now, with the  
11 technology at hand, as to how they would identify the  
12 fastest path of likely travel and how they would go  
13 about those technical determinations. So we have  
14 found groundwater travel time to be a technical  
15 uncertainty and are addressing it as so. We had an  
16 initial meeting with the NRC staff just last week, a  
17 workshop type of a session to set up the approach that  
18 we will use to evaluating groundwater travel time.

19 COMMISSIONER CURTISS: Okay.

20 MR. BERNERO: I'd like to add, on that one,  
21 that's a particularly difficult and sensitive one.  
22 Because, as Wes says, the uncertainty of it might be  
23 characterized as the -- the rule is painfully clear,  
24 but it is not so clear what the object of the rule is  
25 or what is achieved by the rule in isolation of waste.

1           Given that, one can then have that rule on  
2           the table for revision toward a more clear purpose,  
3           toward a more clear objective in isolation of waste.  
4           And that's where you get into the question of what is  
5           the relationship between the geologic isolation of  
6           waste, as characterized by groundwater travel time to  
7           some measure, and the packaging isolation of waste or  
8           containment isolation of waste. And this is a very  
9           difficult one, and it won't come out of this first  
10          stage. It'll come out of the second stage.

11           COMMISSIONER CURTISS:     Just a couple of  
12          quick questions for our staff. The schedule on the  
13          revision of 88-285, do you have a feel yet for, based  
14          on what you've seen here, how long that will take?

15           MR. BERNERO:    I think it --

16           MR. LENAHAN:    It's scheduled right now in  
17          the May time frame.

18           MR. BERNERO:    Yes.     Early May, mid-May,  
19          something in there.

20           COMMISSIONER CURTISS:   And do we have a good  
21          enough sense yet, from what we've seen in the report,  
22          how the results will affect the significant  
23          rulemakings like substantially complete containment,  
24          and anticipated and unanticipated processes and  
25          events?

1 MR. LENAHAN: I don't think we've had an  
2 opportunity to look at it well enough. The one I can  
3 comment on is substantially complete. It does confirm  
4 the direction we were going in. There's a technical  
5 feasibility study that's ongoing right now, but for  
6 the others we still need to do more evaluation.

7 COMMISSIONER CURTISS: I think that's -- one  
8 other question. Focusing on the relationship between  
9 the EPA and the NRC standards, people have commented  
10 in the past that there are issues that are addressed  
11 in one and not the other. Taking a specific example,  
12 we address krypton in our regulations. EPA does not.  
13 Is that the kind of thing that fell within the scope  
14 of what you looked at where the requirements in the  
15 respective bodies of regulation on a particular issue  
16 might be different because one is silent and one  
17 addresses the issue?

18 DOCTOR PATRICK: The answer is, for the  
19 general case, yes. For addressing specific nuclides,  
20 we have not delved to that level of analysis. We  
21 haven't looked at the presence or absence of krypton.

22 COMMISSIONER CURTISS: What kind of general  
23 analysis would you do? I guess I'm --

24 DOCTOR PATRICK: Just looking at the basic  
25 provisions of the regulation. For instance, when

1 60.112 invokes the generally applicable standards, we  
2 went over at that point and drew in 40 CFR 191. And  
3 of course, it being in a remanded state, we evaluated  
4 primarily the rule as written and the current working  
5 draft 1 to determine if there were any  
6 inconsistencies.

7 The implication of 112 is that the staff is  
8 going to work with EPA in such a manner that, whatever  
9 comes out in terms of 40 CFR 191, it will be  
10 consistent with the current rule or that the  
11 conforming rulemaking activity for Part 60 will fix  
12 any disconnects that might exist between the two.  
13 That's my understanding.

14 COMMISSIONER CURTISS: Okay.

15 MR. BERNERO: And you should also appreciate  
16 that during this interaction with EPA that's underway  
17 at the present time on the EPA standard where broad  
18 questions like implementability or stringency are  
19 being addressed, there are particular regulatory  
20 issues being raised by a variety of sources, including  
21 for instance one identified in the Nuclear Waste  
22 Technical Review Board report of recent vintage. And  
23 given the EPA standard as implemented, or presuming  
24 one implemented it, what weight should be given to  
25 carbon 14? Because, initial analyses on an

1       unsaturated site show releases.       And is that a  
2       stringency question, or is that a specific individual  
3       nuclide issue? These other uncertainty questions are  
4       coming into the process as well.

5               COMMISSIONER CURTISS:   Okay.   Well, let me  
6       thank you again.   I think, as I said at the outset,  
7       I'm most impressed with the work that's been done.  
8       It's extremely thorough, this and the previous two  
9       reports that came in on this subject.   I'm very  
10      pleased to see that you're geared up and cranking out  
11      some products.   Very helpful.

12             DOCTOR PATRICK:   Thank you.

13             CHAIRMAN CARR:   Let me ask you one more  
14      time.   I may have missed it.   We got through talking  
15      about staffing.   Did I understand you to say you'd be  
16      staffed by the end of the year?

17             MR. LATZ:   It is anticipated that we will be  
18      staffed by the end of the year, based upon the revised  
19      staffing plan as a consequence of the DOE stretch-out.  
20      So, yes.

21             CHAIRMAN CARR:   You'll be staffed at a  
22      reduced level by the end of the year?

23             MR. LATZ:   A reduced level, exactly.  
24      Exactly.

25             CHAIRMAN CARR:   I gather that.   I understand



1       that.

2               Well, I'd like to thank the NRC staff, Mr.  
3       Latz, and Doctor Patrick for providing this update on  
4       activities at the Center for Nuclear Waste Regulatory  
5       Analyses. I know these periodic discussions are  
6       helpful to each of us on the Commission to follow the  
7       progress of research and technical assistance  
8       activities at the Center and to ensure that the  
9       Commission's objectives in establishing its federally-  
10      funded research and development center are being  
11      achieved.

12             I commend the Center management and the  
13      staff as well, and the NRC staff for the extra efforts  
14      that were involved in the start-up of the Center  
15      activities. With two and a half years of experience,  
16      my assessment is that we're well on the way to a  
17      successful partnership.

18             I would also like to acknowledge the  
19      progress we have made in the area of staffing. I am  
20      impressed with the quality of the people on the staff  
21      at the Center, and I would encourage Center management  
22      to continue this emphasis in seeking qualified  
23      candidates as you work to achieve full staffing  
24      levels. I also encourage you to emphasize staff  
25      development activities both at the Center and for the

1 NRC staff. Such activities are key to ensuring that  
2 we achieve technical excellence and keep abreast of  
3 the technology.

4 I encourage you to move forward as quickly  
5 as possible to recommend the priorities and the means  
6 of reducing those regulatory uncertainties that have  
7 been identified by the Center so that the results of  
8 this work can be factored in as soon as possible into  
9 the development of rules and technical positions.

10 In closing, I know that recent delays in the  
11 repository schedule have raised questions about the  
12 future budget for the NRC High-Level Waste Program. I  
13 want to assure you that I assign high priority to the  
14 responsibilities that the Congress has assigned us for  
15 licensing a high-level waste geologic repository, and  
16 I will continue to support a budget commensurate with  
17 these responsibilities.

