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NUCLEAR REGULATORY COMMISSION

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REVIEW COMMITTEE

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PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Thursday, July 8, 1993

The Commission met in open session, pursuant to notice, at 2:00 p.m., Ivan Selin, Chairman, presiding.

COMMISSIONERS PRESENT:

IVAN SELIN, Chairman of the Commission
KENNETH C. ROGERS, Commissioner
FORREST J. REMICK, Commissioner

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

SAMUEL J. CHILK, Secretary

WILLIAM C. PARLER, General Counsel

DR. DAVID MORRISON, Chairman, NSRRC

DR. NEIL TODREAS, NSRRC

EDWIN E. KINTNER, NSRRC

DR. HERBERT ISBIN, NSRRC

DR. FRED J. MOLZ, NSRRC

SOL BURSTEIN, NSRRC

DR. DONALD L. TURCOTTE, NSRRC

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

2:00 p.m.

CHAIRMAN SELIN: Good afternoon, ladies and gentlemen.

The Commission pleased to welcome the members of the Nuclear Safety Research Review Committee to brief the Commission on topics of mutual interest. I was stunned to realize this is the first time the Committee will have appeared before the Commission as a Committee, an oversight that we will clearly rectify as time goes on.

We appreciate the excellent, both profound and comprehensive work that the Committee does. It's true that the Committee's main responsibility is to advise the Director of Nuclear Regulatory Research, and through him the Commission, on the quality and conduct of NRC research activities and that the Committee gives recommendations concerning the overall management direction of the Nuclear Safety Research Program. But given the importance of safety research to the Commission as a whole, and given the interconnection between the safety work, the direct safety research work and some of the regulatory activities, these are of great interest to all of us.

We appreciate the efforts made by this

Committee and by your timely reviews of research programs which support important safety issues. Although this is the first such meeting since the Committee's formation, it won't be the last.

Today's briefing will provide a broad overview of many of the Committee's recent activities and there are at least half a dozen of these that are in the Committee Chairman's prepared remarks and we look forward to those.

I personally would appreciate whatever update you might have on the five questions I asked you in the fall of 1991. You've corresponded with us at different points, but these are clearly ongoing questions. Your deliberation this week, we're expected to update your reviews in these areas, as well as to provide some additional perspectives on the research program in general.

I understand a copy of the Committee's to the Office Director of Research are available at the entrances to the room.

Doctor Morrison has some comments. Have these been prepared? If not, we'll listen even more attentively to make sure that we catch all of your words.

Do any of the other Commissioners --

Doctor Morrison, would you care to proceed?

DOCTOR MORRISON: Well, thank you very much, Chairman Selin, for inviting us. We're pleased to meet with Commissioner Rogers, Commissioner Remick and yourself.

Yes, these remarks have been prepared. I don't know whether they're out there available by the door, but certainly they're in prepared form.

We are pleased that we are having our first meeting with you since the Committee was formed in 1988. However, I want to point out for the record that you personally, each of you personally, have visited with the Committee, as well as several of your predecessors, so that we have had the occasion to visit with members of the Commission.

What I'd like to do is to just make a few stage-setting remarks talking about the role of the NSRRC as we see it, what we believe our accomplishments have been since its founding and then several of the members who are chairing our subcommittees are going to introduce some specific topics.

Behind me, all of the members of the Committee are here today, so that we're prepared to

answer any question and they should feel free to make comments as they so see fit.

Now, as you know, the NSRRC was established pursuant to a recommendation by the National Research Council in its 1986 report on revitalizing nuclear safety research. At that time the National Research Council reached the conclusion that there were many structural and procedural problems the NRC had to address if it were to have a sound research program.

One of the management changes recommended was the establishment of a strong advisory group that includes independent experts from industry and academia, along with representatives of organizations performing research. NSRRC was subsequently formed to provide advice to the Director of the Office of Nuclear Regulatory Research and through him to the Commission on all matters of overall management importance in the direction of NRC's program of nuclear safety research.

Now, many changes in the management and the content of NRC's research program have occurred since the establishment of NSRRC. As one of the charter members, I'd like to think at least we have been partially responsible for some of these changes.

The NSRRC has encouraged and observed improvements in NRC's planning for research, the transition to a user needs driven agenda, and the incorporation of PRAs as a means of setting research priorities, the strengthening of project management accountability, the implementation of a peer review process of research products, continued focus on the use of best researchers to perform the research, and expansion of involvement of universities and small businesses in the research program.

In our letter of January 27 of this year to the Office of the Inspector General, we took exception to the impression that that office has that the research program is grossly mismanaged and that adequate management tools have not been established. NSRRC has adopted the practice of program review and assessment that involves both full committee meetings to gain an overview and perspective of all of the research activities, and subcommittee meetings through which major program elements are reviewed in detail and facts and analyses are developed for the full committee's consideration. These assessments are thorough and objective and our conclusions are drawn after considerable discussion among the members of the NSRRC who are indeed independent and recognized

technical experts.

Overall we have observed within the NRC an evolving research program that is redirecting the limited resources at the most important problems facing the regulators while maintaining technical quality and research products and preserving technical competence to support future regulatory needs. For example, over the five year period, NSRRC has had the opportunity to review the research program. We have noted significant redirection of the severe accident research program and the establishment of criteria in a timetable for closure, reduction in the number of accident codes that are supported by NRC, a redirection in the human factors research program to emphasize safety implications brought about by the transition to advanced digital control systems, the identification of research need for advanced reactors in the establishment of its research objectives and priorities within the program, completion of research on the accident source term, and the reorientation of the high-level waste research efforts toward the most critical problems.

These changes in the NRC's research program are typical of a well managed program that is responsive to changing events and needs. Research is

a dynamic process and as more knowledge is obtained on a given topic, research efforts must be directed by dropping less important items and adding more important ones.

What hasn't changed since 1986 is a stagnant market for new nuclear power plants and the difficulty of both government and industry to make major investments in nuclear safety research and development. The challenge to NRC over the next five years will be to maintain a strong independent technical base and to extract full value from level or decreasing federal expenditures. Doing more with less means working smarter and being even more certain that the best people are performing research. The NRC must find means to conduct collaborative R&D projects with the industry it regulates while maintaining its independent posture, and this will be especially true in the case of advanced reactors.

NRC will need to gather experience from other agencies, such as the DOD, NASA and FAA in human systems interactions and to strengthen its technical base in the design and development of advanced instrumentation and control systems.

International cooperation in reactor safety research will continue to be an area of

emphasis for NRC. As a result of the review of the research program yesterday, and in light of the pressures to do more with less, the NSRRC plans to focus on the efficiency and effectiveness of various activities in the research program over the next year.

I'm sorry to report that there are two changes in the membership of the Committee that won't be participating in this next year. Professor Donald Turcotte from Cornell University, who has been a member of the Committee for a couple years, is leaving in September for a sabbatical in England and we will miss his expertise in the earth sciences area on the Committee.

This last week we got a letter of resignation from Professor David Woods of Ohio State University and we will be filling that position as well in the next several months.

Now, with those general comments on the scope and operations of the Committee, we're open for questions or can move to specific topics of your interest.

CHAIRMAN SELIN: Are we on the overview of the nuclear safety research program now or is that a presentation?

DOCTOR MORRISON: That was it, just the

overview of the --

CHAIRMAN SELIN: One of the questions I'd asked you a year ago was the general size and adequacy of the program as well as the focus. You answered in a quite thorough letter in October. I wondered if you or your colleagues would care to update or is there anything you'd care to add now that it's basically nine months later?

DOCTOR MORRISON: We've had a chance to review the letter obviously in preparation for this meeting expecting such a question. The Committee, in its overview of the research program yesterday didn't specifically try to readdress those questions, but I would anticipate that we will address these in our letter in response to it.

My summary of what I think I heard yesterday, and that doesn't necessarily reflect the whole Committee's impression, is that a plant life extension and how that my tie into anything that is done in the research program is probably at the top of the list right now in activities, and I think followed very closely behind by waste management. We've seen a considerable amount of progress in the severe accident research program. Obviously I think all of us would think that that should come to a logical

conclusion and one wouldn't disrupt the funding there. Several other items that we mentioned on the letter a couple years ago are still on the table, but probably a lower priority.

I don't know whether anyone else has a comment to offer on that.

MR. BURSTEIN: In the area of aging that some of us had a chance to address beyond the main Committee's review, I think we found that the organizational structure appeared to be entirely adequate to handle that problem at least as it was defined. We know that there has been a relationship between aging degradation phenomena and license renewal and we're glad to see that some of that is being separated because the aging phenomena is by itself something we need to be concerned about in the operating plants perhaps as much if not more than otherwise.

We think also that the funding and emphasis that has been placed in these areas appears to be adequate despite everybody's traditional request for more money and more people. But if indeed the demands on addressing or readdressing some of the issues related to aging become more pronounced, we can see some pressures beginning to apply. At present, I

think this Committee is impressed by the organization and the skills, particularly the expertise that is being developed within the staff as being entirely competent to handle these issues for the moment.

CHAIRMAN SELIN: You're going to brief us on each of five specific topics. The question was really more oriented towards are we attacking more or less the right issues and with more or less the right level of resources. Are there other topics that are missing or is there any work here that's disproportionately over or under emphasized compared to what you think other priorities --

DOCTOR MORRISON: I believe the general answer to the question is that we're satisfied with the balance within the research program, and as Mr. Burstein said, the level of funding that is available. Obviously if there are some changes, especially in the advanced reactor program, as we sort of got a heads up from the director yesterday, additional funding would be required to do that.

CHAIRMAN SELIN: The second question is not so much a question, but as you go through your presentations, the line between research and in particular NRR is a pretty fuzzy one. So, insofar as you're able to, it would be useful if you would

comment on the whole Commission program and not just on that part which happens to be funded out of the Office of Research. It's particularly relevant on the INC area and on the aging area and probably on some of the other areas.

Typically the Commissioners show a great deal of interest in what you're doing and will chime in when they have questions. So, a good idea is just to keep talking until somebody stops you.

DOCTOR MORRISON: Very good. If you think we're going into too much detail, cut us off and we'll move to another topic.

COMMISSIONER ROGERS: Well, let me move in then. The invitation was there.

I wonder if you could comment in general on the extent -- your impressions of the extent to which NRC research is subject to peer review and is being submitted to peer reviewed publications.

DOCTOR MORRISON: I think embedded in that are two questions. First of all is the overall peer review process, which as I commented on in the introduction has undergone considerable expansion and strengthening during the five years the Commission has been in operation. The number of peer reviewed products is increasing and the nature of the peer

review is more often in a peer review of a particular research report that may not end up in a peer reviewed publication. That from time to time is supplemented by peer review. It's totally outside of the system, so to speak, in the publications. But in general I think we're satisfied with the peer review process as its evolving and continuing to be applied.

COMMISSIONER ROGERS: Well, do you think there's enough effort on the part of NRC to have its research results published?

DOCTOR MORRISON: I wonder if someone else wants to answer that. My own personal opinion is yes, I think there's enough emphasis. But perhaps those who have more of an academic background may want to comment on it.

DOCTOR TODREAS: I think you're speaking of the technical literature.

COMMISSIONER ROGERS: Yes. Yes.

DOCTOR TODREAS: Yes. I think probably the answer is we've gone miles in --

COMMISSIONER ROGERS: Oh, yes.

DOCTOR TODREAS: -- recent years, but in some areas the tradition is very solid to do this and it's second nature. Probably in a few of the other areas there could still be some pushing, but the

situation is good.

COMMISSIONER ROGERS: Well, I guess one concern that I have, and you might try to address that when you talk about the instrumentation and control area, is one in which the peers that we may see as appropriate for reviewing NRC research work may be within that same community of interested parties with respect to nuclear power plants, for example, that doesn't necessarily include those people outside that community who, in fact, may have much more expertise in this area. I think that you've commented in your papers to us that the nuclear industry in the United States has not been very advanced in the use of advanced instrumentation, digital instrumentation and control compared to what's happened in other countries or even compared to what's happened in other industries in the United States.

So, when we're talking about peer reviews by simply looking at the comments of peers within the nuclear industry, I'd be interested in the comments of peers outside the nuclear industry and my guess is that we're unlikely to get that unless we submit our results for publication in a more broadly read journal.

DOCTOR MORRISON: I think one of the very

important mileposts of perhaps such an outreach effort is the workshop that's being organized for us.

Is it September, Ed?

MR. KINTNER: September 13th and 14th, a joint workshop between NRC and the National Institute of Standards and Technology. I think it's the first of its kind. It's a good beginning.

COMMISSIONER REMICK: Can I follow-on?

COMMISSIONER ROGERS: Sure. By all means.

COMMISSIONER REMICK: Neil, in your response to tremendous improvement in publications and so forth, were you speaking about NRC staff or contractor staff or both?

DOCTOR TODREAS: No, contractor staff.

COMMISSIONER REMICK: Contractor staff.

DOCTOR TODREAS: I don't know very many publications at all.

COMMISSIONER REMICK: From NRC staff?

DOCTOR TODREAS: Yes. But the tremendous improvement I was talking about was we used to get a document that would show peer review progress and what it would be would be filled with internal reports and one inside group looking at the other inside group. That was my impression and that's been turned around.

DOCTOR ISBIN: I could respond to that in

my presentation on severe accidents and try to give you an example or two.

DOCTOR MOLZ: In the area of nuclear waste, I'm aware of several publication type activities that are out in the general professional areas. I'm thinking of the American Geophysical Union right now. Next spring there's a session dealing with low-level nuclear wastes that's going to be held in conjunction with the AGU meeting. So, I think in general in the waste area there's quite a lot of dissemination into peer review journals and also professional meetings.

COMMISSIONER REMICK: Now, are those coming from the center in Texas? Are they coming from our own staff here in Washington?

DOCTOR MOLZ: Your own staff. That's the one I'm aware of.

COMMISSIONER REMICK: Okay.

DOCTOR MOLZ: But they could very well involve people from the center.

COMMISSIONER REMICK: Sure. Yes.

DOCTOR MORRISON: Well, perhaps we should move to the first subcommittee report by Neil Todreas on the advanced reactor research.

Neil?

DOCTOR TODREAS: The Advanced Reactor Subcommittee, in terms of scope, it's important that you pick up that first. The Advanced Reactor Subcommittee could essentially subsume the whole Committee in time. What we've done though is on certain specific areas, like I&C and human factors, severe accidents, some of the structures area, and we have separate subcommittees reporting on those so that my report covers a narrower area. It's fundamentally thermal hydraulics, reliability and seismic. Those are the three residual areas. On seismic, we're taking advantage of Don Turcotte's presence. When I finish on the first two, he'll pick up on the seismic and that's how we'll do that.

The other point of perspective is I'm reporting to you on activities that have been ongoing for about a little over a year in terms of focus here. They've been reported in our letters. The director of RES has responded back. By going over some of these activities, I think you'll see the spectrum of interactions. In some cases we agree, in some cases we've disagreed but agree in principle, but have not come together on exact agreement to move ahead, and in a third case we've disagreed with the research activity. So, this Subcommittee has a spectrum of

examples.

What I'll cover then is three areas. One is the experimental programs thermal hydraulics. The second is code assessment activity and third is reliability of passive systems. Those are three examples that I'll basically give you an update on things you may have read before.

On the experimental program, we're talking about the activities within the NRC for confirmatory research on passive reactor systems. Generally we've moved ahead on the PWR and BWR. By we I'm talking about the NRC and the Research area to establish facilities and get the tests underway. Our function in the Committee over the past year was to basically evaluate the strategy and the approach for building facilities in a timely manner or modifying existing ones to move ahead to get the data.

I know all three of you are very familiar with the Rosa interaction that occurred about a year ago in which we made a review and resolution that that was a proper course. On that, we were very anxious or are very anxious that the instrumentation capability from INEL be applied strongly and that follow-up analysis activities by U.S. people on the data. That's the focus of our follow there.

One recent development was the development coming from NRR that the OSU, Oregon State University facility be held as potentially available for the NRC to follow-up after the Westinghouse tests to extend the research base. That's under review by the Research Office. We will discuss that with them when they come to a judgment, but in a sense we're heartened by the acceptance of the concept that you can take one facility, split the NRC industrial roles in that facility so that it's efficient in terms of time and schedule for both, get separate data, and proceed with everybody discharging their responsibility in the correct way. So, we look forward to that possibility.

COMMISSIONER REMICK: Yes. If I recall, one time there was concern whether OSU would be willing to do that because of other commitments, but I guess that has all been resolved.

DOCTOR TODREAS: I'll say it wasn't brought up as a problem yesterday, but I don't know if somebody behind me will clarify it if it needs it now.

So, the PWR was an example that way of a review and an agreement. The BWR case, there's a negotiation ongoing this month with an unnamed vendor to proceed to build an apparatus. Our Committee in

terms of review on that would have done the technical analysis in an inverse order from what actually is going on now.

When this was presented to us, we basically said it sounds reasonable in principle, but before we would agree that such a facility was necessary we'd like to see an analysis that would show the difference in performance between the vendor facility, between the design and between a loop that could be built to see what areas in terms of confirmatory research could actually be accomplished. Because the analysis wasn't in hand, this type of answer couldn't be given in specifics. It was made and given in engineering judgments, which as I said seemed reasonable, but we did not write in an agreement on our part that such a loop was required.

The interchange though was healthy in the sense that I believe the push to perform this kind of analysis came from the Subcommittee, was adopted by the staff, will be performed by the staff and the results of this will be cranked into the loop activity, construction activity that's underway. So, from a technical point of view, I think a lot was accomplished and will be accomplished.

I'll just insert one other thing, since

the Chairman referred to these five points on the letter. This has to do with people and people in the NRC staff. In this area of thermal hydraulics, we've pointed out that you're into a new regime and the new regime is technically difficult, technically daunting. Our observation has been over the last several years, two years, there's been some additions of very strong technical people both in NRR and in RES who can hold their own with the contractors, who can engage in a debate and get the best, I think, out of this exchange program. In fact, as you suggest, in my mind these people are equally capable of writing peer reviewed papers if they're not too bogged down in schedule and cost and everything else.

COMMISSIONER REMICK: I have a question later for the Committee about that.

DOCTOR TODREAS: But they can do it as long as they keep their eye on the main ball, which is to run the program right. Technically I think you've made a major advance in the Commission in strengthening capability in this area.

The second point --

COMMISSIONER ROGERS: Well, are you going to move off that?

DOCTOR TODREAS: Yes.

COMMISSIONER ROGERS: Before you move off that, your letter to us -- well, your letter to Doctor Morrison of January 14th indicated some skepticism with respect to the need for a test facility.

DOCTOR TODREAS: BWR?

COMMISSIONER ROGERS: Yes. SBWR. Since January, have you heard any more convincing arguments?