18 Are there any additional questions or  
19 comments from my fellow Commissioners?

20 If not, we stand adjourned.

21 (Whereupon, at 11:37 a.m., the above-  
22 entitled matter was concluded.)  
23  
24  
25

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: PERIODIC BRIEFING ON STATUS OF CENTER FOR  
NUCLEAR WASTE REGULATORY ANALYSES

PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: MARCH 30, 1990

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

NEAL R. GROSS  
COURT REPORTERS AND TRANSCRIBERS  
1323 RHODE ISLAND AVENUE, N.W.  
WASHINGTON, D.C. 20005

STATUS OF CENTER FOR  
NUCLEAR WASTE REGULATORY  
ANALYSES

MARCH 30, 1990

BRIEFERS: R. BERNERO - NMSS  
J. LATZ - CNWRA  
W. PATRICK - CNWRA

CONTACT: JESSE L. FUNCHES  
PHONE: 492-3324

### BRIEFING OUTLINE

- O INTRODUCTION
- O STATUS OF CNWRA
  - STAFFING
  - PRINCIPAL ONGOING ACTIVITIES
  - PERSONNEL, FACILITIES,  
TRAINING, ACCOMPLISHMENTS, ETC.
- O UNCERTAINTY ANALYSES RESULTS

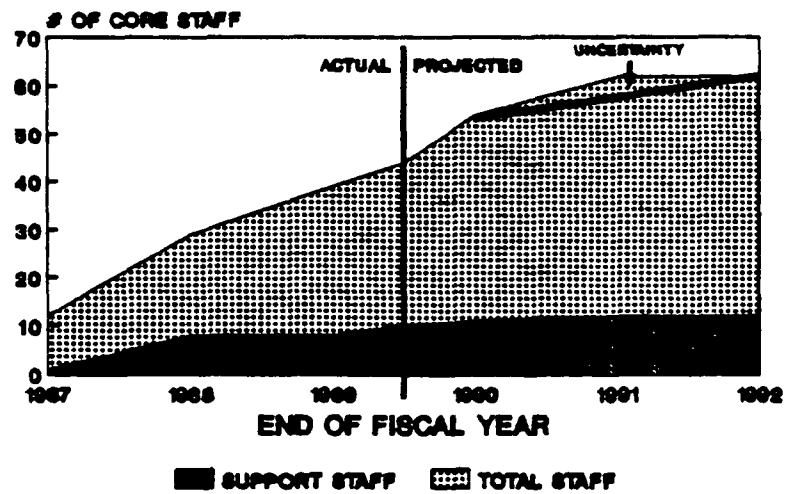
SLIDE 1

CENTERS OF EXCELLENCE

	<u>CURRENT</u>	<u>FTE</u> <u>PLANNED</u>
GEOCHEMISTRY	3	6
HYDROLOGY/CLIMATOLOGY	2	5
ROCK MECHANICS/MINING	2	5
MATERIAL SCIENCES	5	5
STRUCTURAL/TECTONICS	3	5
PERFORMANCE ASSESSMENT	2.5	6
MECHANICAL & FACILITIES ENGINEERING	1	2
SYSTEMS ENGINEERING	7.5	8

SLIDE 2

## CENTER STAFFING, FY88-92



SLIDE 3

PRINCIPAL CENTER TECHNICAL  
ASSISTANCE TASKS

- O PERFORMANCE OF PRELICENSING REVIEWS  
AND EVALUATIONS OF DOE SUBMITTALS AND  
ACTIVITIES
- O PERFORMANCE OF QUALITY ASSURANCE  
AUDITS OF DOE
- O DEVELOPMENT OF BASIS FOR RULEMAKINGS,  
TECHNICAL POSITIONS AND OTHER  
REGULATORY PRODUCTS

SLIDE 4



PRINCIPAL CENTER TECHNICAL  
ASSISTANCE TASKS CON'T

- O DEVELOPMENT OF PERFORMANCE ASSESSMENT  
CAPABILITIES
- O DEVELOPMENT OF TECHNICAL ASSESSMENT  
CAPABILITIES AND METHODS
- O IDENTIFICATION OF REGULATORY AND  
TECHNICAL UNCERTAINTIES

SLIDE 5

### PRINCIPAL CENTER RESEARCH TASKS

- O UNSATURATED MASS TRANSPORT
- O THERMOHYDROLOGICS
- O SEISMIC - ROCK MECHANICS
- O INTEGRATED WASTE PACKAGE EXPERIMENTS
- O STOCHASTIC ANALYSES OF FLOW IN  
UNSATURATED ZONE

SLIDE 6

PRINCIPAL CENTER RESEARCH TASKS CON'T

- O GEOCHEMICAL ANALOGUES\*
- O SORPTION MECHANISMS\*
- O PERFORMANCE ASSESSMENT\*
- O CLIMATOLOGICAL EFFECTS ON RECHARGE\*

\*NEWLY INITIATED OR TO BE INITIATED IN  
THE NEAR TERM

SLIDE 7

## **CNWRA PRESENTATION**

---

- **STATUS**
- **UNCERTAINTY REPORT**

**SLIDE 8**

### **STAFF CHARACTERISTICS**

---

	<u>RES/TECH</u>	<u>TOTAL</u>
● Ph.D. LEVEL	17 (85%)	17 (50%)
● M.S./M.A./J.D. LEVEL	3 (15%)	6 (18%)
● B.S./B.A. LEVEL	0 ( 0%)	11 (32%)
● EXPERIENCE (SINCE FIRST DEGREE)	19 YR	19 YR
● EXPERIENCE (SINCE LAST DEGREE)	12 YR	14 YR

## **STAFF DEVELOPMENT**

---

- NEW EMPLOYEE INDOCTRINATION
- IN-HOUSE STAFF DEVELOPMENT
- CONTINUING EDUCATION LOCAL UNIVERSITIES
- SPECIFIC PLAN FOR 1-WEEK TRAINING
- SYMPOSIA, CONFERENCES, WORKSHOPS AND TECHNICAL INTERCHANGES
- INTERNAL RESEARCH AND DEVELOPMENT

## **CNWRA FACILITIES**

---

- **EXPERIMENTAL FACILITY**
- **SEISMIC ROCK MECHANICS TEST APPARATUS**
- **IBM MAINFRAME AND PERSONAL COMPUTERS**
- **ACCESS TO SUPERCOMPUTERS**

**CNWRA PRINCIPAL  
PROGRAMMATIC AREAS**

---

- TECHNICAL ASSISTANCE
- RESEARCH
- TRANSPORTATION RISK STUDY



## **TECHNICAL ASSISTANCE ACCOMPLISHMENTS**

---

- PREPARED INPUTS TO SITE CHARACTERIZATION ANALYSIS
- INPUT TO EXPLORATORY SHAFT FACILITY DESIGN ACCEPTABILITY ANALYSIS
- COMMENCED WORK ON TECHNICAL POSITIONS AND RULEMAKINGS
- PARTICIPATED IN QA AUDITS

**TECHNICAL ASSISTANCE  
ACCOMPLISHMENTS (CONT'D)**

---

- **ADVANCED ENGINEERED BARRIER SYSTEM  
PERFORMANCE ASSESSMENT CODE (EBSPAC)  
CAPABILITIES**
- **ASSISTED DEVELOPMENT OF FORMAT AND  
CONTENT GUIDE FOR LICENSE APPLICATION**
- **DEVELOPED STATUTORY AND REGULATORY BASIS  
FOR PERFORMANCE ASSESSMENT**

## **TRANSPORTATION RISK STUDY: ACCOMPLISHMENTS**

---

- COMPLETED EVALUATION OF RADIOACTIVE TRANSPORTATION CODES RADTRAN III AND 4.0
- EVALUATED CONSISTENCY OF PRIMARY RADIOACTIVE MATERIALS SHIPMENT DATABASE
- DEVELOPED NEW PROJECTIONS OF RADIOACTIVE MATERIAL SHIPMENTS

## **RESEARCH ACCOMPLISHMENTS**

---

- **GEOCHEMISTRY**
  - MODIFIED COMPUTER CODE EQ6 FOR  
NONISOTHERMAL KINETICS AND GAS  
FRACTIONATION
  - CHARACTERIZED MINERALS FOR PHASE  
EQUILIBRIUM AND ION EXCHANGE STUDIES
- **THERMOHYDROLOGICS**
  - INITIATED SEPARATE EFFECTS STUDIES AND  
FLOW-VISUALIZATION EXPERIMENTS
  - INITIATED MODELING OF EXPERIMENTS USING  
"TOUGH" CODE

## **RESEARCH ACCOMPLISHMENTS (CONT'D)**

---

- **SEISMIC ROCK MECHANICS**
  - COMPLETED DEVELOPMENT OF DYNAMIC SHEAR TEST APPARATUS
  - COMPLETED COLLECTION OF LARGE-DIAMETER WELDED TUFF CORES
  - COMPLETED SITE SELECTION FOR FIELD STUDIES
- **INTEGRATED WASTE PACKAGE EXPERIMENTS**
  - CONDUCTED ELECTROCHEMICAL CORROSION TESTS
  - COMPLETED TEST METHOD DEVELOPMENT FOR HYDROGEN RELATED STUDIES

## **SYSTEMS APPROACH TO LICENSING**

---

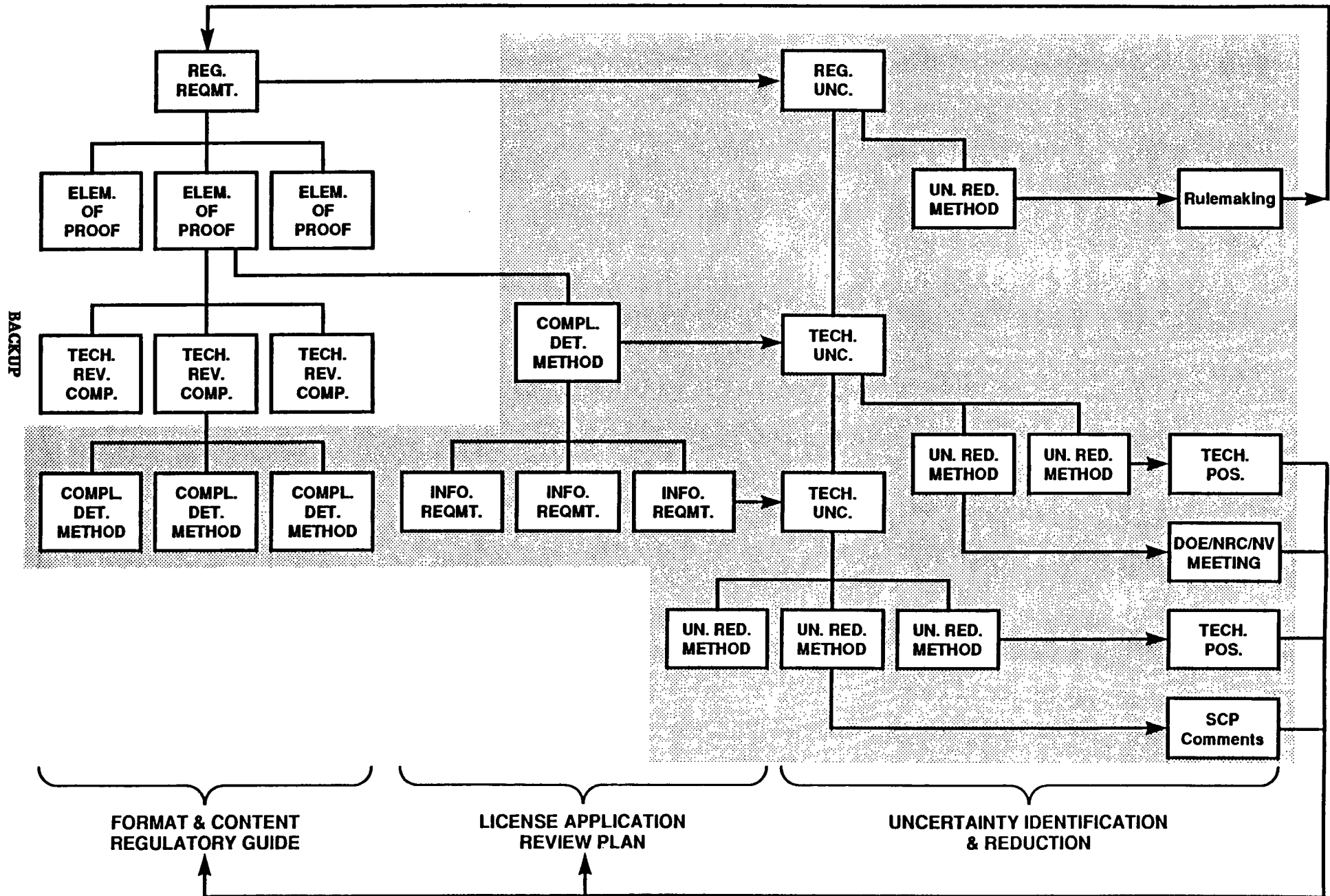
- OVERVIEW OF SYSTEMS APPROACH
- ACCOMPLISHMENTS TO DATE
- REGULATORY ANALYSIS METHOD
- SUMMARY OF RESULTS
- SUGGESTIONS FOR FURTHER ACTIONS

## **SYSTEM ENGINEERING: APPROACH**

---

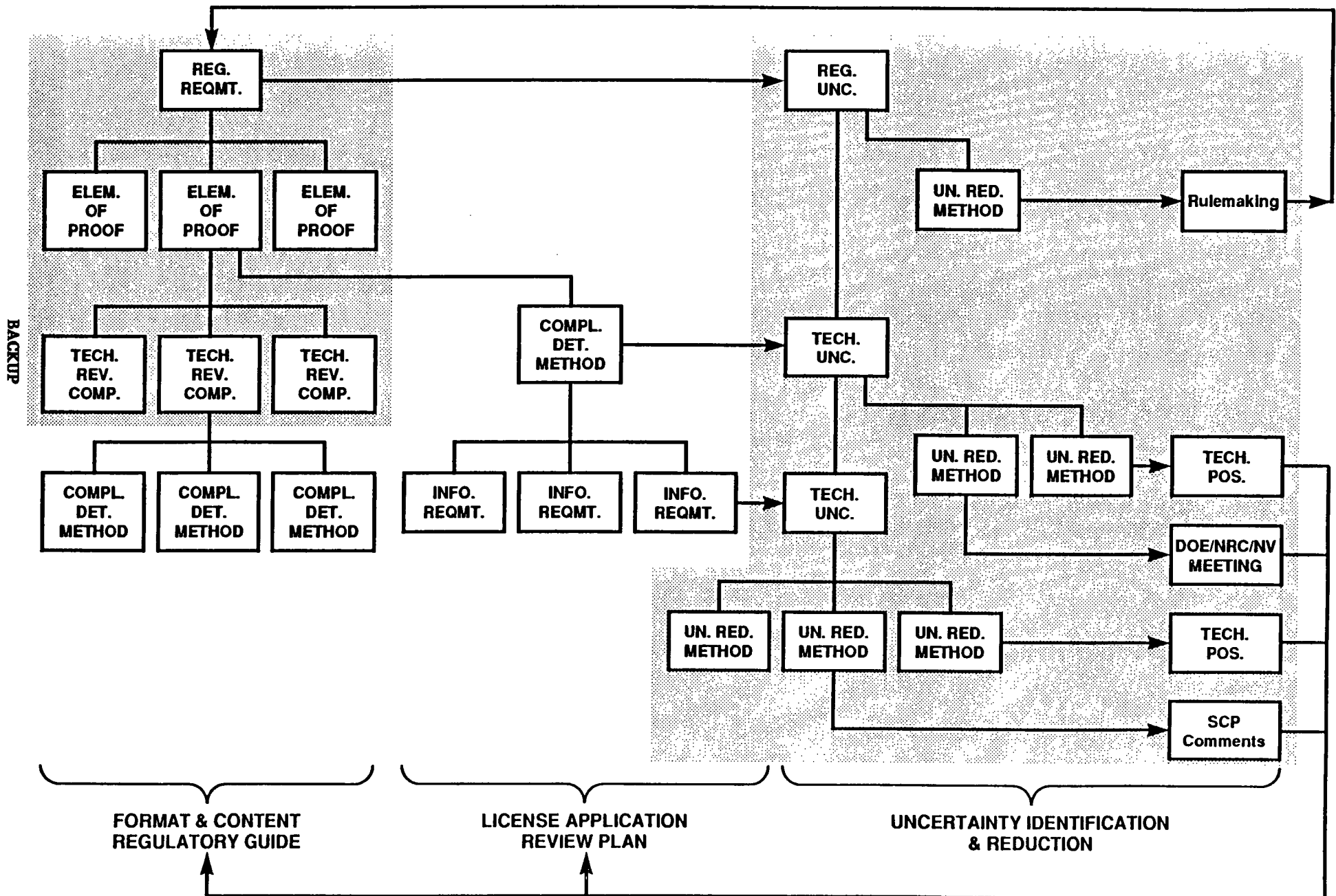
- **MISSION ORIENTED** - NWPAA FOCUS
- **REQUIREMENTS-BASED** - 10 CFR 60 AND 40 CFR 191  
PRIMARY FOR REPOSITORY
- **PROACTIVE** - SUFFICIENT AND TIMELY  
GUIDANCE TO DOE
- **BASIS FOR INTEGRATION** - ORGANIZATIONAL  
AND FUNCTIONAL
- **DYNAMIC** - ADAPTS TO CHANGES