DOCTOR TODREAS: Well --

COMMISSIONER ROGERS: Without necessarily being convinced, but have you seen some progress in addressing your concerns, I guess?

DOCTOR TODREAS: Yes. We have seen more convincing arguments, but of the same character, qualitative judgment with a little bit more beef in it, all in the right direction. But what we were looking for was a different type of argument and that hasn't been done. There's an honest disagreement. The staff is saying basically you can't do the analysis until you have the loop design in place so you know what to analyze. Our point back was, well, you guys know probably enough about a loop design with your contractor that you could characterize it even though you haven't got the proposal in finally and you could move ahead a little faster on it. That's where the disagreement was.

COMMISSIONER REMICK: You're going to leave the thermal hydraulic area?

DOCTOR TODREAS: Yes.

COMMISSIONER REMICK: I had a couple questions on that. One of the questions that I have, and it's a delicate one, is when I look at the resources we have available in the thermal hydraulic area and I look at the number of research providers that we're distributing that over a little bit at this lab, a little bit at that lab, a little bit at that lab, does the Committee have any concerns about that, maintaining that viable nucleus? It's distributed at least between four national labs and some other research providers. Has this come up before the Committee with any kind of concern? Some people have a small piece of the action, somebody else have a small piece of the action. It depends whether it's PWR, BWR.

DOCTOR TODREAS: We haven't addressed it cohesively like that. I could make some comments to you though and observation and invite other people. The way the program is starting to be organized, you do have three to four facilities at universities which will develop researchers. In fact, your expert group that's working with RES is drawn from university

faculty. So, you've got raw material coming into the system. Your question is where are they going to go and how are they going to be effectively utilized.

COMMISSIONER REMICK: That's one part of the question. The other is are we spreading the resources too thin and therefore at any one location we don't have that viable nucleus that these people get because we aren't funding them full-time. They're off doing other things and then we'd call them in and they perhaps no longer are the experts.

DOCTOR TODREAS: We haven't looked at it. We've focused on INEL. That is certainly critical, a critical mass. But I would say we should take on that question and look at it because it's right up the alley.

COMMISSIONER REMICK: Before you leave the thermal hydraulic, have you looked at code maintenance? You did not mention that. You talked about code assessment and so forth.

DOCTOR TODREAS: Right. Yes. Code maintenance has been presented. There's four codes, four places where they are placed and it looks like that's a stable situation.

COMMISSIONER REMICK: Do you think the codes are being adequately maintained?

DOCTOR TODREAS: Okay. That's the second layer. That says how good is the technical work. We haven't done that. We've looked to see whether the boxes are in the right pews and that's correct.

COMMISSIONER REMICK: How about other codes other than thermal hydraulic in the severe accident area? In other words, have you looked at those or will that come up as part of another presentation?

DOCTOR MORRISON: That part will be addressed by Herb Isbin in the severe accident.

COMMISSIONER REMICK: Okay. I'll wait.

DOCTOR TODREAS: Well, that's a lead. Relative to the code assessment issue, we -- well, first we're talking about the codes for the passive system analysis. The concern there was to get the selection of the codes tied in with the assessment required on the codes so that you didn't select too many and then have a large assessment bill, mortgage down the road that you had to pay but you didn't think of up front. We quickly got into philosophical agreement with the staff and now we're discussing the issue in the trenches code by code, assessment of transient by transient. So, that activity is underway. We're motivated because of the track and

MELCOR experience in which there was a huge bill to do the assessment because it wasn't recognized up front, undertaken too late. So, we're talking about RELAP-ROMONA and RELAP-CONTAIN hooked together. What's the plan for this? That's on our agenda. That's what I wanted to say about that.

Then, finally on the reliability of passive systems, that's an example of an activity that we visited twice to try to understand what the program was, what the depth of accomplishment was. We couldn't come to an understanding and agreement on that. The letters have very specific technical questions we raised. It's a very important question and so we stayed with it. The upshot of it was the existing program, RES decided to close that and start again, try to get a firmer base. By firmer, technically firmer and on a schedule that would come in with results over a year or two instead of multiples of that.

COMMISSIONER REMICK: Could you elaborate on what you mean by reliability of passive systems? I think I understand, but I'm not sure.

DOCTOR TODREAS: It turns out that was one of the questions we weren't sure of either because within the definition of that program was the question

of uncertainties and natural processes which we raised and that seemed to be -- not to be amenable to an analysis, but right up the thermal hydraulic experimental program. That's where that would be assessed and analyzed.

But fundamentally, the question would be -- going back to your first question is can you count on the passive systems operating when called upon? Allied to this but not quite tied directly to it is credit for non-safety systems. I think when we get into the issue of reliability of passive systems we're also counting to some extent on non-safety systems and that's another piece that would need to be folded in.

That one is the subject -- that whole area is the subject of a fall workshop that the office is running in which they're going to really try to redefine the basis for that and launch off on that.

I would stop at that point.

DOCTOR MORRISON: Don, would you like to pick up on the seismic aspects?

DOCTOR TURCOTTE: Well, just for a minute or two. I'd just like to comment with regard to the Committee's activity on particularly the probabilistic approach to the seismic hazard in terms of proposed new regulation. We have put in our written reports

that we strongly support the change to a probabilistic approach and I think it's fair to say that the general activities in the Research Division over the past say ten years on the seismic hazard and the development of the probabilistic approach has really been one of its prime achievements working along with the study sponsored by EPRI.

I'd just like to make a short analogy. If you're going to build a levy on the Mississippi River, one way to do it would be a deterministic way. The deterministic way would be to look at the biggest flood you had in recorded time, say the last 60 years, and build the levy that high. Of course right now that levy might not be high enough, although you had an absolute deterministic way to do it. Now, in fact, the Corps of Engineers today uses a probabilistic point of view. They have a statistical approach to floods and they have an official designated probabilistic approach to the flood hazard, which may or may not be successful. I think the analogy to doing probabilistic hazard assessment on seismic is fairly direct and I think it can be very strongly argued that the modern approach, even though it's not going to guarantee success, is to look at a combined probabilistic approach based on seismicity and the

local geological record. The proposed regulations are generally sound, although they do require some changes, particularly with regard if the two approaches give different results, just how you're going to pick between one or the other or how you're going to resolve that difference.

I think also it's worth pointing out that the Research Division has funded a National Research Council committee to study these problems over the next 18 months and this is a very distinguished committee and I think that this is an appropriate way, and I think the Committee feels this is an appropriate way to bring further expertise into this rather sticky problem that's likely to be an issue in the years to come.

COMMISSIONER ROGERS: Just on that, again the letter of January indicated some concern on your part with respect to the potentially limited role of that national organization. Do you still have that concern or do you feel that that role is now broader with respect to --

DOCTOR TURCOTTE: From what we heard yesterday, the charter of that Committee has been broadened along the lines that are suggested in that letter.

COMMISSIONER ROGERS: So you feel satisfied?

DOCTOR TURCOTTE: Yes.

COMMISSIONER REMICK: Has the Committee had access to the number of comments that have come in on the revised Part 100 on the probabilistic approach? There's some pretty strong comments against going that direction and certainly against both having deterministic and probabilistic approaches at the same time for the reason you pointed out. What if they differ? What do you do then? Has the Committee seen those?

DOCTOR TURCOTTE: I don't think the Committee as a whole. I spent Tuesday looking over some of that, particularly the input from the foreign countries, and that was one of their main points. But it would not change what I stated, but I do think -- and I think the staff agrees that the question of how you resolve this difference must be resolved in a concrete way, although all their preliminary studies on existing plants indicates that differences are extremely small when they look at the existing plants in the two different ways.

COMMISSIONER REMICK: I always kind of favored the probabilistic approach just purely from

the standpoint if you're going to do a probabilistic PRA and included seismic as one of the external initiators, it seemed to make sense. But now the staff is moving away from doing seismic PRAs. They're including seismic as an external initiator in PRAs and doing seismic margin studies. If one does seismic margin studies then I don't think one necessarily needs a probabilistic approach from feeding into a PRA.

DOCTOR TURCOTTE: This gets down to a very sticky point, I think, that has been avoided to some extent. That is if you've got a probabilistic risk of something happens, what is your absolute standard? Now, the way it's been stated is that the present philosophy defined to be safe and that provides you with your absolute standard. But there is always some risk of a natural event occurring, like a meteorite striking the plant or something. So, there's always that infinitesimal risk. Once you go probabilistic and say you could have a big earthquake right underneath the plant, which is possible in some cases, you're faced with just what is your acceptable level of risk.

COMMISSIONER REMICK: Why is it that you feel the probabilistic route is the route to go? The

technology, the knowledge and so forth, the uncertainties have been reduced such that that's the modern way to look at seismic events?

DOCTOR TURCOTTE: I think that -- as in the flooding case, the inherent geological problem is probabilistic. In other words, it's like weather. It is not a deterministic system. To try and claim you can do it deterministically is not recognizing the problem that you're faced with. The question is how good is your probabilistic approach and that is where the uncertainties basically arise. But it's certainly better today than it was five years ago and it's certainly a lot better than it was 20 years ago.

COMMISSIONER REMICK: This is the route, I guess, USGS is now supporting?

DOCTOR TURCOTTE: I think the differences have been resolved.

DOCTOR MORRISON: Well, let's move on then to a discussion of the advanced instrumentation and controls and the human factors research. Ed Kintner is the Chairman of that Subcommittee.

MR. KINTNER: The questions that the Chairman gave us about a year ago I think implies something that we believe, that the single most significant technical advance taking place in the

nuclear industry requiring some regulatory attention is the application of modern digital systems to control rooms and to individual control systems in the plant. Since this is so crucial a safety in every aspect, the hardware, the software reliability must be assured and there is not yet a long body of experience with which to base that assurance. So, a certain amount of work needs to be done to provide that base of assurance.

But I think everyone agrees that if it's properly applied, modern electronics can significantly improve the interface between the operators in the plant and they can improve reliability, testability, maintainability and calibration of the systems and therefore overall total system safety. But this, of course, is a two-edged sword. Here we are dealing with a more modern new relatively unproven technology and depending on it for very important systems. So, it must be done with a great deal of care and we feel that one of the first tasks that research division has carried out is to provide mechanisms to discriminate for the regulatory process between the side of the sword that is dangerous as well as the side of the sword that can provide a great deal of benefit from the safety perspective.

There is, of course, a clear distinction between subsystem replacements in existing plants and using digital systems, modern control systems throughout an entire plant, which is proposed for the next generation. There are 13 subsystems already approved by the NRC for use in existing plants. So, this is not absolutely new and the process is well underway to move into using them for auxiliary feedwater system controls and so forth.

In the case, however, of the total use of digital control systems, modern electronics, this Committee has counseled that research should base all its activities in our recognition that must be approached as a system concept, that this approach must integrate the human perspective with the plant perspective. We no longer call it instrumentation and control, we call it man/machine interface and that definition is, I think, profound. It indicates the possibility here to connect human intelligence with the plant in its totality which was not there before. That's difficult to do and may not be the NRC's apparent responsibility to do it, but my sense is that working with the ALWR program and in terms of the circumstances of the industry today, it's not being done as well as it could be and eventually will have

to be if maximum benefit is taken from modern control systems.

So, we've recommended that there be this interface, this systems approach to the interface and that shows in the way the Research Division is now organized, in which the human factors and the advanced I&C are combined, and also it shows in the way our subcommittee works, which is a combined subcommittee with those two subjects. We've suggested that in order to provide a mechanism to get started down this track, the division should develop a statement of criteria by which systems can be judged as to their benefit to overall plant safety.

So, much has been done with regard to the needs to validate systems, to try to develop a mechanism to measure the reliability of the systems, and far less has been done to make this combination of man and machine using the most modern techniques. That, as I said, is a very difficult thing to do. There is not a great deal of background in which to do it. People will, of course, think immediately about aircraft or military capabilities, but I must suggest that a total reactor plant with implications of its operation is a bigger task in that regard than aircraft is.

So, we've suggested that first of all the Division recognize the system aspects of this question, that they make a very significant effort to obtain and digest information being generated in other countries and other fields. Some of that is being done, but not enough. Finally, that they look for ways through research or their own activities relative to NRR to provide inspiration, leadership, guidance with the industry and to developing a better understanding of how to use these new most powerful processes to improve reactor safety. By no means are we at the end of that process. As a matter of fact we are, in my view, just beginning.

CHAIRMAN SELIN: Are you suggesting that some additional work be undertaken that's not even undertaken now to try to get the man/machine interface or the software including the operators into the PRA analyses, for instance?

MR. KINTNER: Yes, that's what I'm suggesting. The question is such a subtle one that it's difficult even to define the total that needs to be done, but that clearly needs to be done. It is not being done very much. There are some human factor studies going on, but human factors in relationship to the digital control systems, very little is being done

in that regard.

CHAIRMAN SELIN: The problem I have with seeing the implications of what you're saying is that when we're looking at the actual certifications and the NRR work, we seem to be about three generations behind what you're talking about. They were talking about how do you ascertain software reliability, how do you set up some systems, really sort of basic questions, not qualitatively different from the types that we have in the higher energy part of the reactor design. What you're talking about is at least two jumps ahead of where we are in doing the current evaluations. There's nothing wrong with that intrinsically, but what I'm trying to figure out is if you think we're able to do what we have to do to certify the evolutionary designs and now we should be preparing for more sophisticated topics or since we can't do what we have to do to certify the evolution designs anyhow, we might as well jump over it and get on to the next, or someplace between the two.

MR. KINTNER: Somewhere between because this ground can't be made up in the time you have available, but there has to be from some source a beginning, an inspiration, a motivation to do something about it. Therefore, you can start today

because you didn't start five years ago and it is a difficult thing to do. But the first plants, my own estimate is they're going to be certified without that kind of appreciation of what could, in fact, eventually be done.

COMMISSIONER ROGERS: If I could ask a question then, do you think that this approach is a useful one for considering the introduction of digital control rooms in existing plants as replacements for analog-driven systems that just have to be replaced? Do you think that there is some possibility that by a more aggressive approach here that the industry might be encouraged to, in a sense, redesign control rooms in totality rather than just simply piecemeal replace an analog system with a digital system?

MR. KINTNER: I don't know how to answer that question. I think that for the time being at least it's going to be piecemeal replacement of individual parts. But as the industry matures, depending on what does happen in the future plants and what happens to the industry as a whole with regard to taking care of the future, then it will move slowly but surely into the field in which there will be total new control systems applied to present plants. It's that area which, it seems to me, we ought to be

preparing for and it's going to be difficult to do.

MR. BURSTEIN: The industry is getting some experience with replacing component systems. For example, a turbine generator governor speed and load control system, as a system, there have been many electronic applications in system panel display arrangements that are not necessarily the whole control room, per se, but portions and significantly greater portions of the control room. I think the Committee generally is in agreement that existing plants face an insurmountable hurdle in replacing an entire control room at this point in time.

CHAIRMAN SELIN: Could I ask you just a couple simple questions? When you're talking about advanced I&C systems, is that synonymous with digital I&C systems? Are you talking about systems that are beyond the ones that are proposed for the evolutionary --

MR. KINTNER: No, I'm talking about digital I&C in terms of the ones that are being proposed. In principle, the type, yes.

CHAIRMAN SELIN: Because the job that NRR is facing is really a fairly simple one. It's to take a look at a specific proposal and say without necessarily being able to evaluate this in the

universe of all possible systems, are there fatal flaws in this, are there deterministic flaws, will this work? Not is it better or worse than some other alternative. On the other hand, from a research point of view, it's not our job to evaluate alternatives, but it is our job to be able to give some kind of an overall evaluation for a conceptual design which means being able to put numbers on some broader systems, which include the advanced electronics, including the people working with the electronics, et cetera.

It is pretty clear to me that you're saying we're not in anywhere near a position to do the second point yet, but it's not clear to me what you're saying about the first point. Are we able to take a specific design, a GE design, a CE design and do an evaluation or are we not even able to do that? In other words, are we forcing people to do foolish things because that's all we know how to evaluate?

MR. KINTNER: I think you know that as it now stands certification is going to require backup systems, which implies a certain lack of knowledge or confidence, which is understandable at this stage. But with that approach and with a backup, I don't think anyone is questioning the ability to certify safe plants. But are they optimum in terms of the

ultimate safety that could be provided by this additional capability? That's the question which I'm asking.

MR. BURSTEIN: The current designs for the plants to follow, advanced light water reactors such as liquid metal reactor plants, are being designed with digital and computer control systems without backup and without the kind of qualification that is presently demanded of light water reactor control systems in the hope that the abilities of people and the maturity of development will proceed to a point in time where that will be possible.

CHAIRMAN SELIN: The areas that I'm familiar with, that I was familiar with before I came here, such as aircraft systems, the aircraft designers never got off backup systems until they finally were designing airplanes that were so fast that the backup systems wouldn't work. It wasn't that they ever were comfortable or even today are comfortable with the analysis of the fly by wire systems, they just got the planes that were intrinsically unstable and the pilot could not control them. So, they finally said, "Well, let's drop the electromechanical and hydraulic systems because the system is too fast." I don't think the state of the ability to evaluate the software ever got

to the point where the safety evaluator said, "We don't need a backup system." It got the point of saying, it won't work anyway, so it's all or nothing with the true lack of the backup systems.

I don't see how we get out of this particular box. I don't see some kind of a set of algorithms where we can agree that the analysis is to the point that we don't have to require not so much a non-digital system but a not so highly automated system for the extreme case where everything fails.

One of your colleagues --

DOCTOR UHRIG: I'm Bob Uhrig. I'm a member of the same Subcommittee.

I think you have to distinguish in the safety systems, control of a nuclear reactor is relatively benign and lumbering slow changes. The major concern here I think we haven't addressed is in the safety systems. That has to be to make sure that that works. That's at the present time the area where backup is required. There's not backup required in the control systems --

CHAIRMAN SELIN: What do we hope to get out of the seminar in September to address the safety?

MR. KINTNER: Well, what we hope to get, we had recommended that there be a wider, more

aggressive attempt on the part of the staff itself to learn what was going on in the rest of the industry or abroad and that's what they've tried to do. There are, for example, questions here about the relationship of the humans to the system. There are lectures on testing to assure reliability and so forth. So, this is the first step to getting a broader participation by experienced people in this subject.

CHAIRMAN SELIN: And the other related question is, is there a research program that would allow one to do some evaluation of risks or probability of the loop which includes both the software and the operators?

MR. KINTNER: To the best of my knowledge, the answer to that is no. That touches on the area that I was mentioning. There may be others who can answer this, but as far as I know that's not in the program as it exists.

DOCTOR MORRISON: I think your answer is correct, Ed. The Subcommittee, as well as the Committee, has recommended several times that one needs to investigate how one can factor in humans into the PRA that one normally does. It's conceptually easy to say, functionally it's rather difficult to do.