# RELATIONSHIPS AMONG COMPONENTS OF NRC PROGRAM AND SYSTEMATIC REGULATORY ANALYSIS

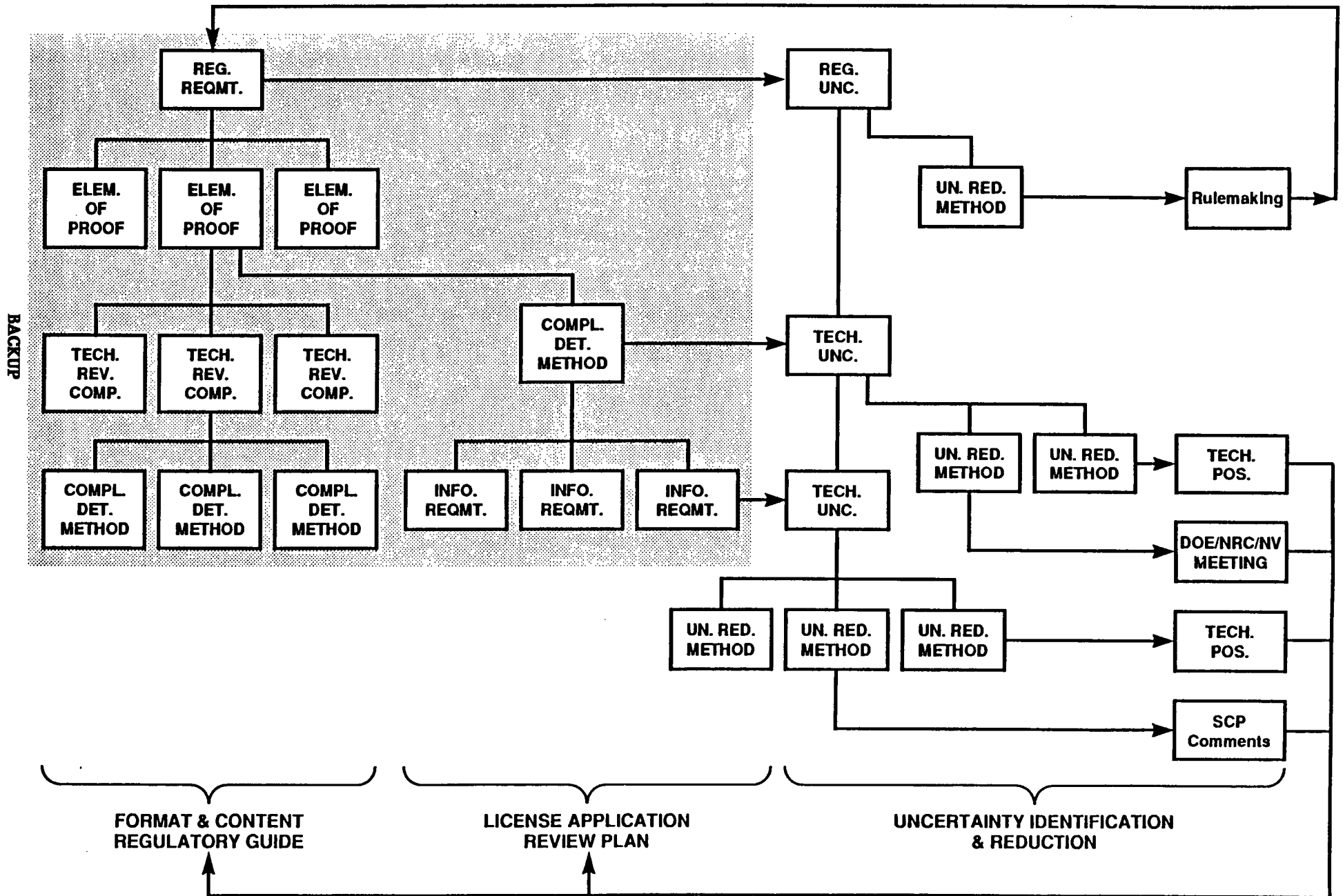




# RELATIONSHIPS AMONG COMPONENTS OF NRC PROGRAM AND SYSTEMATIC REGULATORY ANALYSIS



# RELATIONSHIPS AMONG COMPONENTS OF NRC PROGRAM AND SYSTEMATIC REGULATORY ANALYSIS



## **SIGNIFICANT ACCOMPLISHMENTS – SYSTEMS ENGINEERING**

---

- **PRIORITIZED STATUTES AND REGULATIONS**
- **DELINEATED REGULATORY REQUIREMENTS IN  
10 CFR PART 60**
- **BASELINED PROGRAM ARCHITECTURE PROCESS  
AND PROCEDURES**

## **SCOPE OF UNCERTAINTY REPORT**

---

- IDENTIFICATION OF REGULATORY AND INSTITUTIONAL UNCERTAINTIES (TECHNICAL UNCERTAINTIES NOT ADDRESSED)
- EXCLUSION OF UNCERTAINTIES
- GROUPING AND CATEGORIZATION
- CORRELATIONS WITH RULEMAKINGS AND TECHNICAL POSITIONS
- RECOMMENDED ACTIONS

## **REGULATORY ANALYSIS METHOD**

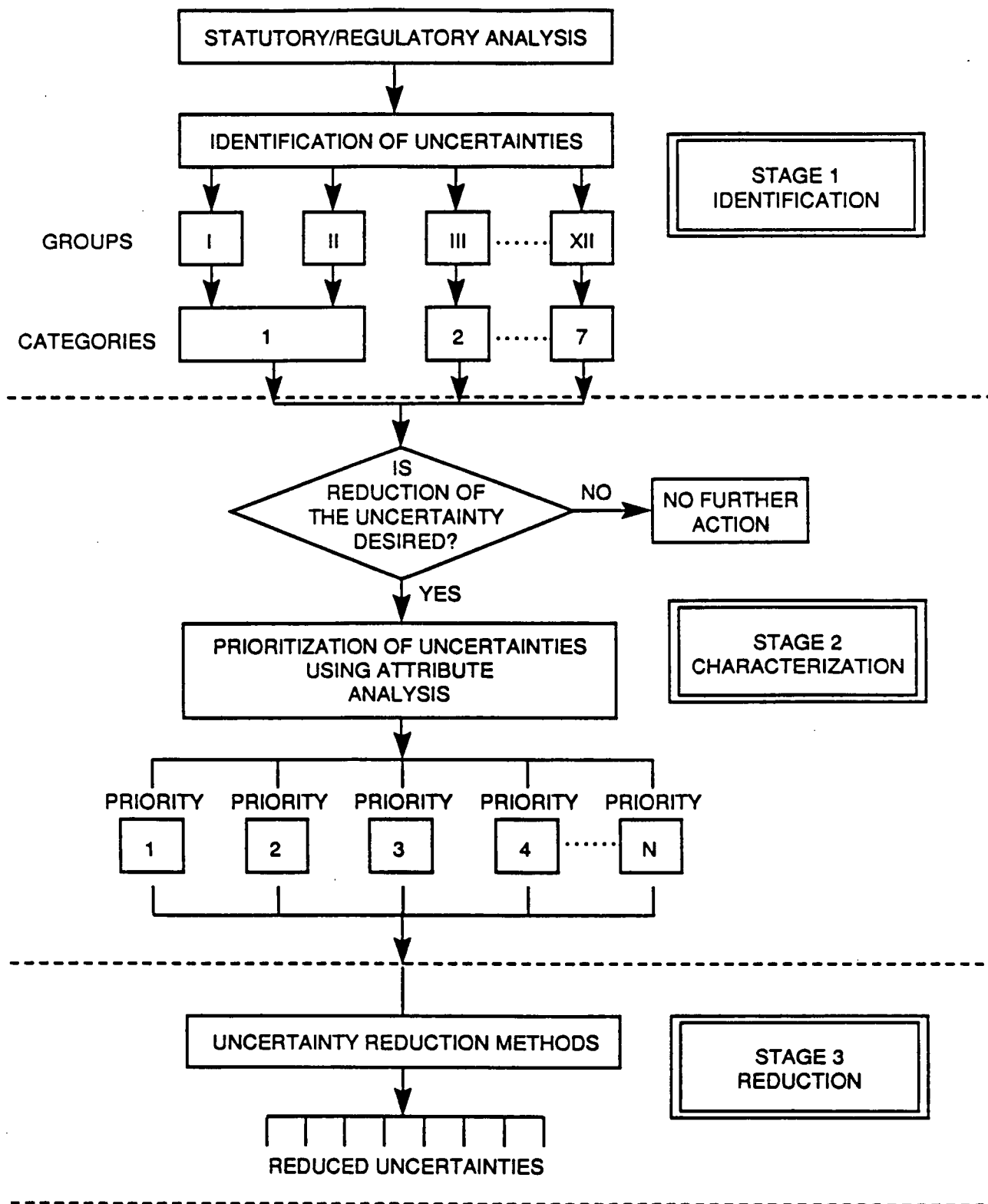
---

- IDENTIFY REGULATORY REQUIREMENTS
- DELINEATE LOGICAL RELATIONSHIPS OF REGULATORY ELEMENTS OF PROOF
- IDENTIFY REGULATORY AND INSTITUTIONAL UNCERTAINTIES
- ANALYZE AND DEVELOP RATIONALE FOR UNCERTAINTIES IN CONTEXT OF AVAILABLE DOCUMENTATION
- EXCLUDE UNCERTAINTIES AS APPROPRIATE

### **THREE STAGE PROCESS:**

---

- **UNCERTAINTY IDENTIFICATION**
- **UNCERTAINTY CHARACTERIZATION**
- **UNCERTAINTY REDUCTION**



### **THREE TYPES OF UNCERTAINTIES**

---

- **REGULATORY** - UNCLEAR WHAT MUST BE DONE
- **INSTITUTIONAL** - UNCLEAR WHO IS RESPONSIBLE
- **TECHNICAL** - UNCLEAR HOW COMPLIANCE WILL  
BE DEMONSTRATED



## **REGULATORY UNCERTAINTY**

---

**" . . . LACK OF CLARITY . . . AN ESSENTIAL  
REQUIREMENT HAS BEEN OMITTED, OR WHEN  
REQUIREMENTS . . . DETRACT FROM . . . OR DO NOT  
CONTRIBUTE TO THE REGULATORY PROGRAM . . . . "**

## **INSTITUTIONAL UNCERTAINTY**

---

**" . . . LACK OF CERTITUDE REGARDING THE  
ROLES, MISSIONS, ACTIONS, AND SCHEDULES  
OF AGENCIES WHICH HAVE REGULATORY  
REQUIREMENTS THAT AFFECT THE HIGH-LEVEL  
WASTE REGULATORY PROGRAM . . . . "**

## **UNCERTAINTY GROUPS**

---

- **BASED ON TOPIC OR SUBJECT**
- **PRIMARILY AS AID TO DISCUSSION**
- **MAY INDICATE WHERE ONE UNCERTAINTY  
REDUCTION COULD BROADLY APPLY**

## **SUMMARY OF UNCERTAINTIES BY GROUP**

---

<b>GROUP I:</b>	<b>CRITERIA FOR GENERAL ADEQUACY OF SITE CHARACTERIZATION</b>
<b>GROUP II:</b>	<b>ANTICIPATED/UNANTICIPATED PROCESSES/ EVENTS</b>
<b>GROUP III:</b>	<b>IMPORTANT TO SAFETY CONSIDERATIONS</b>
<b>GROUP IV:</b>	<b>EBS PERFORMANCE</b>
<b>GROUP V:</b>	<b>RADIOLOGICAL SAFETY CONSIDERATIONS</b>
<b>GROUP VI:</b>	<b>RETRIEVABILITY CONDITIONS</b>

**SUMMARY OF UNCERTAINTIES  
BY GROUP (CONT'D)**

---

**GROUP VII: CONDITIONS FOR CONSTRUCTION  
AUTHORIZATION AND LICENSE**  
**GROUP VIII: MINE AND NONRADIOLOGICAL SAFETY**  
**GROUP IX: CONDITIONS LAND ACQUISITION/CONTROL**  
**GROUP X: QUALITY ASSURANCE AND INFORMATION  
REQUIREMENTS**  
**GROUP XI: COMPLIANCE WITH EPA STANDARD**  
**GROUP XII: EMERGENCY PLANNING CRITERIA**

## **UNCERTAINTY CATEGORIES**

---

- FURTHER DIFFERENTIATE AMONG SUBTYPES OF REGULATORY AND INSTITUTIONAL UNCERTAINTIES
- GIVE EARLY INSIGHTS INTO UNCERTAINTY REDUCTION METHOD
- NO IMPLICATION OF IMPORTANCE OR NECESSITY OF REDUCTION

### **SUMMARY OF UNCERTAINTIES BY CATEGORY**

---

● NEED FOR DEFINITION	24
● OMISSION	15
● INCONSISTENCY	2
● LACK OF NECESSITY	0
● INSUFFICIENCY	0*
● EXCEEDS AUTHORITY	0
● QUESTION OF AGENCY JURISDICTION	2
*TO BE DONE	

## **RESULTS OF CORRELATIONS**

---

- **5 TENTATIVE RULEMAKINGS CORRELATED WITH UNCERTAINTIES**
- **15 TENTATIVE TECHNICAL POSITIONS CORRELATED WITH UNCERTAINTIES**
- **13 UNCERTAINTIES DID NOT CORRELATE WITH RULEMAKINGS AND TECHNICAL POSITIONS**



## **SUGGESTIONS FOR FURTHER ACTIONS**

---

- **CONDUCT SUFFICIENCY ANALYSIS**
- **DETERMINE NECESSITY AND IMPORTANCE OF REDUCTION, INCLUDING PRIORITIZATION**
- **IDENTIFY AND IMPLEMENT UNCERTAINTY REDUCTION METHODS**

### **SUGGESTIONS FOR FURTHER ACTIONS (CONT'D)**

---

- WHERE UNCERTAINTY CORRELATES TO  
RULEMAKING OR TECHNICAL POSITION - EVALUATE  
WHETHER IT WILL BE APPROPRIATELY REDUCED
- WHERE UNCERTAINTY DOESN'T CORRELATE -  
EVALUATE NEED TO:
  - INITIATE REGULATORY ACTION
  - MODIFY SCOPE OF EXISTING REGULATORY ACTION

**CURRENT CNWRA AND CONTRACTOR  
PERSONNEL ROSTER**

**BACKUP**

GEOCHEMISTRY/ISOTOPE CHEMISTRY

CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

NAME	TITLE	DEGREE	DATE	SCHOOL	AFFILIATION
MURPHY, William M.*	Senior Research Scientist - Geochemist	Ph.D./Geochemistry M.S./Geology B.S./Earth Sciences	1985 1977 1974	U. C. at Berkeley U. of Oregon U. C. at Berkeley	CNWRA
PABALAN, Roberto T.*	Research Scientist - Geochemist	Ph.D./Geochemistry B.S./Geology	1986 1976	Penn State U. of Philippines	CNWRA
PEARCY, English C.*	Research Scientist - Geochemist	Ph.D./Geology A.M./Geology B.S./Geology	1989 1986 1983	Harvard U. Harvard U. Furman U.	CNWRA
ERWIN, Jimell	Institute Research Scientist - Chemical Engineer	Ph.D./Chemical Engineering M.S./Chemical Engineering B.S./Chemical Engineering	1980 1975 1973	U. of Illinois U. of Illinois Carnegie-Mellon U.	SWRI
KOHL, Karen B.*	Institute Research Scientist - Geochemist	M.S./Geochemistry B.S./Chemistry	1976 1972	S. Methodist U. S. Methodist U.	SWRI
SCHWAB, Stuart T.	Institute Research Scientist - Chemist	Ph.D./Chemistry B.S./Chemistry/English	1986 1981	U. of Texas in Austin Duke U.	SWRI
BIRNBAUM, Stuart Jay*	UTSA Associate Professor of Geology	Ph.D./Geology B.S./Geology	1977 1971	U. of Cambridge (England) State U. of N. Y.	CONS/SUB

\* Denotes personnel with significant contribution to research projects.