COMMISSIONER REMICK: Ed, in your letter and several times you've said some of this is being done, but not enough. I take that at face value. But couldn't I say the same thing about the vendors in this area of instrumentation? It's not only the NRC, but it's the vendors who perhaps haven't fully grasped --

MR. KINTNER: That's why I made the comment that I'm not sure this is the prime responsibility of the NRC. But you are, in some sense, on the horns of a dilemma because the industry is absolutely new. They don't have the resources, they believe, to do this in the way it could be done and therefore it seems to me that the NRC is in the position of trying to find some way to inspire or motivate or encourage that kind of activity. One way to do that is to do some of it yourself. Another way to do it is to write regulations and requirements or documents which encourage the industry to take certain directions. It's not an easy thing to write down.

Maybe this doesn't seem like a good analogy and it's not a good analogy, but it's an example to show what could be done. In modern collision avoidance, suddenly the pilot hears the word spoken to him very loud and clear, "Pull up, pull up."

Now, that's not a direct application to reactors, but the digestion of information, which is made possible by these systems and presented in a way which encourages or simplifies operator response is what ought to be the objective. We're not there yet by any means.

Another question, just as another example, one of the things that troubles me is that we've worked very, very hard to provide simplicity in this next generation of reactors. Nowhere in the safety analyses does that ever show and it's a question of the relationship to the operator, the simplicity of the plant and its presentation to him in terms of the ability to operate it and operate it safely. So, there are many areas associated with this, but it does, I think, come back to this question of probability of operator reaction to certain signals and how they're digested and presented.

COMMISSIONER REMICK: When I read the letters in this area, I thought this encouragement of tying together the human with the I&C control made a lot of sense. But then I got thinking, how is that any different with analog systems? Certainly the same thing could be said about analog controls, right, except that the digital provides a lot more potential

of information and intelligence and so forth? But basically the importance of tying to two together could have been said or should be said about analogs.

MR. KINTNER: I think that's right. It's a question of the capacity of the systems and speed with which it's going to be presented in the variety of presentations which are available.

CHAIRMAN SELIN: I've always thought that digital is sort of a red herring. The real question is does somebody have to look at 20 different meters on a panel or get some kind of composite that puts them together where the meters happen to be flashing numbers or dials.

COMMISSIONER REMICK: Or, as you say, the pull-up signal.

DOCTOR UHRIG: Just one comment here. You're suggesting we might comment about the overall progress. I think this is an area where a lot of progress has been made in the last four or five years. Five years ago a couple of us went around the country talking to utilities, vendors, et cetera, about this whole area and the essence of what they were saying is, "We won't touch it with a ten foot pole until we know precisely what has to be done for approval." We're now in a situation, as Ed indicated, where there

are 13 systems approved. There's seven or eight more that are under consideration and the NRC has defined very clearly what could be done under 10 CFR 50.59 and what has to be reviewed by the Commission. I think we're not completely out of the woods, but I think a lot of progress has been made.

CHAIRMAN SELIN: When Dwight Eisenhower became President he was aware of the paperwork in the Pentagon and he required that all files more than five years old be destroyed, and about two months after his order he asked what was happening and the answer was, "We can't do that yet, sir, we have to first make copies of all of them." Sometimes I think our I&N systems have some of the same labor saving characteristics.

Commissioner Rogers?

COMMISSIONER ROGERS: Yes. Well, I was very glad that Commissioner Remick brought up his point about the human factors question applies to analog control rooms as well, and it really makes the point that I'm a little concerned about here, and that is that just our discussion around the table this afternoon would seem to imply that the coupling of human factors to the I&C system is maybe something that's really important for the future, but we're

maybe not ready to do it. I don't think that's quite true. I think that there is progress being made in understanding something about human factors in the way control room teams operate and I am concerned about the extent to which the NRC research is able to address that, has addressed it and is looking at it for the future.

There's a comment made in your letter that, "In the past the history of the subject," whatever the subject is, but I'm reading it to be human factors, "has appeared to be a chopped sine wave and a reasonable effort is started, but terminated or significantly reduced before useful results are obtained." I seem to have the sense that we're repeating that history with respect to human factors research and I would hope that your concern with respect to human factors research is not simply directed towards these advanced control room questions of digital systems, but also what perhaps we should be doing at some level with respect to human factors research as applied to control room teams today.

MR. BURSTEIN: You will recall, sir, that much of the human factors research began as a response to human error statistics, and that still is an ingredient which we should not overlook and I don't

think we have. But indeed the human factors is broader than simply the application to a cathode ray tube or a display screen in a digital system.

COMMISSIONER ROGERS: Well, I think one of our concerns is that it could be too broad with respect to how the whole company is organized, for example. I think that's something that I personally have no interest in whatsoever with respect to our research program. I don't know that anybody else on the Commission does either. But I do have a very strong interest in a more limited view of human factors research, particularly the way the control room team behaves and the way those individuals who directly interact with the control room team behave. I would appreciate your thoughts as to the level and kinds of research that NRC should be involved with on issues of that sort. Not necessarily today.

MR. KINTNER: Now or later? There's been a great deal said about those subjects now from TMI-2 and maybe even for the whole question of what is the relationship of the management of the company to the director of the plant, the training programs, the simulators and so forth. There's been a huge amount done in those areas. So, although there are several tasks in the research program as it now exists which

talk to that sort of subject, it seems to me that in terms of total safety, it's almost been exhausted. Not quite, but almost. And people, I think, can now have a regard to present circumstances, done a very good job with INPO and with the kinds of economic pressures the corporations are under to find out how to manage and operate safely. My own impression would be it would be hard to find gold nuggets in that stream now.

DOCTOR MORRISON: Just one quick comment before we move on in this particular area, and coming back to your question earlier, Chairman Selin, about the staffing, the level of competence among the staff. As one involved in this for about five years on the NSRRC, I would say personally I've seen a considerable increase in the competence of the staff both in Research as well as in NRR in this particular area. I think we're now dealing with some very competent people that understand this subject area and are able to deal with it as peers in the external community. The changes have been very effective.

I'd like to turn now to Herb Isbin, who is the Chairman of our Severe Accident Research Subcommittee.

DOCTOR ISBIN: The Severe Accident

Subcommittee met with Research about a little over a year ago and the meeting was to review the severe accident research program plan, which is called SARP. This was an update and this was draft NUREG-1365, Revision 1.

The Subcommittee had a very fruitful exchange with Research in terms of discussions and information. From this exchange we were able to assign priorities to eleven major severe accident issues. We placed them into three categories. The first category was called high priority. It included closure of Mark I liner failure issue, the closure of direct containment heating, advanced light water reactors, severe accident codes. And into the second category, which was called medium priority, it included fuel coolant interactions and degree coolability, core melt progression and hydrogen generation, hydrogen transport and combustion. And in the last category it was labeled issues almost complete and continuing studies considered confirmatory including international work. Four items there were scaling, and this is now a finished product, source term, TMI-2 vessel investigation project, and core concrete interaction.

The Subcommittee and the full Committee

concurred with Research in the goals of SARP. Complete all the major severe accident experimental programs within the next two to three years, and closure of all severe accident issues in four years.

The question of criteria or closing out issues was thoroughly discussed. It's contained in the SARP report and the criteria were also augmented by the presentation of the Deputy Officer Director of Research.

In response partly to your question, Commissioner Remick, although the Committee met on June 2nd, we had time to formulate our response and we took into account your June 3rd memo to Eric Beckjord, which is called, "Closure of Research Projects and Maintenance of Capabilities," and also Eric's June 15th, 1992 response, and the Committee was satisfied with these memos.

There's quite a bit in our Subcommittee report, but let me skip over to try to answer partly Commissioner Rogers' question on use of peers in your question with reference to authorship of journal articles. At our June meeting, we noted considerable progress in the Mark I liner failure issue and to resolve the Mark I liner failure issue it required the use of a relatively new methodology which is called

risk-oriented accident analysis methodology. It has the acronym of ROAAM, R-O-A-A-M. I should add that ROAAM proves to be very useful. When doing PRAs, you come to event trees in which the experts really disagree. ROAAM is complimentary to PRA. ROAAM is a process. It requires a disciplined approach to devising a structure for analyzing the problems at hand. It requires a thorough technical review of the literature. It requires the presentation of the causal relationships and it requires the input of the various parameters which might affect the results. It is a process.

The reason why it's called a process is that once a document is formulated and presented, it has to be submitted for panel review. The robustness of ROAAM is dependent upon this process and in this panel review you also include those who disagree with you. The importance is that it forms a framework and a structure of reconciling differences of information based upon documented reports. I'll give you a further example of that.

So, at this particular June meeting we mentioned the progress of ROAAM. It was also introduced to our Subcommittee meeting that ROAAM could be used hopefully to resolve the direct

containment heating issue, at least for Zion-like and Surry-like containments using to the fullest the integral test data that had been obtained and were being obtained at both Sandia and at Argonne. I'd like to -- this was a year ago.

I'd like to come back now to the review that Research provided to us yesterday. We now have a document which is NUREG/CR-6075, the Probability of Containment Failure by Direct Containment Heating in Zion. This was to have been a collaborative effort between a member at Sandia and two staff members at the University of California at Santa Barbara. So, this is now at a -- the reading of this report is exciting in that it provides a basis for resolving direct containment heating in many kinds of containments, not only Zion itself, but these are features which have to be fulfilled. This report is now at a stage where it has to undergo this ROAAM process of review by a peer panel. I understand that the peer panel has now been chosen. The Committee had recommendations of expanding that panel to make sure that the robustness of this process is achieved. So, that's a positive step.

The Committee also had updates on a number of other issues which were included in the eleven

issues which have now narrowed down somewhat, core melt progression, fuel coolant interactions, fission product release and transport, core concrete interaction, additional work on direct containment heating, hydrogen transport and combustion, and fission product behavior. These are to be topics which our Subcommittee will consider in more depth on August 2nd and 3rd.

That completes the short --

COMMISSIONER REMICK: You were going to make some comment about co-authorship, I thought.

DOCTOR ISBIN: Oh, yes, co-authorship. Thank you.

The ROAAM methodology is a good example for co-authorship. I should have brought the papers with me, but see what I can do by memory. At least two. In November of 1990, a paper was presented I think at a Canadian meeting which described at that time what Research was doing in terms of revising the severe accident research plan. In addition to the comments on revising the plan, it also included a description of the ROAAM method which was being used for the resolution of the Mark I liner issue. The authors of that paper were Theophonous and included three staff members, Speiss, Sheron and Eltawila.

Additionally, if you look in Nuclear Technology, March 1993 ~~Engineering, I think it's March or April,~~ you'll find a series of three papers dealing with Mark I liner issue in which the authors again will include Theophonous and Yon and a member or two from the Research staff. So, there is participation and presumably there's strong endorsement of this method.

COMMISSIONER REMICK: Good.

CHAIRMAN SELIN: Thank you very much, Professor.

DOCTOR MORRISON: Okay. Let's move to the next topic then, which is the high-level waste research program and Fred Molz is the Chairman of the Subcommittee that's got responsibility for that.

DOCTOR MOLZ: What I'd like to do is first make a few statements about the overall program that most people are familiar with to more or less set the context of the discussion. Then I'll present some observations that the Committee pretty much agrees upon in this area.

The purpose of the high-level waste research program is to do two main things: provide scientific and engineering support for the evaluation of DOE's repository license; and also to support the development, modification and interpretation of

regulations.

Since 1987, a lot of this is focused towards the Yucca Mountain site. To understand the basic problem, the disposal process has been divided into two subsystems, one called the engineered system, referring to the actual structure, the devices containing the waste and those sorts of things, and then the other system was the natural system dealing with the near and far field surroundings.

The overall strategy in order to build the required knowledge base was to identify key technical uncertainties and then to try to prioritize these and begin to solve them.

Why would we have these uncertainties? Well, there are two main reasons for that. Part of the requirements written into law is to be able to -- or requires the predicting of the performance of an engineered system for a period of 300 to 1,000 years, and this is not something that has been done before. And when it comes to the performance of the natural system, that required predicting or understanding or evaluating period goes out to at least 10,000 years, again something that has not been done at all.

I mean, we've only recently discovered plate tectonics and we've been looking at that for

quite a while, so to anticipate the behavior of a natural system for 10,000 years is quite a challenge. No one knows how to do this well and therefore evaluations will involve the extrapolation of short-term studies to a great extent, so we're in the position in both the engineering and the natural systems where people will do studies where traditionally we might call ten or 20 years a long-term study and then have to take that information and extrapolate it many multiples of time beyond the period of study.

The only way we know how to do that sort of thing is to rely on models, models of all types, physical, conceptual, and of course mathematical models that we now use computers to elaborate and solve. One of the concerns the Committee has is the proper role of models in this sort of thing. Sometimes I think if we didn't have these kinds of models it would be easier in some ways to handle the problem because we would use more traditional engineering judgement and that kind of approach that has worked in the past with engineering problems, but there's a lot of pressure now to use the most modern tools and just how this should be done is something the Committee thinks needs to be reviewed quite

frequently as we move over the next decade.

COMMISSIONER REMICK: As I interpret what you're saying, the development of the models raises more questions than they answer.

DOCTOR MOLZ: In many cases you could make that argument, definitely, because now within these models we can define many things the measurement of which is very foggy and so it literally does raise many questions.

COMMISSIONER ROGERS: So how do you see controlling this process? I mean, it looks almost hopeless from that point of view.

DOCTOR MOLZ: Well, I don't think it's hopeless. There are all types of models and the question, I think, is to find the balance, the right balance. To say what that is right now --

COMMISSIONER ROGERS: But aren't you going to wind up by introducing essentially engineering judgement to do that when all is said and done, just on a higher level in a sense?

DOCTOR MOLZ: Yes. That is going to be one of the conclusions that I mention.

COMMISSIONER ROGERS: Well, I'm sorry.

DOCTOR MOLZ: I guess I'm pointing in that direction already.

One area that is somewhat of an exception to the extrapolation problem is the study of natural analogs. Here we have systems, in some cases they're very large, and so a large amount of radionuclides were created naturally in the past. Oftentimes we're dealing with thousands, tens of thousands, even millions of years in some of the natural analogs, and so the time period is there. The problem is that they're not perfect analogs, but nevertheless they do eliminate this extrapolation problem.

With careful measurement you can identify what has happened over long periods of time and for that reason the Committee believes that maximum use should be made of natural analogs. We've had some concern in our Subcommittee as to whether the natural analog studies are moving along as rapidly as they should. We don't have a strong feeling about that, but we sense that here is some very useful information and we should move quickly to make use of it.

COMMISSIONER ROGERS: Is there any systematic way of looking for natural analogs? In other words, are we just using what happens to have turned up so far that people are aware of?

DOCTOR MOLZ: I think that so far we are using what has turned up, and there are several fairly

well-known locations now.

COMMISSIONER ROGERS: Yes, I'm aware of that.

DOCTOR MOLZ: I don't know if there is a search going on, a planned search for more natural analogs.

Do you know anything about that?

DOCTOR TURCOTTE: Ore deposits are the natural place to look. Obviously, we're always looking for ore deposits.

DOCTOR MOLZ: I think still they're discovered sort of along the way, but I think we have some good natural analogs. I'm thinking now of the Peña Blanca site as one of them and of course that is being studied.

Again, getting back to the key technical uncertainty approach, in order to further define some of these the studies that are going on have been broken down into six areas that I'm just going to briefly mention.

Area number one is containment and a key technical uncertainty there relates to corrosion.

Area two is all the questions relating to the engineered system, exactly how this should be designed and how it should be sealed, how it will

respond to seismic events.

Pretty much, we think we have the expertise to handle those kinds of problems, the engineered system problems described under these two areas. For one thing, you're dealing with a 300 to 1,000 year period rather than 10,000 years as a minimum and those kinds of problems are things that we have dealt with in the past, but not over that time period.

The remaining four areas relate more to the natural system.

Hydrology, and here I don't make an exhaustive list but property measurement on a large scale is an area that is very difficult to handle.

Climate change, we're aware now and have become more aware over the last five years of the potential for climate change. In my own opinion, we don't know which way climate change is going to go in the future or if it's going to go. It could get warmer or it could get colder either way, so there's a lot of uncertainty there. And again, when you see a lot of uncertainty --

CHAIRMAN SELIN: Why do you say that? I thought it was -- a fairly naive view, I thought the idea was that we're coming into another ice age. Is

that not so obvious?

DOCTOR MOLZ: You're thinking it will tend to be colder?

CHAIRMAN SELIN: Right.

DOCTOR MOLZ: Well, I think in the climate change area, as caused by greenhouse gas accumulation, the view there is that things are going to get warmer and that's where a lot of the recent information has come about. Within that group there is -- I'm reasonably sure it's a minority of people that feel that if we continue to warm the paradoxical effect would be to flip us towards an ice age because it seems like something like that's happened in the past.

Between various glaciations it gets warmer and then something turns it around and you have another glaciation and my personal opinion is that it is the more likely scenario. Even if we do warm greenhouse gases, the response of the climatic system will be to switch to somehow absorb that and to make the climate colder. That would have to be viewed as speculative, but I think the point is we don't really know.

COMMISSIONER REMICK: I've actually recently read a report that shows a decline, an increase from the 1800s going up, but in about the

last 50 years indications going down in some areas. So there is some documented evidence that perhaps that's occurring, but I agree it's questionable.

DOCTOR MOLZ: And some very recent data indicating climatic oscillations at the end of the last glaciation, which again lends some support to this flipping theory. By that, I mean that you had very major changes in climate over a period of a few years. The climate actually was unstable for a while before it dropped into its current more stable phase coming up to the present, but that's just to get an idea of some of the problems of dealing with the natural systems.

Then we have geochemistry and absorption, ion exchange. Questions are very important there, how the temperature of the repository will affect the chemistry. There haven't been too many experiments studying that type of thing.

The geology relates to earthquakes and tectonics that occur in the area and also volcanic processes. For the first time, we're facing the study of these kinds of things and then trying to anticipate or project what may happen over an extended period of time.

And then finally, the performance

assessment part is supposed to bring all this together.

Now what can the Committee say in a few words that might be of some use in dealing with this overall problem?

First of all, we might observe that the iterative performance assessment philosophy seems to make a lot of sense, that you keep trying to assess. You identify more key uncertainties. You do more research. You try to assess again. That has a nice long-term stability to it and we think that is a good approach.

Given the advances that we're having in molecular biology and genetics, we think there's a good chance that small releases of radionuclides won't be of much concern in the future. And by that, we mean 100, 500 years, something early in the lifetime of the repository. There's a good possibility that current concerns of small exposures to radiation are way over-blown and our ability to deal with these problems are increasing, so the Committee suspects that this will not be a major future concern. It's more important to eliminate possible blunders in the whole deal.

I can also observe that a lot of our

current concern relates to small slow movement of radionuclides, releases that would probably be small and slow, many, many hundreds or thousands of years in the future. It may be that that will not be a long-term concern.

It's likely that the mathematical modeling approach is not going to be able to give the kind of objective answers that people would like to have and that we'll end up evaluating the natural system and to some extent the engineered system based on engineering judgement. What implications that has for licensing is not at all certain, but it may be that it could move the NRC towards considering shorter-term licensing rather than one licensing for the entire 10,000 year period or whatever that ends up being. We could change opinion in this area as these models that people are attempting to use evolve, but, given the uncertainties, trying to be objective with the computer model, I'm not sure that that will provide the kind of information everyone will agree on anyway.

If we had to identify one most serious concern relating to a repository, it would be the potential for direct volcanic disruption. That would be an example of a blunder. You'd almost want to do anything rather than have something like that occur.

One other concern, I don't think we've studied this in any depth, but a lot of studies I've read about the operations of things that are potentially dangerous, and you're looking for possible or probable failure mechanisms, it relates to human intrusion. That's another thing that I think has to be considered carefully. If you had a war sometime in the future, somebody might want to bomb your repository. Certainly, Saddam Hussein torched the oil fields. We didn't think about that when we built the oil fields. I don't think there was a lot of thought about it, but those kinds of things in many cases have higher probabilities than some of the natural types of disaster.

As far as the existing research program is concerned, we feel that it's balanced. It certainly recognizes the basic problems. The context within which the research is being planned, and there's been a lot of attention given to that in the last year, seems quite logical to us.

The right questions are being asked and I think discussed in our meetings and we don't see major problems with program management. We seem to have open discussions. Nothing seems to be out of bounds as far as a topic for discussion in our meetings.

People seem to be frank and open. So I see a difficult problem, but I don't see any major reorganizations or even minor ones, I would say, that are needed in order to handle it.

I might just mention some of the environment within which the research is being done that adds some difficulty. Often the research is driven by regulations and so if regulations change programs can suddenly be changed, extremely difficult to anticipate what to do in something like that. And of course, in our society there's a tremendous amount of controversy and misunderstanding mixed together concerning this whole question. That also makes the research difficult because people are emotional about results.

So that more or less completes my introduction.

CHAIRMAN SELIN: Professor Molz, perhaps it's your extraordinary candor, but I had the impression, not when you were talking about the importance of blunders and some of the common sense ones, but getting to the more technical points that it could almost have easily come out the other way in a lot of these questions, whether the earth is getting warmer or colder, whether -- is your Subcommittee

pretty much of one mind on these questions or if somebody else had given the presentation would it have come out quite differently?

DOCTOR MOLZ: It's a controversial subject. The experts disagree. The greenhouse effect people are very focused on warming and having that be a major problem. The reason I bring it up is that, if you were going to put some kind of climatic boundary conditions on your models to try to determine how the system is going to respond to the radionuclide releases, which one do you pick?

DOCTOR ISBIN: Was your question directed to whether another member of the Subcommittee giving the same report, is that what you asked?

CHAIRMAN SELIN: Yes. Not on the sort of general "program is well-run," but some of the technical points you were making. Is there controversy within the Subcommittee as to whether temperatures are going up or down or do you --

DOCTOR ISBIN: This has not been a factor. We have reviewed with Research what efforts they have on climatic changes. We have not placed any personal interpretations on that information or personal interpretations on the outcome of some of these very complex problems.

We've tried to recognize, as Fred has indicated, that the iterative performance assessment is a long process. It's a complex process. It requires extreme care, and this is where the Committee is trying to focus its attention on just how this is being done.

CHAIRMAN SELIN: This is illuminating. It turns out I know even less than I thought I knew.

DOCTOR MOLZ: Well, we do. We all do.

COMMISSIONER ROGERS: I wonder if you could say something about chemistry. You made a comment in your December report. Your last point was that a great deal of chemistry is involved in the high-level waste program and the closing sentence of that little paragraph was "the chemistry base may be in the program, but it was not apparent to the Subcommittee." I wonder if you could clarify that remark.

DOCTOR MOLZ: Yes. One of our members was particularly concerned with that.

Perhaps you would be best qualified.

CHAIRMAN SELIN: Come up to one of the microphones, please. There's a mike at the lectern, if you care to use it.

DOCTOR VOGEL: I didn't have in mind

giving a lecture.

My name is Vogel and the thrust of my comment was simply that the presentations were not presented from a context of being concerned about the chemistry involved. Now it may have been there and was not made apparent to us. I think we should follow-up on that.

COMMISSIONER ROGERS: Well, does that suggest that you think that we perhaps aren't paying enough attention to the chemistry in our research program?

DOCTOR VOGEL: That certainly is my suspicion. It's not apparent, but I'm not sure of it.

COMMISSIONER ROGERS: Well, I think it would be helpful to us if when you pick up on something like that whether you might be able to pursue it a little more deeply, because we will pay attention very much to what your conclusions are.

DOCTOR VOGEL: Thank you.

DOCTOR ISBIN: I think in that context, Dick, you were interested in not only uranium transport but the specific isotopic transport of constituents which might be of more interest.

DOCTOR VOGEL: That's correct, and there seemed to be some focus on, for example, the transport

of uranium which does not seem very interesting. On the other hand, the uranium is there so it's rather easy to do. When we start talking about the transport of plutonium, I guess it would be a very sticky experiment but more important.

COMMISSIONER ROGERS: Well, I guess what I'm interested in is whether we have the capability of looking at that, the in-house capability of seeing that the research that would have to be done there is done and done well.

DOCTOR MOLZ: And the comment also related to the content of the presentation. As I remember, it did not relate -- it wasn't clear to us whether this was left out of the presentations or if it was out of the research program and so it was put in there for that reason also and we didn't follow it up beyond putting it in the Subcommittee report.

COMMISSIONER ROGERS: Okay.

COMMISSIONER REMICK: You mentioned that if the regulations change the type of research that might have to be done might change. Have you given any thought that if, say, the National Academy of Science came out recommending a risk-based approach or a dose approach whether some of these questions will be easier to answer? On a risk-based approach, would

the concern about volcanism perhaps recede, the probability of a particular site having a volcano?

DOCTOR MOLZ: I think a risk-based approach has a lot to say for it, because when you come right down to it you're always going to have to accept some risk in anything that you do and I don't know if we've really studied the problem in depth enough to really answer how we would respond to something like that.

COMMISSIONER REMICK: In your reports you indicate that something to the effect -- yes, a substantial increased funding of waste management research, but you weren't specific of where you thought we should be specifically putting those funds. Now you mentioned a lot of areas in your discussion today, but what would be your priority? And if we weren't able to do that, would you see us becoming on the critical path, the NRC coming on the critical path of the licensing of a repository?

DOCTOR MOLZ: Well, it's sometimes hard to separate in your mind the difference between designing and justifying a repository versus evaluating the license. When researchers talk about the problem, they almost always mix those two things together.

Certainly this question about property

measurement is an important one, especially when you're dealing with an unsaturated type of material. It's among the most difficult materials to measure hydraulic and chemical properties of, but, at the same time, you could make the argument that that would be the DOE responsibility because that would be the information needed in order to justify the application for the license and that kind of work, which involves field work, is very expensive.

I guess, basically, without more detailed study, I wouldn't be prepared to say where more money ought to be spent. It's not something I've honestly thought about.

COMMISSIONER REMICK: Well, was the Committee recommendation addressed to NRC research or research in general, DOE and NRC? I assumed it was a substantial increase in NRC research.

DOCTOR MOLZ: It should have been NRC.

COMMISSIONER REMICK: That's what I assumed it was.

DOCTOR MOLZ: Which report was this? Was this a Subcommittee report or one of our main reports?

COMMISSIONER REMICK: That I don't remember. It's one of the reports that --

COMMISSIONER ROGERS: I remember the

statement. I don't remember where it was, though. I think it may have been in the main report.

DOCTOR MOLZ: Yes. I didn't think it was in our -- and so, that would have gone beyond just the waste program.

COMMISSIONER REMICK: No, this was waste. I have it somewhere in my book that I read.

DOCTOR MOLZ: The one thing that we urged more rapid attention be given to was the natural analog studies and they would be somewhat expensive. Again, you're in the field.

DOCTOR MORRISON: Commissioner Remick, that is in our 1 October '92 report where we make the statement. "NSRRC questioned the sufficiency of funding for the waste management program and suggests that NRC consider a substantial increase in research efforts."

COMMISSIONER REMICK: That's it, yes.

DOCTOR MORRISON: And that was tied to the priority that we assigned to waste management as a key item within the NRC program.

COMMISSIONER REMICK: Well, it would be helpful, if that's the Committee's view, to know the priority items, what items you think specifically need additional NRC attention.

DOCTOR MORRISON: We'll address that in future reports.

CHAIRMAN SELIN: Thank you very much, Professor Molz.

DOCTOR MORRISON: Let's turn to the final subject, then, which is the aging research, and Sol Burstein.

MR. BURSTEIN: If you do all of these things, of course, and do them well, we can guarantee you an old nuclear facility.

We've already talked a little bit earlier about the adequacy of the organization and the improving and good skills that most of the people that we've at least talked to have exhibited in the areas of expertise necessary to discharge the staff's responsibilities.

We talked about the funding and the emphasis as being adequate for those programs that are currently identified. We recognize that there is some potential for programs that people are talking about that have not yet surfaced to be matters perhaps from regulatory to research concern. They will perhaps require additional funds if the closures that we anticipate occurring within the next few months and years are not matched equally by the increases.

The important observation that our Committee came to was that there was no aging phenomena that we could identify that was particular or specific or special, I won't use the word "unique," to the licensing renewal activity or process and I think the Commission has done a great service to all of us by separating this out in its recent letter and setting up proposed workshops and handling of these issues. That helps very much in clarifying what had been a potential difficulty in dealing with an issue, this whole phenomena of age degradation, which we feel has its greatest value or impact of this research in its effect on operating plants. These are the plants who are going to feel it soonest and most serious and of course of which we have yet to see some of the results implemented in maintenance activities, and again I think the Commission has addressed that.

I think the staff is paying attention to both our comments and certainly yours and we expect to see some more definitive results. Things like environmental effects such as you've identified, we have talked about fatigue and equipment qualification, again those are being placed in the right categories.

There are problems associated with communicating between -- communications between the

staff, its approach to age degradation concerns, and we have urged more reliance on workshops and meetings and the inclusion of aging impacts or effects in probabilistic risk assessment activities so that at least we have a guideline on how to do those and not have to do them twice.

Details, of course, of all this are available to you in what we have already sent you and we'd be glad to respond to any further comment or question you may have.

CHAIRMAN SELIN: May I ask you a question?

The aging research that we've done has been more or less tied to materials or to specific processes, what happens to certain kinds of metals that are exposed to neutron flux over a while, et cetera. There's a much more complex system which ties in with -- you have an underlying aging process, but there's a refurbishment and a maintenance process. How close do you get back to the original condition when you try to control aging? Is there any research done or doable that has to do with the impact on a complex body if there is maintenance being performed on parts of that body as time goes on, not in the physics but the systems area?

MR. BURSTEIN: This is a very sensitive

and important area and our attention to configuration control in trying to make sure that we understand the design requirements of the system, how it has been modified over time and how we maintain control and integrity of that system by any changes we make, we've alluded to this already in our discussions on advanced instrument and control systems. Because, indeed, it's a lot easier to tinker with an electronic or computer program than it is with a hard-wired analog system as an example, and the idea of how to maintain or the need to maintain the integrity of those systems is occupying a great deal of attention.

To my knowledge, we're not doing any new research work within RES in that area, but have already demanded certain adherence to configuration control requirements.

CHAIRMAN SELIN: I'm not sure that the answer exactly answers the question. Maybe I didn't ask it right, but, when you have a complex organism like a human being and the cells are replacing each other or an airplane where you're replacing panels and you're replacing fasteners, et cetera, but some parts cannot be replaced or some damage is done, is there any research that's done to try and look not at the aging of the components but the aging of this overall

organism or this overall system as the parts are being refurbished and aging is being partially replaced among these parts?

MR. BURSTEIN: I don't know of any research that addresses the aging, as such, of the system. There is a great deal of specification and criteria regarding the function of a replaced or maintained or modified system. That may cover the aging phenomena as well, but it is not specific to that, to my knowledge.

CHAIRMAN SELIN: Do some of your colleagues have something?

DOCTOR BUSH: My name is Bush.

There is work not only in this country but elsewhere. Now, you have to take bits and pieces, some of the code approaches that Sol referred to, as an example, where you have an iterative process. You examine, you modify, you correct a problem and effectively you have changed what I'd call its "predicted life path" by so doing.

This has also been investigated from a probabilistic point of view. In fact, there are risk-based studies that are looking at this particular concept. They have actually looked at this. You have to recognize that almost every reactor out there is

not the way it was built originally. There's a great deal of change in that and in essence you have a whole series of life scans on there. Some of these, probably the more comprehensive studies I'm aware of, are in the risk-based area which have been going on now related directly to nuclear for about three and a half to four years. In other areas there are similar studies.

DOCTOR SHAO: Our research program, aging research program, is very comprehensive. It includes major primary pressure components such as reactor vessel, steam generator and piping. It also includes most important electrical and mechanical components.

Now with the components we also include 20 major systems, also including containment and major structures, so essentially we are looking at about one-quarter of the whole plant. And in the process we also look at the replacement, the refurbishment, whether the replacement criteria, refurbishment criteria of every component is sufficient or not sufficient. So essentially, we are looking at the most important components of the nuclear power plants.

COMMISSIONER REMICK: It's my impression that in the nuclear area internationally that the NRC probably has sponsored more research in the area of

aging than other comparable organizations internationally. Is that a correct assumption?

DOCTOR SHAO: I think that's correct, yes. It's because of our program that the IAEA wanted to start an aging research program. Our program started in about 1985 and some of the programs even started earlier like the HSST program. But right now, I think the whole world has some kind of aging program now.

COMMISSIONER REMICK: Incidentally, you should identify yourself for the record, Larry.

DOCTOR SHAO: Larry Shao, NRC staff.

MR. BURSTEIN: Of course, we all recognize that there are many other licensing bases adopted by other nationalities than what governs in the U.S.

COMMISSIONER REMICK: Yes.

CHAIRMAN SELIN: Doctor Morrison, thank you very much.

The sweep of the discussion was really quite astounding. I would like to, in addition to asking you to follow up on a couple of the specific questions that either the Committee raised or that were raised by one or the other of the Commissioners, is to try to in addition keep track of these broad questions.

The questions that come up are always the

same ones. Are we doing the right things? Do we have roughly enough resources to do what we're doing? Are the skills of the staff and our contractor base keeping up with the changes in the needs that we have? Are we getting ahead of the problems or are we trying to catch up to the problems? Are the skills of the Committee consistent with what we're asking you to do?

As you look at these issues over time, it would be useful if you could update us on the broad questions as well as the specific individual questions that come up.

DOCTOR MORRISON: We'll be very pleased to do that, Chairman Selin. Unfortunately, the fun things for most of the Committee members are getting down in the trenches with regard to the technical issues. You raise those very tough management issues which are much more difficult to deal with.

CHAIRMAN SELIN: They look pretty technical to me.

COMMISSIONER REMICK: Just a couple questions.

Several times in the past the ACRS tried to answer the question of what is a minimum amount of research funding that the NRC needs to maintain a viable program? On each of those occasions when it

tried, it ended up saying, "Well, if it goes below where it is now, it's viable." I guess I'd call that a cop-out, but I noticed that in your report you basically said, "Well, that is a matter which the senior managers and the Commission should decided. However, if it goes below where it is now, why, it becomes dangerous." I wouldn't want to call it a cop-out in your presence, but it is a very important item and I don't know how to address it.

Have you come up with anything better in your consideration of that because the amount of research funding basically does go down. You consider inflation and so forth. I know that true researchers are never finished with a subject, particularly basic researchers. There's always something else they want to know. So, it is important to close things out. Yet there are certain areas that if we didn't continue the research efforts year after year when we needed the answers, we couldn't get it because there's nobody else interested in doing that work. So, one has to look at sacred cows. Have you identified any sacred cows in the research programs that perhaps time has passed and we should consider phasing out so that we can continue others or start new ones?

I was a little disappointed, I must admit,

but I understand because I participated in ACRS efforts to try to answer the same questions and it's very difficult. What besides what you had in the letters did you come up with, if anything?

DOCTOR MORRISON: Well, we certainly did not come up with a new methodology that would give you a definitive answer easily. You obviously recognize that there's a number of dimensions in that particular problem and they're very much time dependent and even the horizon dependent are looking at the waste program, which has a very long horizon, or if you both look at a plant life extension which may hit us in the next couple years if we don't have the technical basis to address those.

I think one of the tougher issues that we've talked around a lot, and I mentioned it briefly in my overview remarks, is how much research does NRC need to do to preserve the independence of its technical capability versus being able to rely on the industry itself to bring forward information? That came to a head when one was considering some of the advanced reactor containment studies, whether Westinghouse and the Commission could get together and do experiments and that was apparently ruled out on non-technical issues, policy issues, and that would

affect the budget.

So, there's a policy driver in there which the Committee can come up only so far on being able to estimate it from a technical needs standpoint to eventually get into the policy decision.

DOCTOR TODREAS: I'd like to answer that by giving you a perspective, because I can go back to when the Committee started. From that sweep, we really went through a time when the budget was decreasing rapidly. We as a group really stayed away from the idea of becoming an advocacy group for the NRC research budget. We were really much more focused on looking at the excellence of the work. So, sacred cows effectively went their way because of the trend of the whole budget. If we had felt, and we talked about this a great deal over the last six years, that we were really going below in a critical area, we weren't bashful or we wouldn't have been bashful. So, that's still on the table and I'd say we welcome the opportunity. I gather from all of you you want to hear about that.

COMMISSIONER REMICK: Absolutely.

DOCTOR TODREAS: And maybe our credibility is high because we haven't really gotten on the bandwagon of always calling issues.

The other thing that perhaps -- I wasn't the one who raised it, but has come up recently is we're really more attuned to really checking the efficiency and the effectiveness of the program.

COMMISSIONER REMICK: Quality? I hope so.

DOCTOR TODREAS: Well, yes, that too, but that's always been on it. But now we realize things are tight and we really want to make sure everybody is squeezing the right results out of the dollars. So, that's a little bit higher on our minds than feeling right now there's a problem because the bottom is falling out.

COMMISSIONER REMICK: Well, in a related area, we certainly are concerned about maintaining our own in-house expertise. One of the things that we hear back from the Office of Research when it comes to the question of authorship of articles or greater technical involvement in managing the research that basically research staff is understaffed from the ability to be fully involved from a technical standpoint and they're overburdened with a lot of administrative duties associated with supervising the research and so forth.