GEOCHEMISTRY/ISOTOPE CHEMISTRY

CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

NAME	TITLE	DEGREE	DATE	SCHOOL	AFFILIATION
BROOKINS, Douglas G.	U. of New Mexico - Geochemist	Ph.D./Geology	1963	Mass. of Tech.	CONS/SUB
		A.B./Geology	1958	U. of Calif.	
		A.A./Geology	1956	Santa Rosa Jr. College	
LEEMAN, William P.	Structural/Tectonics/ Volcanology	Ph.D/Geology/Geochemistry	1974	U. of Oregon	CONS/SUB
		M.A./Geology	1969	Rice U.	
		B.A./Geology	1967	Rice U.	
LUHR, James F.	Structural/Tectonics/ Volcanology	Ph.D./Geology	1980	U. C. Berkeley	CONS/SUB
		M.A./Geology	1977	U. C. Berkeley	
		B.S/Geology	1975	U. of Illinois	

HYDROLOGY/CLIMATOLOGY  
  
CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES  
-----

NAME -----	TITLE -----	DEGREE -----	DATE -----	SCHOOL -----	AFFILIATION -----
ABABOU, Rachid*	Senior Research Scientist - Hydrogeologist	Ph.D./Civil Engineering	1988	M.I.T.	CNWRA
		Dr.Ing./Fluid Mechanics	1981	Inst. Mech. Grenoble (France)	
		Eng.Deg/Hydraulic	1978	Inst. Nat. Polytech (France)	
GREEN, Ronald T.*	Senior Research Scientist - Hydrogeologist	Ph.D./Hydrology	1986	U. of Arizona	CNWRA
		M.S./Geophysics	1981	U. of Utah	
		B.S./Geology	1978	Grand Valley State University	
		B.S./Industrial Engineering	1972	U. of Michigan	
DODGE, Frank T.*	Institute Engineer - Computational Fluid Mechanics	Ph.D./Mechanical Engineering	1963	Carnegie-Mellon	SWRI
		M.S./Mechanical Engineering	1961	Carnegie-Mellon	
		B.S./Mechanical Engineering	1960	U. of Tenn.	
FREITAS, Christopher J.*	Institute Senior Research Engineer - Computational Fluid Mechanics	Ph.D./Civil Engineering	1986	Stanford U.	SWRI
		M.S./Civil Engineering	1978	Utah State U.	
		B.S./Environmental & Ocean Engr.	1977	Humboldt State U.	
SVEDEMAN, Steve	Institute Senior Research Engineer - Geohydrologist	B.S./Mechanical Engineering	1980	Texas Tech U.	SWRI
		M.S./Mechanical Engineering	1981	Texas Tech U.	
BROWN, Adrian	ABC - Geohydrologist	M.B.A./Administration	1974	Monash U.	CONS/SUB
		M.S./Engineering Science	1970	Monash U.	
		B.E./Civil Engineering	1966	Monash U.	

\* Denotes personnel with significant contribution to research projects.

HYDROLOGY/CLIMATOLOGY  
CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES  
-----

NAME -----	TITLE -----	DEGREE -----	DATE -----	SCHOOL -----	AFFILIATION -----
EVANS, Daniel D.*	University of Arizona - Geohydrologist	Ph.D./Soil Physics, Math	1952	Iowa State U.	CONS/SUB
		M.S./Soil Physics	1949	Iowa State U.	
		B. S./Agronomy	1947	Ohio State U.	
LOGSDON, Mark J.	ABC - Hydrogeochemist	M.S./Geology	1981	U. of New Mexico	CONS/SUB
		A.B./Geology	1972	Princeton U.	

\* Denotes personnel with significant contribution to research projects.

ROCK MECHANICS/MINING  
CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES  
-----

NAME -----	TITLE -----	DEGREE -----	DATE -----	SCHOOL -----	AFFILIATION -----
CHOWDHURY, Asadul H.*	Manager - Repository Design, Construction and Operations	Ph.D./Structures M.S./Structures B.S./Civil Engineering	1974 1971 1966	Cornell Cornell U. of Eng. & Tech. (E. Pakistan)	CNWRA
HSIUNG, Simon*	Research Engineer - Mining & Rock Mechanics	Ph.D./Mining Engineering M.S./Mining Engineering  B.S./Mining Engineering	1984 1979  1974	W. Virginia U. National Cheng-Kung U. (Taiwan) National Cheng-Kung U. (Taiwan)	CNWRA
BRADY, Barry*	ITASCA - Geomechanics & Seismic Response	Ph.D./Mining & Geo-Engineering M.S./Engineering Rock Mechanics M.S./Engineering Thermodynamics B.S./Applied Science	1979 1975 1967 1963	Imperial College (London) Imperial College (London) U. of Queensland (Australia) U. of Queensland (Australia)	CONS/SUB
DAEMEN, Jaak	ITASCA - Geohydrologist & Seal Performance	Ph.D./Geo-Engineering	1975	U. of Minnesota	CONS/SUB
HART, Roger	ITASCA - Geomechanics	Ph.D./Civil Engineering M.S./Civil Engineering - Soil Mechanics B.S./Civil Engineering	1981  1972 1971	U. of Minn Ohio U. U. of Minn.	CONS/SUB
ROARK, Glenn L.*	Kaman Sciences - Seismic Response	M.S./Management Science B.A./Physics & Math	1972 1951	West Coast U. Union College	CONS/SUB

\* Denotes personnel with significant contribution to research projects.



MATERIAL SCIENCES/ELECTROCHEMISTRY

CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

NAME	TITLE	DEGREE	DATE	SCHOOL	AFFILIATION
CRAGNOLINO, Gustavo*	Principal Research Scientist - Electrochemistry & Corrosion	Doctor/Chemical Science	1975	U. de Buenos Aires (Argentina)	CNRA
		Licenciado/Chemical Science	1966	U. de Buenos Aires (Argentina)	
MANAKTALA, Hersh K.*	Senior Research Engineer - Materials	Ph.D./Materials Science and Engineering	1974	N. Carolina State	CNRA
		M.S./Mechanical Engineering & Materials Science	1970	Duke U.	
		B.S./Mechanical Engineering	1967	Panjab U. (India)	
HAIR, Prasad K.*	Manager - Engineered Barrier System	Ph.D./Engineering Mechanics	1974	Virginia Polytech.	CNRA
		M.S./Civil Engineering	1971	S. Dakota School of Mines & Technology	
		B.S./Tech/Civil Engineering	1970	Indian Inst. of Tech. (India)	
SRIDHAR, Narasi*	Senior Research Scientist - Corrosion	Ph.D./Metallurgy & & Materials Science	1980	Notre Dame	CNRA
		M.S./Materials Engineering	1977	Virginia Polytech.	
		B.S./Madras Metallurgy	1975	Indian Inst. of Tech. (India)	
LYLE, Fred	Staff Corrosion Engineer - Corrosion Engineer	M.S./Mechanical Engineering	1964	U. of Texas in Austin	SWRI
		B.S./Ceramic Engineering	1962	U. of Texas in Austin	

\* Denotes personnel with significant contribution to research projects

MATERIAL SCIENCES/ELECTROCHEMISTRY

CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

NAME	TITLE	DEGREE	DATE	SCHOOL	AFFILIATION
WILDE, Bryan	Ohio State University - Corrosion & Materials	Ph.D./Materials Engineering	1966	Rennselaer Polytec. Inst.	CONS/SUB
		Ph.D./Physical Chemistry	1964	Royal Inst. of Chemistry (London)	
		M.S./Physical Chemistry	1961	Royal Inst. of Chemistry (London)	
		B.S./Physical Chemistry	1959	Royal Inst. of Chemistry (London)	

STRUCTURAL TECTONICS/GEOLOGY  
CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES  
-----

NAME -----	TITLE -----	DEGREE -----	DATE -----	SCHOOL -----	AFFILIATION -----
MIKLAS, Michael P.*	Senior Research Scientist - Geologist	B.S./Geology/Geography	1964	Southeast Missouri State U. Eastern Michigan U.	CNWRA
		M.A./Physical Geography	1965		
RUSSELL, John L.*	Manager - Geological Setting	Ph.D./Geology	1974	U. of Nebraska Kansas State U. Kansas State U.	CNWRA
		M.S./Geology	1967		
		B.S./Geology	1966		
STIREWALT, Gerry L.*	Principal Scientist - Structural Geologist/Tectonics	Ph.D./Structural Geology	1970	U.N.C. at Chapel Hill Catawba College	CNWRA
		B.A./Geology/Mathematics	1964		
YOUNG, Stephen R.*	Structural Geologist	M.S./Geology	1981	Texas A&M U. Texas A&M U.	CNWRA
		B.S./Geology	1979		
LEWIS, Mike*	Research Engineer - Geologist	M.S./Civil Engineering	1987	U. of Texas U. of Texas	SWRI
		B.S./Geosciences	1983		
CAMPBELL, Thomas M.	Geophysicist	B.S./Geology	1964	Villanova U.	CONS/SUB
GALSTER, Richard W.	Engineering Geologist	M.S./Geology	1956	U. of Washington U. of Washington	CONS/SUB
		B.S./Geology	1951		
GIBBS, Betty L.	Computer Application Software Evaluation	M.S./Mining Engineering	1972	Colorado Sch. of Mines	CONS/SUB

\* Denotes personnel with significant contribution to research projects.