Does the Committee have any observations in that area or any recommendations of things that

might be done so that the staff would have that time to maintain their own expertise and competence in their areas of specialty and not just become program managers that we've seen some agencies in town go to? Have you looked at that at all or do you have any observations about it? I'm saying this not in any sense to be critical of the stuff, but in an effort to be helpful to them so that they can do the things that they feel they need to do to maintain their expertise.

DOCTOR MORRISON: Well, I would make an observation from my own personal experience in research organizations for my entire career, none of which that were academic-based organizations that really advancement and career depended upon outside publication. I think you have the same sort of situation that exists within the Nuclear Regulatory Commission. There isn't a need to publish in order to be able to get tenured professorships. So, publication always tends to come to the bottom of the list. One is busily doing the research and unless there is a need for the publication, one simply is concerned with getting the results and moving on to the next particular project.

So, there are a number of institutions that I think have good technical reputations that have

not published at all. So, I wouldn't really look at it as a black mark against the NRC staff for not publishing and I don't think there's any way to eliminate the administrative burden that the managers within NRC's program have to fulfill in order to complete the research program and to make sure that it's well managed. I think that should take precedent, in my own mind, to publication.

That's a very personal observation.

COMMISSIONER REMICK: How about continued development? Should that be an expectation of people in the Office of Research, continued professional development, personal development?

DOCTOR MORRISON: Absolutely. The half life of technical skills is extremely short. If one is going to continue to be able to be productive, even in the management of research, professional development is, in my mind, much more important than simply publications.

DOCTOR ISBIN: In one of our earlier full Committee meetings we tried to address this. I can't give you the date of that report, but it's there.

COMMISSIONER REMICK: What was the result?

DOCTOR ISBIN: Well, just that there should be greater emphasis -- the Committee thought

there should be greater emphasis on development and the research staff tried to give us a few examples of what they were doing. Naturally I think our conclusion was they could do more.

DOCTOR TODREAS: I'd add I think one of the greatest impetuses for their professional development is the kind of questions you asked them and review with them because if you have a discussion like you've had with us, it's a technical discussion and I think the existence of our Committee in the way we've operated with them has also been an impetus to them to maintain technical capability. In the real world, with the interactions they have, that's probably what propels the technical motivation.

COMMISSIONER REMICK: Yes, I agree.

CHAIRMAN SELIN: Thank you very much, folks.

DOCTOR MORRISON: We appreciate your invitation and the time you spent with us. Thank you.

CHAIRMAN SELIN: Thank you.

(Whereupon, at 4:14 p.m., the above-entitled matter was concluded.)

CERTIFICATE OF TRANSCRIBER

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

TITLE OF MEETING: BRIEFING BY NUCLEAR SAFETY RESEARCH REVIEW COMMITTEE

PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: JULY 8, 1993

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

Carol Lynch

Reporter's name: Peter Lynch

7/1/93

SCHEDULING NOTES

Title: Briefing by Nuclear Safety Research Review Committee (NSRRC)

Scheduled: 2:00 p.m., Thursday, July 8, 1993 (PUBLIC)

Duration: Approx 1-1/2 hrs

Participants:

NSRRC

- Dr. David Morrison (1) Chairman
- Dr. Neil Todreas (2)
- Mr. Edwin E. Kintner (3)
- Dr. Herbert Isbin (4)
- Dr. Fred J. Molz (5)
- Mr. Sol Burstein (6)

Other attendees

- Full Committee

Speaking Topics:

(1) Overview of NRC Nuclear Safety Research

(2) Advanced Reactor Research

(3) Research on Advanced Instrumentation and Controls and Human Factors

(4) Severe Accident Research

(5) High-Level Waste Research

(6) Research on Aging of Nuclear Power Plant Systems, Structures, and Components

BRIEFING PACKAGE

COMMISSION MEETING WITH

NUCLEAR SAFETY RESEARCH REVIEW COMMITTEE

July 8, 1993

Contents:

Three recent NSRRC Reports: Letters from D. Morrison, Chairman, NSRRC, to E. Beckjord, Director RES, dated October 1, 1992; November 16, 1992; and February 10, 1993

UNITED STATES
NUCLEAR REGULATORY COMMISSION
Nuclear Safety Research Review Committee
Washington, D.C. 20555

1 October 1992

Mr. Eric S. Beckjord
Director
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Nuclear Safety Research Review Committee's Response to Chairman's Questions, 30 April 1992

Dear Mr. Beckjord:

At its meeting in Rockville, MD on 29 and 30 April 1992, the Nuclear Safety Research Review Committee (NSRRC) addressed two topics, advanced instrumentation and control (I&C) systems, and the questions raised by Chairman Selin when he met with the Committee on 25 November 1991. This letter contains NSRRC's response to four of the Chairman's five questions. The fifth question on how well the NRC is addressing advanced I&C issues is addressed in a separate letter that comments as well on the discussions held with the RES staff on 29 April 1992. A general introduction to the role of research within NRC is followed by a response to the four questions.

Role of Research in NRC

In its 21 December 1990 report to you, the NSRRC responded to a request from the Executive Director for Operations to consider what the strategy and content should be for a research program designed to meet NRC's essential regulatory requirements. The committee noted that the NRC nuclear research program has three main purposes: (1) to provide information and independent expertise for making timely regulatory judgments; (2) to anticipate problems of potential safety significance for which new or

expanded knowledge can assist NRC in pursuing its mission; and (3) to develop the regulations and guides necessary to implement Commission policy or technical requirements. In addition, NSRRC concurred with the Office Directors that NRC's research program should include the following requirements:

1. Provide technical bases to confirm safety margins assumed in regulatory decisions.
2. Lead to the timely resolution of generic safety issues.
3. Develop requirements for new technologies, such as digital instrumentation, and new areas being placed under regulatory oversight, such as waste and advanced reactors.
4. Develop new and improved methods of safety analysis.
5. Maintain technical capability to deal with regulatory issues as they arise.

Since the mission of the NRC to ensure safe design, construction, and operation of the nuclear facilities and activities it regulates is unchanged, the above statements of purpose and the requirements are the context in which NSRRC addressed the Chairman's questions.

Given the role of research within the NRC, the NSRRC has devoted considerable attention to the subject of the scope of the research program and the selection of activities within it. In its 11 August 1988 letter, the NSRRC noted the actions that NRC had taken to develop a cogent philosophy of safety research and reorient its safety program as recommended by the National Research Council (*Revitalizing Nuclear Safety Research*, National Research Council, 1986). This 1988 statement of philosophy still stands as the current policy of the NRC regarding its research program. The importance of integrating the research program with the needs of user offices was identified by the National Research Council and progress in achieving this integration

was addressed by the NSRRC in its letters of 11 August 1988, 11 August 1989, and 21 December 1990. The process appears to be working well and the research program is being directed to fulfill its stated purposes.

One of the most compelling statements in support of the role of research within NRC's mission is that made by Chairman Selin to the Subcommittee on Energy and Water Development, Committee on Appropriations, United States House of Representatives on 12 March 1992.

> The NRC's nuclear safety research program will continue to provide the independent expertise and technical information that we need to support our regulatory activities and to develop the regulations and guidelines necessary to implement Commission policy. Throughout the world, the United States has been the leader in the civilian use of nuclear energy. We have been viewed to be exemplary in the design and operation as well as in the regulation of nuclear power. This international recognition and respect have been due to the strong technical bases for our decisions affecting public health and safety. It is essential to maintain an adequate research base if the safe use of nuclear power is to be continued; within the Federal government this responsibility falls almost entirely on the NRC.

NSRRC concurs with the Chairman that it is essential to maintain an adequate research base to provide the independent expertise and technical information to support NRC's regulatory activities.

The results of NRC's research program have to a large extent led the Commission to adopt in 1986 two qualitative safety goals and two supporting health objectives (i.e., the risk to an individual of prompt fatalities is less than 0.1 percent of the sum of prompt fatality risks from other accidents, and cancer fatalities should not exceed 0.1 percent of the sum of cancer fatality risks from all other causes). These risk objectives can be translated into an upperbound frequency spectrum for a range of accidents with given magnitude of fission product release from the reactor containment. Through the research program, greater understanding has been gained of the initiation

and course of hypothetical reactor accidents, the magnitude of fission release, the transport mechanisms by which radioactivity is distributed within the reactor containment, the modification to design and operation to reduce the potential for accidents and the techniques to manage an accident if it should occur. Recognition of this knowledge base has now led the Commission to study risk-based reactor regulation, a concept the NSRRC encourages.

What is the right level of research that should be conducted by the NRC?

In the previous portion of this letter, NRC's policies that provide the context within which it conducts research were described. The question of the right level of research is, in the final analysis, a policy decision and must reflect the collective judgments of the Commission and its senior managers. Research needs set the scope and milestones for the research program; a detailed analysis of the funds necessary to address each tack over a given period of time is necessary input to this process. NSRRC can assess the right level of research only from a limited perspective since it has neither performed a detailed analysis of the cost, anticipated value, and need of each project in the current portfolio, nor has NSRRC directed the staff to present such an analysis to it.

However, a qualitative appraisal of the right level of effort can be inferred from several of the findings the NSRRC has reported from its meetings since it was established. In its report on research strategy dated 21 December 1990, "The NSRRC finds the research programs described in the FYP [FY91-95 Five Year Plan] consistent with the regulatory mission of the NRC, responsive to the needs identified by the user offices, and consistent with the research content described above." In the same report, the NSRRC stated that "[i]t would be difficult, however, to sustain a viable nuclear

safety research program to support the NRC if the current budgets are decreased." During its meetings in 1991 and 1992 that addressed the topics of advanced reactors, aging, waste management, and advanced instrumentation and control systems, the NSRRC has found no reason to change its conclusions with regard to the scope, content, and funding of NRC's research program. [See NSRRC letter reports to Eric Beckjord dated 31 May 1991, 30 September 1991, and 24 February 1992.]

Examination of past, current, and proposed funding for NRC's research program provides a useful background to examine the subject. Spending by NRC on research rose from $53 million in FY75 to a peak of $209 million in FY81, and has been at a level between $100 and $120 million (current dollars) since FY86. Actual and estimated research expenditures for FY91-FY93 represent about 22 percent of the total NRC budget. The Environmental Protection Agency which bears many similarities to NRC as a regulatory agency expends 26 to 30 percent of its budget in research. At this level, the NRC research budget would be about $140 million this year. This is an indication that NRC's research expenditures are not out of line, but possibly are low. While a downward trend resulting in a relatively constant NRC research budget might be anticipated as closure is achieved on significant issues relating to reactor safety, such as severe accidents and aging, the looming importance of plant life extension, the introduction of digital instrumentation and control systems in both existing and advanced nuclear power plants, new safety issues to be addressed in advanced reactors, and the need to deal with the long-term storage of high-level radioactive wastes argue for at least a constant budget, if not a moderately increasing budget for the next few years.

Approximately two thirds of NRC's research budget is directed to support user needs, with the remainder devoted to exploratory research, and the need to maintain

technical capabilities to address regulatory needs as they arise. The apportionment of the research funds in this manner is appropriate, that is, the majority of funds is directed at user needs. It is important, however, that NRC carefully track its expenditure against the user needs, plan and report its program in a manner that it is clear to all concerned that it is a user-responsive effort.

What are the three or four highest priority functional areas for research by NRC, and how well is the NRC doing in these areas?

The assignment of priorities for research involves balancing and weighting of a number of factors the most important of which are NRC's goals to be achieved through research; the time-dependent critical actions that must be taken by NRC; the ability to acquire, assimilate or adapt the technical base developed by other sources, particularly other federal agencies, to NRC's needs; the need to sustain or develop an independent technical resource for topics essential to the regulation of nuclear power; and the legacies implied or current commitments under research programs. Although the NSRRC has not exhaustively assessed these factors, through its review of the research program since 1987 and its knowledge of the major issues facing NRC and the nuclear industry over the next decade, NSRRC concludes that the following areas are the highest priority for research by NRC:

- Aging
- Severe accidents
- Waste management, particularly radionuclide transport, volcanism, and tectonics
- Probabilistic risk assessment to include human factors
- Thermal hydraulics

Rationale for the choice of these areas and a summary evaluation of how well NRC is doing is presented in the succeeding paragraphs.

Life extension of operating reactors is among the most important near-term regulatory issues facing NRC, and understanding and management of the aging process is essential to provide the basis for regulatory actions. Continuation of the ongoing research in this area is required to support the development of a risk-based set of criteria by component or system that an applicant must meet. While much of the technical base on aging of electrical and mechanical components can be acquired from sources other than NRC and the nuclear industry, the unique environment in which these components operate demands that NRC have an independent technical assessment capability. The NRC, through the March 1992 "Aging Research Information Conference," provided a very effective forum for the nuclear industry to become an active participant in the exchange of knowledge on aging that it has gained through operating experience and how it applies to the management of ongoing operations, as well as to plant license renewal. As noted in the NSRRC letter to Beckjord dated 24 January 1992, it does appear to NSRRC that research efforts are of high quality, but there is a concern that insufficient attention has been given to the closure of the research efforts, the manner in which results will or can be implemented, and to the future direction of the program. The detailed response by the RES staff that was transmitted to the NSRRC in the 13 April 1992 letter from Beckjord has not been discussed by the Committee.

In May 1988, NRC prepared an integration plan to close severe accident issues and identified technical issues of concern regarding containment performance and release of fission products in the event of containment failure. Technical research has been and is being conducted in this area to address issues that are unique to the

regulation of nuclear reactors and are not the domain of any federal agency except the NRC. A draft of NUREG-1365, Revision 1, Severe Accident Research Program Plan Update, has been released to the NSRRC. A report on the Committee's assessment that addresses how well NRC is doing in this area will be sent to NRC at a future date. At this time, however, it should be noted that the goals of the severe accident research program are to "complete all the major severe accident experimental programs within the next two to three years," and to achieve "closure of all severe accident issues ... in four years." Given the investments that have been made to date on severe accident research, that severe accidents remain an important concern in regulation, that confidence can be gained in the continued operation of existing nuclear power plants, and that the current research expenditures in this area are planned to cease within a four-year period, the NSRRC regards severe accident research as a high-priority target for NRC.

Waste management is considered to be a priority research area by the NSRRC since it is a priority area for the Department of Energy and for all of the nuclear industry and, thus, is a regulatory topic that must be addressed knowledgeably and decisively by the NRC. In its 24 February 1992 report, NSRRC summarized its views on NRC's high-level waste management program. The Committee notes that the Center for Nuclear Waste Regulatory Analysis is slowly reaching a critical staff size with well-qualified people, that the Waste Management Branch is staffed with highly-competent and experienced people, and that with the exception of volcanism and tectonics the research is addressing the key issues for pending regulatory actions. The volcanism and tectonics research program is well planned and under way. Important information should be produced rapidly during the next few years. NSRRC questioned

the sufficiency of funding for the waste management program and suggests that NRC consider a substantial increase in the research effort.

Probabilistic risk assessment has been and continues to be a priority research area for NRC and a later section of this report will address how well NRC is using PRA. Additional research is needed to incorporate aging issues into PRA for plant life extension regulation and to broaden PRA methodologies to include human factors in hardware and software design, verification and operations. It is likely that new conceptual approaches will be needed to verify that safety goals are being met and full advantage can be taken by the adoption of advanced instrumentation and control systems in existing plants and advanced reactors. The technical base outside NRC in the design and development of advanced instrumentation and control systems needs to be captured and used by NRC in its regulatory actions, and hardware and software risk assessments that encompass the human-systems interactions are a means for NRC to achieve these objectives. The Department of Defense for several decades has been using digital systems and safety-critical software in the area of nuclear weapons safety and security. NRC should seek to adapt the available technology and expertise to its needs.

Thermal hydraulics is a technical area whose applications to nuclear reactor safety are unique to the regulatory interests of the NRC, both in severe accidents and in the evaluation of advanced reactors. It is essential to NRC's mission and thus a priority for NRC to maintain technical competence in thermal hydraulics through its research program. The NRC has had a large research program in thermal hydraulics of light-water reactors for many years. However, since no other federal agency has the requirements for similar thermal hydraulics capabilities, and since collaboration between the NRC and the industry it regulates has been ruled out based upon possible

conflict of interest, NRC must maintain expertise in this area through its own projects or collaboration with universities, as well as with other countries. Further, NRC must achieve excellence in managing code developments and in obtaining thorough and disciplined code assessments.

What skills and research will NRC need for advanced reactors and will the skills or disciplines be fundamentally different from those needed for the current generation of reactors?

The skills and research needed by NRC for advanced reactors are fundamentally the same as those needed for existing plants and waste management, but the emphasis will be different in three areas. Evaluation of advanced (digital) instrumentation and control systems will require the acquisition of competence in digital systems and in software engineering, particularly the validation and verification of large, complex software systems requiring a high-level of fault tolerance. As noted previously, NRC's activities in PRA need to be expanded to include consideration of reliability and uncertainty of software and the possibility of human error. Because advanced reactors emphasize passive design features that employ lowhead, gravity-driven configurations, the technical emphasis in thermal hydraulics may shift significantly. A confirmatory research program to acquire the data and analytic tools required to make certification decisions on advanced light water reactor designs has been deemed to be necessary by the National Research Council (*Nuclear Power: Technical and Institutional Options for the Future*, National Research Council, 1992), and the NSRRC concurs with the recommendation.

How well is NRC using the results from probabilistic risk assessments to prioritize the use of resources by licensors and licensees, to address generic applications and to assess plant-specific situations?

NSRRC was impressed by the breadth of use of PRA throughout NRC based upon the briefing presented by Mark Cunningham. Although NSRRC is following the use of PRA's in the IPE and IPEE process, it is premature for the Committee to comment on the use of PRA by NRC and licensees on plant-specific applications. The recent establishment of a working group to address the consistent use of PRA by NRC is commendable and NSRRC looks forward to the report on this activity. The risk-based approach is obviously in the embryonic stage and its implications on the research program are not yet known.

It does appear that PRA has been extensively and productively used by NRC to establish priorities within the research program, especially within the severe accident and aging research programs. Continued use of PRA to guide the research program is encouraged, as is additional effort by NRC to identify and refine uncertainty estimates in hardware components and systems that are infrequently called upon to operate (i.e., passive systems), in software, and in human activities that can intersect system operation. In a related methodology involving risk assessments, NRC has encouraged the development of Risk-Oriented Accident Analysis Methodology (ROAAM). ROAAM has been successful in characterizing steam explosions, is assisting the resolution of the Mark I liner failure issue, and may lead to resolution of the direct containment heating issue for Zion- and Surry-type containments.

The Committee would be pleased to meet with the Chairman to discuss, clarify and amplify these responses.

Sincerely,

David L. Morrison
Chairman
Nuclear Safety Research Review Committee

DLM/sje

UNITED STATES
NUCLEAR REGULATORY COMMISSION
Nuclear Safety Research Review Committee
Washington, D.C. 20555

16 November 1992

Mr. Eric S. Beckjord
Director
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Beckjord:

The Nuclear Safety Research Review Committee (NSRRC) met on 29 April 1992 at the Holiday Inn Crown Plaza in Rockville, MD, to discuss with the staff the Nuclear Regulatory Commission's (NRC) research program for advanced digital instrumentation and control (I&C) systems. At its meeting in November 1991, the NSRRC was asked by Chairman Selin to comment on the role of NRC in digital I&C research. This letter is the report of the April 1992 meeting and its answers to the Chairman's request on advanced I&C research.

The development of digital systems for nuclear power plant applications in the United States has lagged the rest of the world primarily because of perceived concerns about regulatory issues. The NRC needs to identify those issues that are important to safety and to develop criteria which, if met, will assure that NRC safety concerns are satisfied. Then, vendors and utilities would be free to meet these criteria by a variety of means. Areas where criteria are needed include, but are not limited to, hardware reliability, software verification and validation, electromagnetic interference (EMI), radiofrequency interference (RFI), and common mode failure.

NRC's role in advanced I&C research is to develop or acquire the technical basis to prepare regulatory criteria, methods, and regulations that will guide staff reviews of retrofits to operating reactors and its review and certification of advanced reactor designs. This role is clearly understood by the Office of Nuclear Regulatory Research (RES) as evidenced by the presentations made to the NSRRC. In addition to digital instrumentation, control and safety systems, and human interactions, RES needs to become aware of advanced technologies such as artificial intelligence, including but not limited to expert systems, neural networks, fuzzy systems, genetic algorithms, and chaotic systems. The approach that RES is following is driven by the major regulatory issues facing the NRC that are articulated in SECY-91-292, "Digital Computer Systems for Advanced Light Water Reactors," and in the 29 January 1992 memorandum from E. Beckjord to T. Murley, "Status of RES Support for NRR User Needs."

While NSRRC has gained a general understanding of the approach and general directions RES is taking through its discussions with the staff at this and prior meetings, detailed comments on individual elements of the program and current and planned tasks will be reserved until a subcommittee has had the opportunity to examine the program more thoroughly at a meeting later this year. One general and several programmatic issues, however, bear comment at this time.

In general, it appears that the funding allocated to the advanced I&C program, including human factors, is minimal given the long list of research needs. A careful evaluation of the milestones under the program plan against the timing for regulatory actions should be made to ensure that there is consistency.

First, regarding programmatic issues, it is clear from the NRC's documents and the presentations on 29 April that the staff is aware of the need to address the systems aspects of advanced hardware and software applications, such as the operability of the new digital equipment in the nuclear plant environment (e.g., EMI and RFI effects, component aging and performance degradation), increased data information content and data sharing potentially leading to common cause and common mode failures, programming errors necessitating comprehensive software validation and verification methods, and high-level discipline, including standards and criteria for the processes associated with the life cycle phases of design, manufacture, installation, operation and maintenance, and modification of the I&C system. However, it is not clear the extent to which the NRC appreciates the need to integrate the human (operator and developer) into the system along with the hardware and software components. The application of advanced digital systems in other industries and in foreign nuclear plants demonstrates that these support and improve operator performance. Such systems are also reported to improve the overall safety of the facility. Criteria to define what is meant by improved safety need to be established prior to undertaking major expenditures on function allocation research.

While software engineering and reliability are addressed in the research plan, much greater effort, investment and understanding of the issues and implications is needed to deal effectively with advanced I&C (e.g., software problems on the C-17 aircraft; GAO/IMTEC-92-48). Software cannot be seen as a fixed product; software engineering specialists point out that changes in deployed software due to bug correction, changes in functionality, and new functionality are substantial and continue for as long as the software is in use. Problems have arisen because side effects of software changes on other seemingly unrelated parts of the system produced surprising system consequences (e.g., Report on Network Outages by the Common Carrier Bureau, FCC, July 1991—a software error in a minor system upgrade that slipped through laboratory tests of the software led to certain side effects that contributed to six major outages in different parts of the U.S. phone network over three weeks; see also

the GAO report on the Patriot missile failure to intercept the SCUD that destroyed the barracks in Saudi Arabia—the software had not been planned to be used continuously as it was in unforeseen circumstances in Desert Storm which led the software to err in certain values and contributed to the failure to shoot down the fatal SCUD). In addition, software configuration control places a special burden on an operational organization accustomed only to hardware configuration controls. Regulating software systems involves understanding the life cycle of software: how will the organization manage change over the life of the software? From a systems complexity and reliability point of view, software is probably more like people than like hardware.

Second, NRC cannot and should not be the leader in research in this field of advanced I&C systems and the human factors aspects associated with them. It is essential that NRC be fully aware and able to adapt the developments and findings from closely-related work on the use of digital I&C systems in safety-critical situations within the aviation and defense industries, as well as within the Department of Defense, the National Aeronautics and Space Administration, and the Federal Aviation Administration. The considerable investments by these industries, as well as those by the nuclear system supply vendors and the electric utilities both in the United States and abroad must be captured by the NRC. RES has an awareness of these activities, but its plans to use this base of technology are not clear. A thorough study should be made of the experience of the Canadian utilities, vendors, and regulatory authorities with digital instrumentation, control, and safety systems, and an analysis of how their experience can be transferred to the U.S. regulatory environment. NRC must be much more aggressive in learning, integrating, and distilling work in these areas for use in nuclear power. Additional projects that involve the university community can be an effective window into experience from other fields and an additional source of innovation for the NRC program. However, in-house competence must be sufficient to deal with these inputs from a regulatory perspective.

Third, in SECY-91-292, it was stated that the staff intended to require some level of diversity such as a reliable analog backup to digital computer technology-based monitoring, control, and protection systems. Such an approach seems to convey a mixed message to the industry on the use of digital systems. The goal should be for industry to achieve the level of reliability and confidence in digital systems that will meet safety requirements and eliminate the need to consider analog backups. Again, a review of the Canadian experience with diversity using digital systems could be very useful.

At its meeting in November 1991, Chairman Selin asked for NSRRC's views on the question of how well is NRC addressing advanced instrumentation and control issues, which have fundamentally different failure mechanisms, common mode considerations, and software verification. The three points discussed above are in part an answer to this question. It is apparent to the NSRRC that a research plan is being

developed and that some useful projects are being initiated. It was not apparent in our review that NRC had accepted the fact that the conceptual basis for regulation of advanced instrumentation and control system is fundamentally different from analog systems and that the interaction of the human with the system commences with the earliest phases of the design of the hardware and software and evolves through development implementation and operation of the systems. A technology view emphasizes the requirements for accurate and reliable hardware and software to sense and react; a cognitive or use point of view considers how the measurement is made available to information processors and decision makers who need to make evaluations of the situation and decisions regarding them. Until a holistic concept is adopted that integrates the human into the system, it will be difficult for NRC to acquire the necessary expertise through its research efforts to support regulation in a credible manner. It is also recognized that the U.S. nuclear industry cannot leap instantaneously from traditional analog I&C configurations to fully-integrated advanced digital systems.

The successful development and application of digital systems to nuclear reactors requires that all participants, designers, vendors, utilities and regulators utilize a total system evolutionary but integrated approach.

Sincerely,

David L. Morrison
Chairman
Nuclear Safety Research Review Committee

DLM/sje

UNITED STATES
NUCLEAR REGULATORY COMMISSION
Nuclear Safety Research Review Committee
Washington, D.C. 20555

10 February 1993

Mr. Eric S. Beckjord
Director
Office of Nuclear Research
U.S. Nuclear Regulatory Commissic n
Washington, D.C. 20555

Dear Mr. Beckjord:

The Nuclear Safety Research Review Committee (NSRRC) met on 14 and 15 January 1993 at the Holiday Inn Crowne Plaza in Rockville, MD, to receive and discuss reports from its Subcommittees. Based upon its deliberations on these Subcommittee reports, the NSRRC recommended that, with certain alterations and additions to the drafts, these revised reports be accepted as a report of the Committee as a whole. These revisions have subsequently been made by the Subcommittee chairmen and transmitted to me.

Attached please find the following NSRRC reports:

- **Aging.** Meeting of the Subcommittee on Aging, September 16, 1992. Letter from Sol Burstein to David L. Morrison, Chairman, NRSSC, dated December 26, 1992, and revised January 14, 1993.

- **Advanced Instrumentation and Controls.** Meeting of the Subcommittee on Advanced Instrumentation and Controls, December 9, 1992. Letter from Ed Kintner to David L. Morrison, Chairman, NSRRC, dated January 28, 1993.

- **Advanced Reactors.** Meeting of the Subcommittee on Advanced Reactors, December 2 and 3, 1992. Memorandum from Neil Todreas to David Morrison, dated January 20, 1993.

- **High-Level Waste.** Meeting Report, NSRRC Waste Subcommittee Meeting, December 1, 1992.

Two additional items were addressed by the Committee. The first item was the proposed changes in seismic requirements for nuclear power plants. Following a presentation by the staff, and after considerable discussion by the Committee on January 15, 1993, a few changes were made to the Seismic Design section of the report of the Advanced Reactors Subcommittee meeting of December 2 and 3, 1992. As noted above, the Advanced

Reactors Subcommittee report with these changes was accepted as a report of the Committee.

The second topic was steam generator tube integrity research issues. Based upon the information presented by the staff and the Director of RES, the Committee decided that an entire meeting should be held to address this topic. The dates of April 28 and 29, 1993, were chosen. Participation and presentations will be sought by vendors, EPRI and specialists from universities as well as from the NRC staff and its contractors to assemble as much knowledge on the issues as practicable. Based upon the overall perspective which will lead to clarification of the problem, the NSRRC will focus on the research that is underway and planned by RES and assess its potential effectiveness. RES staff will develop an agenda for review by the NSRRC.

A meeting has also been scheduled for July 7 and 8, 1993, to discuss NRC's research and development portfolio and to readdress the questions posed to the Committee in April 1992 by Chairman Selin. Since this meeting and the meeting on steam generator tubes will involve the full Committee, further Subcommittee meetings will be deferred to the fall of 1993 at which time they will address a collection of individual projects with their investigators to develop information and analyses to assist the Committee in evaluation of the quality of the research that is being performed.

Sincerely,

David L. Morrison
Chairman
Nuclear Safety Research Review Committee

DLM/sje

Enclosures(4)

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January 25, 1993

Dr. David L. Morrison, Chairman
Nuclear Safety Research Review Committee
The MITRE Corporation
7525 Colshire Drive
McLean, Virginia 22102

MEETING OF THE SUBCOMMITTEE ON AGING
SEPTEMBER 16, 1992

Dear Dave,

Attached is the report of the Subcommittee on Aging covering its meeting of September 16, 1992. This report has been revised to reflect the discussions at the full Committee meeting on January 14, 1993.

At that time, a NSRRC meeting was scheduled for April 28-29, 1993 to review new developments in steam generator tube degradation of certain pressurized water reactors. In view of the detailed review of the current aging research program covered in the enclosed report and in view of this April meeting, the Subcommittee presently plans no further meetings in 1993. This will be considered again following the NSRRC meeting on July 7-8, 1993.

The Subcommittee stands ready to alter its present schedule should the need arise.

Sincerely,

Enclosure

Copy to T. Boulette
S. Bush
R. Uhrig
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December 26, 1992
Revised January 14, 1993

Dr. David L. Morrison, Chairman
Nuclear Safety Research Review Committee
The MITRE Corporation
7525 \ Drive
McLean, Virginia 22102

MEETING OF THE SUBCOMMITTEE ON AGING
SEPTEMBER 16, 1992

Dear Dr. Morrison,

This is to report on the meeting of the Subcommittee on Aging held in Rockville, Maryland on September 16, 1992 pursuant to notice in the Federal Register of August 31, 1992. All members of the Subcommittee, Drs. Boulette, Bush, Uhrig and the undersigned, were present together with NSRRC Member Isbin.

The enclosed Minutes of the Meeting were distributed to NSRRC members by DFO George Sege on October 5. These Minutes include the agenda that was followed and a full list of participants and attendees. The Subcommittee was particularly helped by the active participation of Director of Research Eric Beckjord.

The entire meeting was open to the public. However, no information was presented to the Subcommittee by members of the public during the meeting nor in the extended period provided for this purpose.

BACKGROUND

The purpose of this Subcommittee meeting was to expand the recent review of the NSRRC by focusing on the NRC current philosophy in respect to treatment of aging phenomena and on a specific example of how this philosophy was being implemented. The NRC staff selected the subject of nuclear plant valves for this illustration.

During his opening remarks, the Director of Research asked the Subcommittee to address the quality and relevance of aging research work presently underway, the issues related to closure identified by the NSRRC in its earlier review, and the emphasis on initial and extended license operating periods. The Subcommittee's responses to these items, as reviewed at this meeting, are contained within this report.

PHILOSOPHY

The staff presented a background description of the overall RES purpose and function, its approach to identifying proactive and reactive research needs, and the place of aging research within this structure. A comprehensive description of the organizations dedicated to the Aging Research Program was provided. The attached chart describes how the RES Engineering Division relates to other branches and institutions in carrying out its work in this area. The Subcommittee believes this arrangement should provide an effective structure assuring an interactive process for managing aging research.

The Subcommittee believes that the RES has given aging research appropriate and balanced emphasis that is relevant to user and industry needs. On several occasions, reference has been made to Nuclear Plant Aging Program funding limitations. The Subcommittee confirms the NSRRC conclusion that the necessary resources are being properly allocated to high priority issues, and in a manner to assure high quality work.

The Subcommittee is aware of the closure schedules identified in Enclosure 2 of Director Beckjord's reply to the NSRRC of April 13. It did not receive any further information in this regard. While several closure targets have been proposed for specific topics, the continuing influence of "new information" keeps extending these completion dates, suggesting that a more disciplined approach to these schedular concerns has not yet been effective. The Subcommittee concurs that as the present aging research programs are completed, it will be essential that RES maintain a level of awareness and competence to deal with future events. The extent of this maintenance level within the NRC and at six independent "Centers of Expertise" requires diligence to avoid excesses. The Subcommittee understood that these matters are receiving the personal attention of the Director and his senior staff and that the NSRRC will be kept informed of program evolutions toward a "maintenance" status.

The Subcommittee agrees that an appropriate strategy for RES includes the following:

1. Complete each research project per current schedule and estimated cost
2. Document the research results in appropriate reports
3. Assure results are distributed to users and industry
4. Maintain awareness and technical vitality

Significant time of the Subcommittee's review was devoted to the relationship of aging research to license renewal. Present aging research activities are said to be responsive to NRC rules on maintenance and license renewal. However, the Subcommittee was given to understand that the justification for much of the aging research program was based on the importance attached to aging issues as phenomena unique to license renewal. Indeed, it was stated that the aging research is largely funded under overall license renewal categories.

The Subcommittee did not express any position as to where these Aging Research Program efforts are identified or under which budget category they may appear. The Subcommittee directed its attention to the level and schedule of effort, the competence and pertinence of the program organization and scope, and the assurance that aging degradation mechanisms are understood and managed wherever and whenever necessary to maintain safety objectives.

Progress in the development of guidance for license renewal applications was described by the staff. Included in the draft regulatory guide DG-1024 are topics covering age-related degradation effects unique to license renewal. Despite substantial probing, the Subcommittee could find no instance where an age-related degradation concern was special, singular or specific to license renewal with the possible exception of components whose design life is 40 years or less. The Subcommittee believes that the greatest value will be derived from the aging research program if its emphasis and application is directed to resolving operating plant problems. A tendency to emphasize aging degradation in the context of license renewal does not appear to be sufficiently comprehensive and may miss issues of significance to current plants.

The NSRRC commented on the implementation of aging research results into operating plant maintenance activities in its February 24, 1992 report. The Subcommittee did not discuss the Director's reply of April 13 that cites some failures by utilities to utilize aging research results effectively. The Subcommittee believes such failures seem to be enforcement matters that should not affect the RES research direction. NUREG/CR-5643 Insights Gained From Aging Research dated March, 1992 presents a good summary of aging research results applicable to operating plant SSC's.

The staff presented a comprehensive description of the utilization of aging research results in rulemaking activities, the development of regulatory guides and the maintenance rule,

resolution of generic safety issues, implementation of generic letters and input to codes and standards developments. The Subcommittee believes these practical demonstrations provide strong evidence of the applicability of the Aging Research Program to manifold regulatory activities.

RELATED MATTERS - MAINTENANCE AND LICENSE RENEWAL

During the initial meeting session, discussions were also held on maintenance of primary system integrity, aging of structures and the identification of other systems and components requiring analyses of their sensitivity to aging degradation. As previously mentioned, the Subcommittee believes the present prioritized funding levels are appropriate, but suggests it may be prudent for RES to reevaluate its schedule for these license renewal issues in light of recent utility application delays.

Another significant discussion concerning the effect of age-related degradation on risk took place during the first session. SANDIA Report SAND91-7093 issued in February, 1992 critically reviewed three risk-related NUREG documents dealing with identification and prioritization of aging components, evaluation of core melt frequencies due to aging effects and licensing renewal rule analyses. RES provided to the Subcommittee a contractor's response to SAND91-7093 that would result in no change to the NUREG reports.

The Subcommittee did not pursue these differences between RES and SANDIA in detail but notes there are other areas where RES and others do not agree on research results or their interpretation. The Subcommittee suggests that RES give appropriate consideration to methods of resolving differing analyses.

The Subcommittee encourages RES to continue work on development of suitable risk assessments involving aging dependencies, particularly where directed toward reducing uncertainties in data bases. RES stated that for a nuclear plant having an effective maintenance program, the use of plant specific data in its Individual Plant Evaluation obviates the need to include age-related dependencies in its IPE. The Subcommittee concurs.

EXAMPLE

The Subcommittee agreed that the subject of nuclear plant valves was an appropriate example to illustrate how the NRC approach to effects of age-related degradation was being implemented, particularly for existing plants. The staff described the

importance of the 30,000 odd valves of varying designs and functions installed in operating reactors in the USA and presented a sampling of their operating histories. The Subcommittee noted the NRC methods of determining the importance of valve performance to safety rely on both risk-based and deterministic evaluations.

Results of RES valve research conducted mainly at ORNL and at INEL have established the technical bases for information bulletins, staff training materials and input to code/standards revisions. These are appropriate techniques to implement aging research results into current operating plants but their effectiveness needs to be evaluated in the future.

The Subcommittee received particularly detailed and vivid descriptions of check valve operating failures, analyses of their root causes, and development of inspection and diagnostic techniques to improve monitoring programs. A review of the motor-operated valve research programs at EPRI and at ORNL was also presented.