STRUCTURAL TECTONICS/GEOLOGY

CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

NAME	TITLE	DEGREE	DATE	SCHOOL	AFFILIATION
MARKHAM, John J.	ITASCA - Engineering Geologist	M.B.A. M.S./Engineering Geology B.A./Geology	1988 1970 1967	U. of Minnesota Cornell University U. of Virginia	CONS/SUB
MCKAGUE, Lawrence H.	Seismo-Tectonics	Ph.D./Mineralogy & Petrology M.S./Geology B.S./Geology	1964 1960 1957	Penn. State U. Wash. State U. Franklin & Marshall College	CONS/SUB
PURCELL, Charles (Rus)	Geomorphologist	M.S./Geomorphology B.S./Geology	1973 1971	U. of Cincinnati U. of Cincinnati	CONS/SUB
SHARP, Jack	U.T. Austin - Geohydrologist & Geologist	Ph.D./Geology M.S./Geology	1974 1974	U. of Illinois U. of Illinois	CONS/SUB
WRIGHT, Robert J.	Natural Resources	Ph.D/Geology M.A./Geology B.A./Geology	1947 1942 1940	Columbia U. Columbia U. Denison U.	CONS/SUB

PERFORMANCE ASSESSMENT  
CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES  
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NAME -----	TITLE -----	DEGREE -----	DATE -----	SCHOOL -----	AFFILIATION -----
SAGAR, Budhi*	Manager - Performance Assessment	Ph.D./Hydrology M.S./Civil Engineering B.S./Civil Engineering	1973 1966 1963	U. of Arizona Panjab U. (India) Panjab U. (India)	CNWRA
WU, Yih-Tsuen*	Senior Research Engineer - Probabilistic Analysis Methods in Engineering	Ph.D./Mechanical Engineering M.S./Mechanical Engineering B.S./Mechanical Engineering	1984 1978 1972	U. of Arizona N. Western U. National Cheng-Kung U. (Taiwan)	CNWRA

\* Denotes personnel with significant contribution to research projects.

MECHANICAL & FACILITIES ENGINEERING

CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

NAME	TITLE	DEGREE	DATE	SCHOOL	AFFILIATION
TSCHOEPE, Emil "Chuck"	Senior Research Engineer - Mech/Materials Engineer	M.S./Mechanical Engineering B.S./Mechanical Engineering	1978 1973	U. of Texas in Austin Texas A&M U.	CNWR
KANA, Dan	Institute Engineer - Seismic Effects	Ph.D./Engineering Mechanics M.S./Mechanical Engineering B.S./Mechanical Engineering	1967 1961 1958	U. of Texas U. of New Mex. U. of Texas	SWRI
VANZANT, Billy W.*	Institute Engineer	B.A./Mechanical Engineering B.S./Math	1956 1949	U. of Texas Baylor U.	SWRI

\* Denotes personnel with significant contribution to research projects.

SYSTEMS ENGINEERING/REGULATORY ANALYSIS

CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES  
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NAME -----	TITLE -----	DEGREE -----	DATE -----	SCHOOL -----	AFFILIATION -----
HAGEMAN, John P.	Manager - Special Projects & Transportation Risk Study	B.S./Physics	1974	U. T. Arlington	CNWRA
LA PLANTE, Patrick	Scientist - Physical and Environmental	B.S./Environmental Sciences	1988	Western Wash. U.	CNWRA
MARSHALL, Robert L.	Senior Research Analyst - Information Management Systems	B.S./Chemistry	1980	Notre Dame	CNWRA
PAPE, Michele V.	Research Analyst - Information Management Systems	B.B.A./Information Systems	1987	U. of Texas at San Antonio	CNWRA
ROMINE, D. Ted	Manager - Waste Systems Engineering & Integration	B.S./Engineering	1961	U.C.L.A.	CNWRA
SPECTOR, Stephen H.	Principal Analyst - Regulatory	J.D./Law B.S./Business Administration	1973 1966	Geo. Wash. U. Long Island U.	CNWRA
WEINER, Ruth F.	Principal Scientist - Physical and Environmental	Ph.D./Chemistry M.S./Physics B.S./Physics	1962 1957 1956	Johns Hopkins U. U. of Illinois U. of Illinois	CNWRA

ADMINISTRATION & SUPPORT SERVICES

CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

NAME	TITLE	DEGREE	DATE	SCHOOL	AFFILIATION
ADLER, Robert E.	Director - Washington CNWRA Office & Assistant to CNWRA President	M.S./Systems Management B.S./Systems Management M.S./Electrical Engineering B.S./Electrical Engineering	1977 1976 1959 1951	U. of S. Calif. U. of S. Calif. U.S. Naval Post Graduate School U.S. Naval Academy	CNWRA
BRIENT, Robert D.	Senior Research Scientist - Quality Assurance	B.S./Biology	1973	Rice University	CNWRA
GARCIA, Henry F.	Director - Administration	M.A./Economics B.A./Psychology	1974 1969	St. Marys U. St. Marys U.	CNWRA
JOHNSON, Rawley D.	Director - Information Management Systems	B.S./Math	1963	Texas Lutheran	CNWRA
LATZ, John E.	President of CNWRA	B.S./Mechanical Engineering	1954	U. of Houston	CNWRA
MABRITO, Bruce	Director - Quality Assurance	B.S./Education	1967	Texas Tech. U.	CNWRA
MCFADDIN, Sharon	Analyst - Information Management Systems	B.S./Mathematics	1987	Howard Payne U.	CNWRA
PATRICK, Wesley C.*	Technical Director	Ph.D./Mining Engineering M.S./Mining Engineering B.S./Mining Engineering	1978 1975 1974	U. of MO. U. of MO. Mich. Tech. U.	CNWRA

\* Denotes personnel with significant contribution to research projects.



ADMINISTRATION & SUPPORT SERVICES

CURRENT PERSONNEL ROSTER  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

NAME	TITLE	DEGREE	DATE	SCHOOL	AFFILIATION
WHITING, Allen R.	Director - Systems Engineering & Integration	B.S./Ceramic Engineering	1961	U. of Texas in Austin	CNWRA

**CNWRA PUBLICATIONS  
AND  
PRESENTATIONS**

**BACKUP**

LIST OF PUBLICATIONS AND PRESENTATIONS  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES  
JANUARY 1990

PUBLICATIONS

1. "Review to Literature Relevant to the Transportation Risk Study", by R. Pierce, CNWRA 88-001, March, 1988.
2. "CONVO Evaluation and Enhancement Plan", by P. Nair, CNWRA 88-002, September, 1988.
3. "Environmental Statatement on the Transportation of Radioactive Materials in the United States", First Interim Report, by R. Pierce, CNWRA 88-003, September, 1988.
4. "Fast Probabilistic Performance Assessment (FPPA) Methodology Evaluation", by P. Nair, CNWRA 88-004, October, 1988.
5. "Irreversible Dissolution of Solid Solutions: A Kinetic and Stoichiometric Model", by William M. Murphy, Radiochimica Acta 44/45, 395-401 (1988).
6. "Heat Capacity and Other Thermodynamic Properties of  $\text{Na}_2\text{SO}_4(\text{aq})$  in Hydrothermal Solutions and the Solubilities of Sodium Sulfate Minerals in the System  $\text{Na}-\text{Cl}-\text{SO}_4-\text{OH}-\text{H}_2\text{O}$  to  $300^\circ\text{C}$ ", by Roberto T. Pabalan and Kenneth S. Pitzer (Univ. of California at Berkeley), Geochimica et Cosmochimica Acta, Vol. 52, pp. 2393-2404.
7. "Apparent Molar Heat Capacity and Other Thermodynamic Properties of Aqueous KCl Solutions to High Temperatures and Pressures", by Roberto T. Pablalan and Kenneth S. Pitzer (Univ. of California at Berkeley), Journal of Chemical and Engineering Data, 1988, 33, 354 (1988)
8. "Models for Aqueous Electrolyte Mixtures for Systems Extending from Dilute Solutions to Fuse Salts", by Roberto T. Pabalan and K.S. Pitzer (University of California at Berkeley), American Society Symposium Series 416, Chemical Modeling of Aqueous Systems II, 44-57.
9. "Analysis of the MUA Decision Methodology for High Level Waste Repository Siting: Preclosure Utilities", by Ruth Weiner, Waste Management 1989, Tucson, Arizona from February 26 to March 2, 1989.
10. "Thermodynamic and Kinetic Constraints on Reaction Rates Among Minerals and Aqueous Solutions: IV. Retrieval of Rate Constants and Activation Parameters for the Hydrolysis of Pyroxene, Wollastonite, Olivine, Andalusite, Quartz, and Nepheline" by William M. Murphy and Harold C. Helgeson (Univ. of California, Berkeley), American Journal of Science January 1989.
11. "Calculations of Geochemical Mass Transfer as a Function of Temperature and Time", by William M. Murphy. Proceedings of the Workshop on Geochemical Modeling, Lawrence Livermore National Laboratory, 1989.