The Subcommittee concluded that aging degradation mechanisms affecting the primary pressure boundary are becoming well understood. This improving understanding allows for the establishment of realistic inspection and maintenance programs to avoid or minimize failures with potentially severe consequences. There appears to the Subcommittee to be adequate understanding by RES of the consequences of functional failures of components like valves. The Subcommittee is less confident that current proposals on how to determine and deal with such functional degradation due to aging will prove adequate.

While pursuing these activities, the staff has also become involved in addressing other valve problems, not related to aging effects, such as design deficiencies. Such revelation of related research needs are bound to occur and it is expected that RES would maintain its alertness to such findings.

The Subcommittee concluded that the valve research program is an appropriate and relevant response to observed valve operating problems and is faithful to the general philosophy in dealing with effects of age-related degradation mechanisms. The valve research work appeared to be of high quality.

ADDITIONAL OBSERVATIONS

The Subcommittee noted that significant discussions are taking place between NRC staff, industry and others regarding environmental effects, fatigue and other aging concerns. The Subcommittee encourages RES to continue these discussions and believes that most differences in expert judgments identified in these dialogues can be resolved by relatively modest additional research.

The RES staff reported briefly on its participation in some international aging research programs. The Subcommittee noted the existence of aging data from sources other than the nuclear industry in this and other countries. The inclusion of aging research results from these origins should prove technically beneficial and cost effective.

Discussions took place on the difficulties of communicating, coordinating and transferring information among the many participants concerned with age related phenomena. RES is encouraged to continue and expand its activities toward resolution of these impediments.

The Subcommittee understood that effects of aging are not required to be considered in current PRA's. The Subcommittee is concerned that such an omission may leave substantial gaps in risk analyses whose significance is not defined. The Subcommittee believes it is important that the NRC determine how aging degradation is to be treated in these assessments in order not to delay or repeat the analyses required of all plants.

The Subcommittee appreciates the substantial efforts expended by the staff and their contractors in making for a meaningful and comprehensive review of the subjects treated.

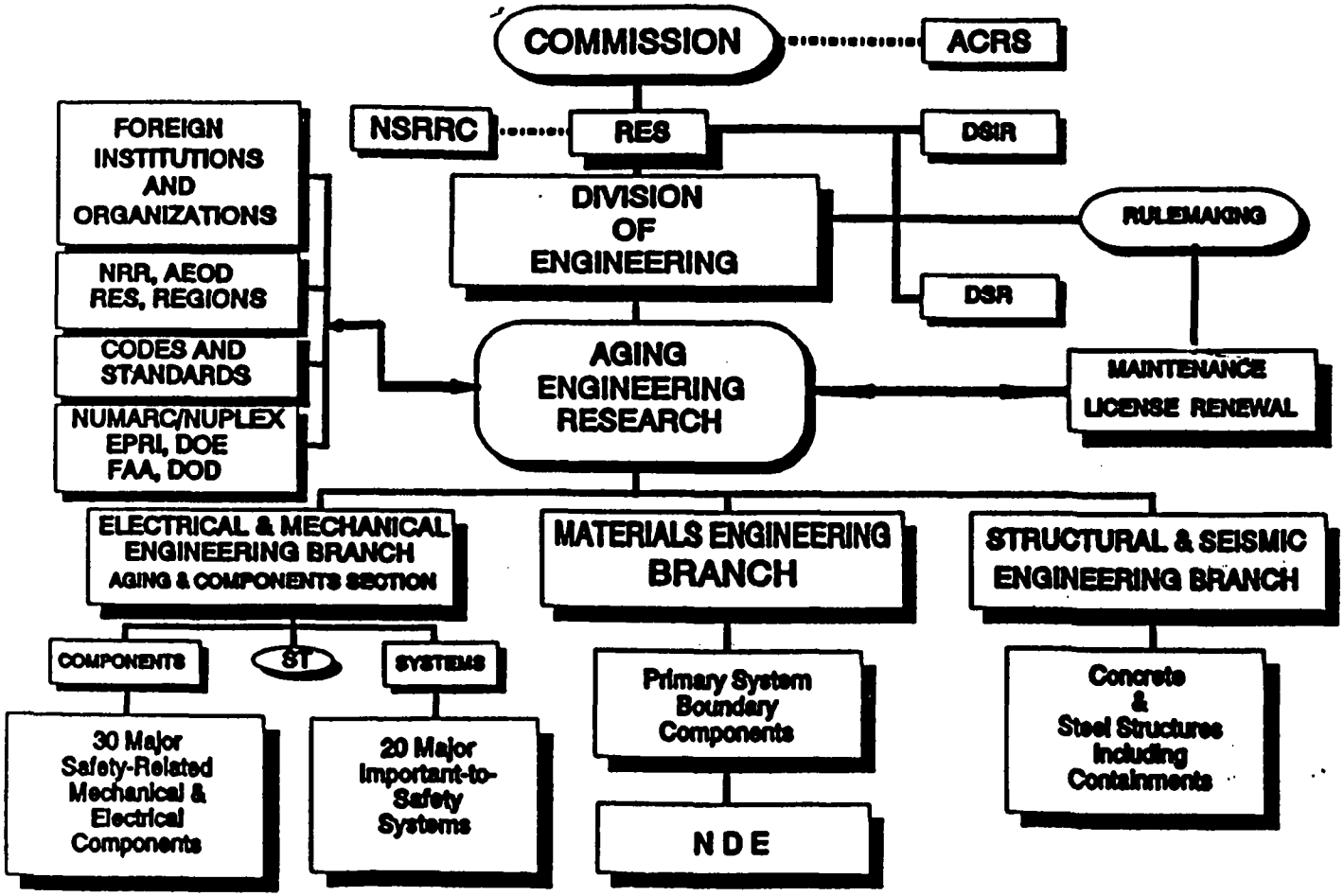
On behalf of the Subcommittee,

Chairman,
Member of the NSRRC

Enclosures

DE NUCLEAR PLANT AGING RESEARCH PROGRAM

AGING RESEARCH STRUCTURE



UNITED STATES
NUCLEAR REGULATORY COMMISSION
Nuclear Safety Research Review Committee
Washington, D.C. 20555

January 28, 1993

Dr. David L. Morrison
Chairman, NSRRC
The MITRE Corporation
7525 Colshire Drive M/S W766
McLean, VA 22102

Subject: NSRRC Subcommittee on Advanced Instrumentation and Controls and Human Factors Meeting of December 9, 1992

Dear Dr. Morrison:

The Nuclear Safety Research Review Committee (NSRRC) Subcommittee on Advanced Instrumentation and Controls and Human Factors met with NRC staff members on December 9, 1992, in Rockville, MD to review the RES program in those areas of research. This meeting was a follow-on to the discussions of the full NSRRC on these subjects on April 29, 1992, the conclusions of which were reported to you in my letter of November 16, 1992. The meeting was intended as a broad review of the programs and not to reach specific conclusions on individual programs. This is a summary report of that meeting.

The Subcommittee's report was discussed by the full Committee at its meeting on January 15, 1993. This letter reflects the result of that committee discussion, in which the Subcommittee report was accepted by the Committee with some modifications.

The application of advanced computer controlled, digital software dependent instrumentation and control to modifications of the control systems of the present generations of reactors and to the design of the next generation of Advanced Light Water Reactors (ALWR's) is very likely to be the single most significant technological advance over presently operating plants. On the one hand, modern electronics provide the opportunity, if properly engineered, to significantly improve the interface relationships between the plant operators and the reactor plant, and improve reliability, testability, maintainability and calibration, and thus total safety of reactor systems. On the other hand, the technology is relatively unproven in reactor applications and if not applied properly would introduce new problems which would result in net reductions rather than improvements to the overall safety of reactor plant operations.

The new technologies involved in advanced I&C are double edged swords: if used skillfully, they can provide many new benefits in safety and in other areas; if used clumsily, they can create new types of problems, such as operational complexities under unusual conditions or configurations. The challenge for the NRC is to develop mechanisms that are sensitive to discriminate whether this double edge sword is wielded clumsily or skillfully. In order to know when new technological possibilities have been used skillfully, we need to learn more about how

to value simplicity over complexity, how to verify that design objectives are being met, and to validate software performance to assure that no new modes of operation are being introduced.

The NSRRC has counseled on several previous occasions that the Commission's research activities (RES) should recognize the necessity to view this area as requiring a systems approach which integrates the human perspective (operator and designer) with that of the instrumentation and control hardware and software. An important potential for improvements in integration appears to be offered by advanced I&C systems.

RES has responded by taking steps in organizing and consolidating its program management. However, based on our review, we believe there is much more to be done in establishing an overarching commitment to system integration between the reactor plant and its operators via I&C systems. Indeed, it appears to us that the NRC does not presently possess in-house capability to address adequately complex issues introduced by modern I&C technology.

Based on our discussions with your staff on December 9, we offer the following suggestions to develop the basis for a strategic vision for this area of research to strengthen the integration between humans and machines:

1) There should be a clearly stated management commitment to the subject of human factors throughout the NRC to further assure safety of reactor design and operations. The complex nature of the subject should be well understood by all levels of management starting with the Commission, and working downward through the Offices, Divisions, and Branches having responsibility for the development of guidance and standards and for the review and regulation of advanced I&C systems.

   In the past, the history of the subject has appeared to be a "chopped sine wave." A reasonable effort is started, but terminated or significantly reduced before useful results are obtained.

2) An agency-wide strategic vision of the concept of integration of the human, hardware, and software aspects of reactor control and operations must be developed and clearly articulated. Such a strategic vision is an essential first step if the NSRRC's recommendation in its November 1992 report is to be achieved, i.e., "criteria to define what is meant by improved safety need to be established prior to undertaking major expenditures or function allocation research." The management process must proceed from a shared vision, to the establishment of requirements, to the setting of criteria. Research programs can then be defined, and performance expectations can be set for individual research projects.

3) As stated in my letter of November 16, "The NRC needs to identify those issues that are important to safety and to develop criteria which, if met, will assure that NRC safety concerns are satisfied."

A principal justification from the NRC's or industry's point of view for advanced I&C systems is improvement in safety. However, as stated above, if not properly understood and applied, advanced I&C systems have a potential to exacerbate rather than cure the disease. We propose, therefore, that RES develop a statement of criteria by which I&C systems will be judged specifically as to the benefit to overall plant safety. Such criteria, properly understood, would then serve to guide the several research efforts toward a more focused and integrated approach.

4) There is a great deal of information and experience in the area of advanced I&C outside the nuclear industry in the U.S. and outside the U.S. Canada, France, Germany, and Japan in particular are well ahead of the U.S. in developing an experience base. Within the U.S., the military, aviation, and other activities are well ahead of the nuclear industry in studying and applying modern I&C technology. There is also information being developed in Russia on error proneness in digital as compared with analog systems.

   It seems obvious, therefore, that there should be a vigorous, focused effort in RES to obtain, assimilate and apply the large amount of experience and information available from these other sources. Certainly some of that is being done, but not enough. We propose that specific directed management steps be taken to strengthen these activities.

   In that regard, members of RES staff, however limited in available effort, should accept as a personal responsibility the objective of becoming technically knowledgeable and expert in the several subspecialties of advanced I&C, rather than relying mainly on presumed laboratory or contractor capabilities.

5) There are within the U.S. institutions which have established reputations as centers of knowledge and competence in the field of advanced I&C. These include Carnegie-Mellon University and the Crew System Ergonomics Information Analysis Center (CSERIAC) at Wright-Patterson Air Force Base. The RES activities could benefit from closer working relationships with such centers--not necessarily by contract, but by visits, personal contacts, organized workshops, participation in expert reviews and the like. We note that three members of the ACRS have proposed recently a special workshop on this general subject to be organized and conducted by the National Academies.

6) Consideration should be given to additional steps to strengthen the RES organization with the objective of furthering integration of human factors with machine considerations, such as providing additional personnel with recognized capabilities in both I&C and human factors fields.

During the discussions on December 9, the subcommittee was told that there were certain RES products of special early interest to NRR, e.g., Reg. Guide for Class 1E Digital Computer Systems, and a basis for establishing criteria for regulatory positions on software. These did not

appear to be receiving priority attention for completion. In other cases, reports have been completed and sent to RES but have not been edited and issued.

If the advanced I&C program is to provide timely input to the certification process greater management attention to program planning, execution and completion seems needed.

A formal prioritization, with schedule dates and progressing actions to meet them, would improve productivity of contractors and RES staff, and lead to a more timely availability of research results to those who must make informed regulatory judgments.

In conclusion, we would like to offer several pertinent observations which may be helpful to you and your managers in carrying out your responsibilities in development of regulatory information in advanced I&C.

1) Software systems are unusual in their having certain characteristics of humans, i.e., error proneness. Like humans they very likely can not be made error free by V&V processes, but errors can be reduced to acceptable levels by sound engineering and the goal of error free operation should not be relaxed.

2) Digital systems offer immense processing capabilities. It is important, therefore, in applying them to nuclear operations to limit them to those which are needed for safe, reliable plant operations, and not confuse the operator with capabilities not useful in carrying out his necessary functions but are provided by the designer simply because they are available as a luxury.

3) There is a corollary conclusion. Experience and insight suggest that simplification of the operational functions could provide great benefits to safety in nuclear plant control rooms. There is little hard data to support that conclusion. A research of literature and plant or simulator experience which shows the relationships between operational simplicity and safety would be extremely valuable. In a sense, this is the heart of human factors I&C-reactor plant integration problem.

4) A clear programmatic distinction should be made between the issues encountered in the form-fit-function conversion of analog to digital systems in present plants and those encountered with advanced digital systems for future plants. While there are common issues facing the operators and the developers, the information base leading to their understanding can be significantly different.

We appreciate the efforts of the RES staff in preparing for and conducting the presentations to the Subcommittee on December 9 and are prepared to discuss this report further with you if you so desire.

Sincerely,

Ed Kintner, Chairman
Subcommittee on Advanced Instrumentation
and Controls and Human Factors

DLM/sje

UNITED STATES
NUCLEAR REGULATORY COMMISSION
Nuclear Safety Research Review Committee
Washington, D.C. 20555

MEMORANDUM

TO: David Morrison, Chairman, NSRRC

FROM: Professor Neil E. Todreas

DATE: January 20, 1993

SUBJ: NSRRC Advanced Reactors Subcommittee Final Report of Meeting of December 2 and 3, 1992

* * * * * *

This final version of the subject report includes all changes agreed upon at the January 14, full-committee meeting.

Sincerely,

Neil E. Todreas
Chairman, Advanced Reactors Subcommittee
NSRRC

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
Nuclear Safety Research Review Committee
Washington, D.C. 20555

January 14, 1993

Dr. David Morrison
Chairman, NSRRC
The MITRE Corporation
7525 Colshire Drive, MC W766
McLean, VA 22102

SUBJECT: NSRRC Advanced Reactors Subcommittee Meeting of December 2 and 3, 1992

Dear Dr. Morrison:

This is a report of the subject meeting. The Subcommittee members participating in this meeting were T. Boulette, S. Burstein, S. Bush, N. Todreas (Chair) and D. Turcotte. Additionally, the Subcommittee was assisted in its deliberation by H. Isbin and E. Kintner who attended the entire meeting and R. Vogel and yourself who attended a moderate portion of the meeting. Advanced reactor activities in Instrumentation and Control and in Severe Accidents are being covered in parallel by separate subcommittees under Messers Kintner and Isbin, respectively, so that their attendance here assured effective coordination of ongoing NSRRC oversight reviews.

The agenda of the meeting was designed so that when taken together with the coverage of our July 1 and 2 meeting it would expose the Subcommittee to the remaining key Research Office activities involving Advanced Reactors. Consequently, a diverse but important number of topics was reviewed. The meeting agenda is appended. The Subcommittee appreciates the continuation at this meeting of the commitment the RES management has made to participate in and gain counsel from NSRRC deliberations.

1. Thermal-Hydraulic Systems Activities

- ROSA Facility Preparation for AP-600 Confirmatory Tests

  RES presented an update on the negotiations for the ROSA facility, and referenced an INEL report (NUREG/CR-5833) which completes the evaluation of the use of the modified ROSA facility. The results of this report were discussed. The Subcommittee requests that in the future, topical report such as this one should be made available to NSRRC in a timely manner. Further, the Subcommittee emphasizes that the expertise and experience of INEL and RES on instrumentation and data evaluations be used to the fullest extent in carrying out the ROSA tests. In response to questions, we were informed INEL had already participated in the instrumentation planning for this facility and that INEL is to have a resident engineer at the site. The most effective means should be selected to reflect the NRC's input on instrumentation, selection and performance as well as control of the data evaluation process. Information pertaining to this activity should be communicated to the NSRRC over the life of this program.

  RES chose not to have a cooperative testing program with Westinghouse using the ROSA/OSU (Oregon)/SPES (Italy) facilities. In this way, NRC maintains its regulatory independence from the vendor tests that are to be used for design certification. While most members of the Subcommittee agreed with this position, at

least one member considered this approach to be yet another element in the persisting NRC/industry confrontational pattern and voiced strong objections.

- SBWR Thermal-Hydraulic Assessment Activity

1) GE's Test Program –

A fairly detailed presentation was made describing the GE testing program in support of the SBWR. The four major test areas being reviewed by GE include stability, full pressure passive heat removal, passive core flooding and passive containment heat removal. The presentation described the tests facilities and requirements, as well as RES' dependence or the GE results for the design certification effort, RELAP assessment and validation support. Subtasks were identified and a schedule of requirements presented.

The overall presentation was thorough; however, interdependencies among RES, NRR and GE were not adequately addressed. In particular, the Subcommittee is quite concerned with the communication aspects of this endeavor. Communication between RES and GE requires routing through NRR, which has apparently slowed the exchange process. Control of information is clearly required, but it should not significantly hamper timely information flow. We are concerned that several subtasks identified by RES regarding this effort are awaiting receipt and review of data from GE. Also, GE is awaiting NRC comments on certain of their test configurations that they indicated would be useful if received by GE in a timely manner.

2) NRC's Proposed SBWR Integral Test Facility –

RES with NRR's concurrence has determined that there is a need for a reduced-height, low pressure integral facility modeling the SBWR reactor and containment. The vendor's GIST facility simulating an earlier SBWR design does not contain the features added in the current design.

In general, the NSRRC supports NRR's need for independent expertise and for confirmatory research programs. However, on the basis of the presentation at this meeting, which were essentially technical judgments, NRR and RES were not able to convince the Subcommittee that the proposed facility was justified. The Subcommittee believes that RELAP 5 evaluations of the GIST facility and of the SBWR or of a test facility with the appropriate features would improve the basis for justifying whether the NRC's facility is needed. The Subcommittee would like to be kept informed on this matter.