12. "Critical Assessment of Seismic and Geomechanics Literature Related to a High Level Nuclear Waste Underground Repository", by P. Nair, CNWRA 89-001, February, 1989.
13. "Dislocations and Feldspar Dissolution" by William M. Murphy, European Journal of Mineralogy, 1989, Vol. 1, p. 315-326
14. "Experimental Study of Line Electrode Method to Detect Underground Cavities, by F. Ziaie, S.S. Peng (West Virginia University) and Simon Hsiung, Proceeding of 30th Rock Mechanics Symposium, A.W. Khair (ED.), pp. 369-376, 1989.
15. "Yield Pillar Application Under Strong Roof and Strong Floor Condition-A Case Study by P.T. Tsang, S.S. Peng (West Virginia University), and Simon Hsiung, Proceedings of 30th Rock Mechanics Symposium, A.W. Khair (ED), pp. 411-418, 1989.
16. "Numerical Simulation of Three-Dimensional Saturated Flow in Randomly Heterogeneous Porous Media," by Rachid Ababou and D. McLaughlin, L.W. Gelhar, and A.F.B. Thompson (All of the Ralph M. Parsons Laboratory, Dept. of Civil Engineering, Massachusetts Institute of Technology), Transport in Porous Media, Vol. 4, 549-565.
17. "Implementation of the Three-Dimensional Turning Bands Random Field Generator", by A. F. Thompson (Lawrence Livermore National Laboratory), Dr. Rachid Ababou, and L.W. Gelhar (Massachusetts Institute of Technology), Water Resources Research, 25 (10), 2227 - 2243, 1989.
18. "Analysis of Regulatory Uncertainties Related to the Site Characterization Plan and the Exploratory Shaft Facility", by W.C. Patrick and R.F. Weiner, CNWRA 89-002, 1989.
19. "Analysis and Evaluation of Regulatory Uncertainties in 10CFR60 Subparts B and E", by W.C. Patrick and R.F. Weiner, CNWRA 89-003, 1989.
20. "Strategic Programmatic Issues and Risks Related to Comprehensive Planning for the High-Level Waste Program", by J.P. Hageman, A.B. Greenberg, and R.E. Adler, CNWRA 89-004, 1989.
21. "Constraints on the Chemistry of Groundwater in the Unsaturated Zone at Yucca Mountain, Nevada, and in the Proposed Repository at that Site". by W.M. Murphy, CNWRA 89-005, 1989.
22. "Progress in Experimental Studies on the Thermodynamic and Ion Exchange Properties of Clinoptilolite", by W.M. Murphy and R.T. Pabalan, CNWRA 89-006, 1989.
23. "Technical Considerations for Evaluating Substantially Complete Containment of HLW Within the Waste Package", by H. Manaktala and C. Interrante, CNWRA 90-001, 1990 (Draft).
24. "Uncertainty Evaluation Methods for Waste Package Performance Assessment", by J. Wu, A. Journel, L. Abramson, and P. Nair, CNWRA 90-002, 1990 (Draft).

25. "Identification and Evaluation of Regulatory and Institutional Uncertainties in 10 CFR Part 60", by R.F. Weiner and W.C. Patrick, CNWRA 90-003, February 1990.
26. "Qualification Studies on the Distinct Element Code UDEC Against some Benchmark Analytical Problems", by B.H.G. Brady, S.M. Hsiung, and A.H. Chowdhury, CNWRA 90-004, January 1990.
27. "Design, Construction, Instrumentation, and Calibration of a Biaxially Loaded Dynamic Shear Testing Apparatus", by K.K. Kana, S.M. Hsiung, A.H. Chowdhury, and B.H.G. Brady, CNWRA 90-005, January 1990.
28. "Qualification Studies on the Finite Element Code HONDO Against Some Benchmark Analytical Problems", by B.H.G. Brady, A.H. Chowdhury, and S.M. Hsiung, CNWRA 90-006, February 1990.

## PRESENTATIONS

1. "Overview of the High-Level Nuclear Waste Program in the United States" presented by J. P. Hageman at the 15th Educational Seminar for Energy Industries on April 19, and at the University of Texas Health Science Center on May 18, 1988.
2. "Systems Approach to Designing a High Level Waste Licensing System" presented by R. E. Adler, at the American Nuclear Society Annual Meeting in San Diego, California, June 13-16, 1988, co-authored by W. Patrick and A. Whiting.
3. "Dislocations and Feldspar Dissolution: Theory and Experimental Data" presented by William M. Murphy at the International Congress on Geochemistry and Cosmochemistry, sponsored by the European Association for Geochemistry held on August 28 to September 2, 1988 in Paris, France.
4. "Coupled Surface Reaction and Diffusion of Aqueous Species in the Control of Mineral Dissolution and Growth Rates in Geochemical Processes" presented by William Murphy at the Geological Society of America annual meeting in Denver, Colorado held October 31 to November 3, 1988.
5. "Future Trends in the Environmental Movement" presented by Ruth Weiner at the annual meeting of the Association of Washington Planning Commissions in Yakima, Washington on October 20, 1988.
6. "Geochemical Mass Transfer and Mass Transport in Hydrologically Unsaturated Rock" presented by William M. Murphy at the Workshop on Flow and Transport through Unsaturated Fractured Rock as Related to a High-Level Radioactive Disposal, sponsored by the Center for Nuclear Waste Regulatory Analyses, Sandia National Laboratory, and the University of Arizona, December 12 to 15, 1988 in Tucson, Arizona.
7. "Mineral Dissolution and Growth: Reaction Mechanisms and Rates" presented by William M. Murphy on February 3, 1989 at Tulane University in New Orleans.
8. "Application System/Project Management Costing at Southwest Research Institute" presented by Robert L. Marshall at the Guide 74 Conference in Toronto, July 19, 1989.
9. "Quality Assurance and The Center for Nuclear Waste Regulatory Analyses" presented by Bruce Mabrito at the Texas Quality Conference held in Austin, Texas, August 19, 1989.

PRESENTATIONS (CONT'D)

10. "Reaction-path Modeling of Groundwater and Mineral Chemistry in the Vadose Zone at Yucca Mountain, Nevada" presented by William M. Murphy at the Gordon Conference on Inorganic Geochemistry held in Andover, New Hampshire on August 13-14, 1989.
11. "An Assessment of Dynamic Response Prediction for a High-level Nuclear Waste Underground Repository" presented by D. D. Kana, B. Brady, B. Vanzant, and P. Nair at the 10th International AASMiRT Conference held in Anaheim, California, August 13-22, 1989.
12. "Probabilistic Performance Assessment Using a New Importance Sampling Scheme Based on An Advanced Mean Value Method", presented by Yih-Suen Wu and P. K. Nair at the FOCUS 89, Nuclear Waste Isolation in the Unsaturated Zone in Las Vegas, Nevada, September 18-20.
13. "Space-Time Structure of Unsaturated Flow in Heterogeneous and Stratified Media" presented by Rachid Ababou at the International Workshop on Field Scale Water and Solute Flux in Soils, held in Monte-Verita, Ascona, Switzerland, September 24-29, 1989.
14. "Models for Aqueous Electrolyte Systems Over Wide Ranges of temperature, Pressure, and Concentration", presented by Dr. Roberto T. Pabalan, at UTSA's Division of Earth and Physical Sciences, October 4, 1989.
15. "Geologic Systems as Chemical Systems" was presented by Dr. William M. Murphy at The University of Texas at San Antonio Geology Graduate Seminar, held October 11, 1990.