- Code Selections and Assessment

The Subcommittee believes that the plans for code selection and code assessment need to be established in parallel because the high cost of an effective assessment process will directly influence the number of codes that can be selected. While the selection process appears essentially complete, the planning for the assessment process has large voids. These specifically include:

a) The assessment plans for all AP-600 and SBWR transients except LOCAs by RELAP 5 are not established.

b) The assessment plan for RAMONA is not established.

Further, while the coupled CONTAIN/RELAP 5 strategy for containment analysis was not reviewed, we understand that the detailed assessment plan for this code is also not established. The Subcommittee would like to be informed of the progress being made in this task by the branches involved.

The Subcommittee's interest in an effective coordinated selection and assessment process was detailed in the letter of the Subcommittee to Dr. Morrison dated October 7, 1992, which was provided to RES well in advance of this meeting. From the RES presentations it is obvious considerable progress has been made since our July 1992 review; however, it is disappointing to see that RES has completed the selection process without concurrently completing the assessment plan. This comment should not be read to infer that we believe that a full CSAU type assessment is needed in every case; rather, we ask only that a timely, technically supported and disciplined approach be developed and presented for our review.

The ongoing approach could lead to a repeat of the unfortunate situation RES experienced with the TRAC and MELCOR codes in which RES funded and completed their developments without assuring the conduct of a parallel assessment process. This led to the very late and costly conduct of assessment programs for both codes—in the case of TRAC as part of the development of the CSAU procedure, and in the case of MELCOR by a peer review process that is only currently being concluded.

2. Passive System Reliability

The initial objective of the study at Sandia National Laboratories is to compare reliability of ECCS systems (including decay heat removal systems) of the Surry plant with the reliability estimated for the AP-600, using core damage frequencies from transients and LOCAs assuming that the reactor protection systems function successfully. The study is to determine, in particular, the uncertainties associated with the state of knowledge involving the functioning, for example, of the natural circulation and gravity fed injection systems. Work is underway modifying the MELCOR code, using the CSAU methodology. This project has been underway since October, 1990, and an estimated $800K has been expended to date. The Subcommittee, while recognizing that the study seeks to evaluate the advantage of greater reliability that the advanced passive reactor should have relative to that associated with current reactors, has the following concerns with the conduct of the current program:

- The MELCOR code has been selected for this study and, consequently, this program carries the burden of application of the chosen CSAU methodology for this code's assessment. Perhaps the use of a severe accident code for this project will be inevitable, but it is costly (because of the assessment needed) and, at present, its need is not definite. This is because the reliability questions to be answered could possibly be answered with surrogate parameters, specifically a thermal-hydraulic characterization of failure in functioning of systems. This would allow use of RELAP 5, which already has an ongoing assessment program. Further, it would give some meaningful results much quicker and certainly cheaper than the existing Sandia program. Such initial results could then be used to assess whether core damage frequencies themselves needed to be determined in what then would be a more ambitious program of the type underway.

- The meaning of the concept of "uncertainties in natural processes" and their evaluation in this program is a concept that still eludes the Subcommittee even though this was the second meeting at which RES staff attempted to answer the Subcommittee's questions about it. Could it be that the Subcommittee's surmise, that such uncertainties are to be resolved by experiments underway or planned and do not belong as elements in a reliability program such as this, is correct? At the least, RES management needs to evaluate this facet of this program and ensure that a coherent explanation can be offered on the next attempt to the Subcommittee.

3. Seismic Design

Regulations with respect to relevant Appendices of 10CFR50 and 10CFR100 were discussed.

- Appendix B

The Subcommittee has serious concerns that the manner in which the deterministic approach is included in the new proposed seismic regulations does not take into account relevant research carried out over the last twenty years. This new regulation, Appendix B, is now released for public comment. The inclusion of probabilistic analysis in the new regulations is certainly a step forward; but using it in parallel with the traditional deterministic approach, with an unclear "comparison," to establish safe shutdown earthquake (SSE) ground motion may represent a step backwards. This is particularly true since one of the principal bases of the deterministic approach, the "capable" fault, has been removed. This has been replaced with the vaguely defined concept of a "capable tectonic source." The deterministic approach is anything but deterministic since no adequate definition of a capable tectonic source is given.

The Subcommittee is concerned that the proposed dual approach makes the new regulation less well defined than the old regulation and provides no real basis for assessing seismic risks. In many parts of the country, a probabilistic approach is fully adequate to demonstrate the seismic safety of a reasonably designed plant. In those areas in which regional tectonic activity can be demonstrated, the more in-depth deterministic approach is certainly justified—but little guidance is provided in the draft regulatory guide as to how this is to be accomplished.

Of particular concern to the Subcommittee is the potentially limited role of the National Research Council Review Panel on Seismic Hazard Evaluation. This is an excellent committee which is capable of considering all aspects of the seismic hazard problem. The purview of the Panel should not be restricted to the intercomparison of the Livermore and EPRI studies. The Panel should also consider the relative merits of the probabilistic and deterministic approaches.

- Appendix S

The NRC proposed changes to establish the operating basis earthquake (OBE) at or less than 1/3 the SSE with no seismic design specification for the OBE appears to allow desired relief to future nuclear plants from unnecessarily burdensome seismic criteria. The concomitant requirements for mandatory shutdown of a plant following exceedance of the OBE set at or less than 1/3 SSE will require more shutdowns than for an OBE set at 1/2 SSE. This may not be inappropriate if the subsequent walkdowns/inspections do not require the reporting and restart procedures currently being proposed. Certainly, there should be a formal approval process when a walkdown after an earthquake discovers damage; however, the formal process of submitting a report to the Director, NRR and the need for his approval prior to startup could result in extensive delays and possible litigation. Hopefully, the wording in Appendix S will clarify how much or how little is required to obtain startup approval.

The use of Cumulative Absolute Velocity as a criterion, apparently modelled after the EPRI approach given in NP-5930, NP-6695 and TR-100082, and the suggested Event Tree for use after earthquakes should lead to sufficient relaxation, assuming that Appendix S finally reflects this approach, so that the probability of extensive shutdowns should be minimal.

4. Analysis and Design of Reactor Internals and Piping Systems

The discussion of reactor internals problems in existing BWRs and PWRs provided an excellent oversight of the spectrum of issues that need to be considered with regard to the advanced reactors such as AP-600 and SBWR. While no specific actions were suggested, the presentation did provide a "snapshot" of the problems that will require corrective action in the advanced reactors.

The past decade has seen substantial and justified relaxations in the conservative seismic and overall design requirements applied to nuclear piping systems. The current activities sponsored by the Advanced Reactor Corporation and by USNRC appear justified in the context of a coordinated assessment of implemented and proposed changes to piping systems. While the suggested review program presented to the Subcommittee is reasonable, caution is needed in how the review is conducted. The application of unduly conservative and cumulative criteria could lead to an unrealistic damage model that might lead to an unnecessary reapplication of requirements that have been removed in the past decade.

5. Reliability of Modular Construction

An interesting program on the subject topic was described. The Subcommittee had no questions on the suitability of the technical topics being pursued, but did question whether the process of placing this work at BNL versus conducting a competitive placement compromised the overall RES objective of having the most competent investigators conduct their research. The staff responded that user time pressures to obtain the needed results led to the selected contracting procedure.

The Subcommittee understands that special circumstances can justify a limited number of such placements, but that such placements must not be allowed to become the rule. In this case, RES should investigate the benefits of engaging other more competent investigators, should they exist, to assist or direct subsequent phases of this modular construction project.

Sincerely,

Neil E. Todreas
Chairman, Advanced Reactors Subcommittee
NSRRC

NET:pjc

AGENDA
ADVANCED REACTOR SUBCOMMITTEE
NUCLEAR SAFETY RESEARCH REVIEW COMMITTEE
Twinbrook Room, Crowne Plaza, Holiday Inn
Rockville, MA
December 2-3, 1992

Wednesday, December 2, 1992

8:00–8:10	Opening Remarks	N. Todreas Subcommittee Chair
8:10–9:00	Update on AP600 thermal-hydraulic research program	L. Shotkin
9:00–2:00*	SBWR thermal-hydraulic research program:	
	a. Unique features of the SBWR	L. Shotkin
	b. User needs for confirmatory research on SBWR	R. Jones (NRR)
	c. GE testing programs in support of SBWR	D. Bessette
	d. NRC confirmatory testing for SBWR	D. Bessette
	e. RELAP5 analyses of SBWR	M. Modro, INEL
2:00–5:30**	NRC code development program for AP600 and SBWR	
	a. Code selection process	L.Shotkin
	b. Code assessment process	N. Lauben M. Modro, INEL G. Johnsen, INEL

Thursday, December 3, 1992

8:00–8:15	DE introductory remarks on advanced LWR research program	L. Shao
8:15–9:15	Seismic site hazard criteria: revisions to Appendix A to Part 100; status and prospects for resolution of the LLNL and EPRI hazard methodologies	A. Murphy
9:15–9:45	Earthquake engineering criteria: Appendix S to Part 50	R. Kenneally
9:45–10:00	Break	
10:00–10:45	Piping design—lessons learned from today's plants	N. Chokshi, with support from: D. Terao and K. Wichman of NRR
10:45–11:00	Reactor internals—lessons learned from present PWRs & BWRs; corrective action needed for advanced reactors	C. Serpan
11:00–11:15	Modular construction for advanced LWRs	G. Arndt
11:15–11:30	AP600 containment structural integrity	J. O'Brien
11:30–12:30	Executive Session	
12:30–1:30	Lunch	
1:30–3:00	Passive system reliability (including discussion of impact of planned experiments on uncertainty estimation)	M. Cunningham A. Buslik A. Camp
3:00	Adjourn	

* Break at 9:45–10:00; Lunch at 12:00–1:00
** Break at 3:00–3:15

MEETING REPORT
NSRRC WASTE SUBCOMMITTEE MEETING
December 1, 1992

MEETING OVERVIEW

GENERAL OBSERVATIONS AND COMMENTS

The structure used to manage and coordinate the High Level Waste (HLW) research program is given in Draft NUREG 1406 (February 28, 1992), portions of which have been sent to the Subcommittee. The Phase 2 Iterative Performance Assessment (IPA) Program Plan is dated December 19, 1991, and is noted as Enclosure 4. Enclosure 5, November 1991, is the Project Plan for Performance Assessment Research and provides the general and specific research objectives for the Center for Nuclear Waste Regulatory Analyses (CNWRA). Program management and organizational structure and responsibility are detailed in these documents. The Subcommittee, however, did not focus its meeting on these areas, but chose to confine the agenda to a general overview of IPA and a few selected topics. (See the attached Agenda.)

For the Subcommittee to provide responsible and constructive input to RES, attention needs to be given to providing options for members to request specific reports available in advance of scheduled Subcommittee meetings. Further, the suggestion is offered that at least the Subcommittee Chairman be alerted to special meetings which would provide substantative accounts of the progress being made in the various HLW research activities. For example, NUREG-1327, "Initial Demonstration of the NRC's Capability to Conduct a Performance Assessment for a High-Level Waste Repository," May 1992, should have been made available to the Subcommittee prior to the meeting so that the agenda would be providing an update of this report.

The Subcommittee has received the May 1, 1992, report of the Advisory Committee on Nuclear Waste (ACNW), entitled "Review of NRC High-Level Radioactive Waste Research Program Plan (Draft-1406)," but has not been advised of the NRC response.

OVERVIEW OF NRC HLW ITERATIVE PERFORMANCE ASSESSMENT PROGRAM

In approaching an IPA, four disruptive scenarios have been identified and involve volcanism, seismicity, climatic and human intrusion. RES reported that the Phase III development will add the biosphere to the modeling for estimating dose and health effects to people.

The research being carried out is divided almost equally into three groups: the NRC's offices of RES and NMSS, and the CNWRA. The research funnels into the development of the HLW IPA program. This Subcommittee meeting is a first step in reviewing and evaluating specific research programs. The inherent difficulties in projecting milestones is illustrated by the delay in the completion of the IPA Phase II, originally scheduled for 6/92. It was reported that contributions to this delay include changes in staff personnel, and perhaps, more importantly, the overall complexities of the IPA activities. The Subcommittee requests that it be kept informed of any future delays in scheduled publication of major PA and research products should they occur.

An informative briefing was made by the NMSS in describing the general features of the IPA programs, including the auxiliary programs involving models and sensitivity analyses. The IPA provides an evaluation of the HLW repository in terms of a complementary cumulative distribution function (CCDF) of radionuclide releases. The specific releases are weighted by a factor proportional to radiotoxicity and are integrated over a time period of about 10,000 years. The performance calculations remain tied to the current EPA Rule 40 CFR 191 and the NRC Rule 10 CFR 60. The NRC staff noted that they have provided and will continue to provide the EPA technical bases which could be helpful in supporting any reevaluations of the EPA Rule that are now underway.

HLW PERFORMANCE ASSESSMENT RESEARCH PROGRAM

The presentation, made by RES, indicated that the basic SANDIA work on developing IPA has been successfully transferred to CNWRA, and that the Sandia flow model can handle the interaction between fractures and the matrix for the unsaturated tuff.

Since only a brief reference was made to the contents of the consequence models, the Subcommittee needs to plan for additional meetings. The Subcommittee would like to receive briefings on the strengths and limitations for models being used in performance assessments by EPRI, and DOE contractors, as well as by CNWRA. The Subcommittee was briefed on the motivation and general programmatic needs, and how CNWRA research tasks are correspondingly structured. Although it is recognized that IPA's can be used to prioritize research, examples were not presented.

The Subcommittee concurs with the broad features of the research programs designed to provide insight and understanding of the many interacting phenomena, characteristics and properties of the materials and structures involved, model developments, and with the process which seeks validation of the performance of the repository. All participants recognize the difficult assignment pertaining to validation of the models. RES has wisely chosen to call the approach a PROCESS which will involve a combination of efforts on a national and international scale. To be defensible, the PROCESS must be scrutable. The Subcommittee plans to review the PROCESS in a timely manner.

The Subcommittee appreciated receiving an overview on research associated with hydrology, volcanism, tectonics, geochemistry, natural analogs, thermohydrologics, and seismic rock mechanics. The presentations were responsive to the NSRRC request. The Subcommittee strongly endorses the format used in identifying and linking the research objectives to the current regulatory bases, identification of the needed research, and defining the technical approaches being used to guide the research.

SPECIFIC COMMENTS

1) There was essentially universal agreement that field work is very important at this stage of the NRC's IPA work and that natural analog studies, in particular, promise to provide broad and useful information. However, there was some concern that analog information is not being incorporated into IPA in a sufficiently rapid manner. For example, why is a greater emphasis not being given to the OKLO site? Here we can locate the daughter species of long ago decayed fission products and actinides and get a reading on the migration behavior under this one set of circumstances. Some of these data have already been collected.

Field and analog studies can provide a wide variety of observations that can be used to test the validity of codes. Field tests can test flow models under a variety of circumstances but the means of code validation should be carefully considered. Given the results, any code can be treated to get the observed results. Either the calculation should be carried out prior to the observations or some observations should be withheld from the modelers until computations have been completed. The analog studies can test sorption models and contribute to corrosion studies among other contributions.

2) The committee was concerned that in the IPA process, too much emphasis may be placed on complex computer models. The vast amount of data required to run such codes in a predictive manner is almost never available. Simply fitting models to data (see comment 1) provides only a limited degree of validation. The committee intends to re-evaluate this concern on a regular basis in the future, and it asks the NRC to do likewise.

3) A serious disruptive process, but possibly of low probability, is the potential occurrence of a volcanic eruption through the repository. The subcommittee believes that the current research in this area is a good start towards resolving this problem. However, it must be approached with great care. The occurrence of massive pyroclastic eruptions associated with the Bishop Tuff and elsewhere in the region raises concerns. Volcanism in the Basin and Range environment is poorly understood, and it appears that a statistical approach is required. The distribution of volcanics (size and ages) within a distance of 500 to 1000 Km should be determined in detail and can form the basis of a probabilistic hazard assessment for the site. This approach follows directly from the current work (as presented by Drs. Birchard and Kovach) and should be given a high priority. The association of Prof. Wernicke with this project is considered to be a real asset. He is one of the leading experts on the tectonics and volcanism of the region. The subcommittee also recommends that a probabilistic risk assessment be carried out with regard to seismic hazards. One can use as models the Livermore and EPRI studies. The subcommittee questions whether the integrity of the repository to large volcanic eruptions can be established. Thus the probabilistic hazard assessment must be the basis of defusing attacks on the site based on volcanic disruption.

4) Some but not all subcommittee members were concerned about the recently proposed idea of high temperature storage and the resulting need for high temperature canisters. Although high temperature, in principle, could provide a dry environment, the thermohydrologies in a partially saturated medium with a variety of matrix and fracture porosity may not be understood well enough to assure dryness under a variety of weather and climatic conditions. A high temperature environment may be viewed as a high risk environment, should anything perform in an unexpected way in the future. If in the future it should become desirable to approach the repository, high temperatures could make this difficult or impossible. It seems more sensible that the design of the repository should conform to the natural environment as closely as practical.

5) NRC should continue to maintain a detailed awareness of external high-level waste programs, both nationally and internationally, and how they relate to NRC & DOE work. For this and related purposes it might be a good idea to develop milestone charts of considerable greater detail than has been done in the past. Such milestone charts should identify the customer for the activity, the time the results are needed and the identification of interim results. Furthermore, the charts should cover not only the NRC program but also the DOE and other programs. The discipline of preparing the charts would help the staff and also give the subcommittee confidence

that the interrelationships between the various parts of the program have been thought through. Such charts should be updated perhaps every six months. This would help to avoid duplication and provide positive synergism between different research efforts.

6) A great deal of chemistry is involved in the HLW program. This includes corrosion of containment, speciation of important nuclides and the adsorption-desorption characteristics of the appropriate nuclides. The speciation of the nuclides requires the identification of the pH, the temperature and the oxidation potential in the aqueous transporting media. The extensive report of uranium results was somewhat discomforting. Some uranium results are of course useful but not readily extrapolated to, for example, plutonium. The chemistry base may be in the program but it was not apparent to the subcommittee.

CLOSING COMMENTS

The Subcommittee appreciated the efforts by RES to provide an abbreviated update of the HLW activities. The oral presentations and written handouts were responsive to NSRRC requests. This does not mean, however, that the program does not need further focusing. The problems that must be solved should be identified clearly. Solution approaches should be selected that are practical and understandable. The proper role of the computer in these endeavors is still not clear. RES must continue its efforts to get firmly in control of the situation from a PA viewpoint. As noted in this report, additional Subcommittee meetings need to be planned for substantive agenda items.

One additional thought is that high-level waste problems cross many disciplines, as do most NRC research topics. Therefore, the use of terms specific to, for example, geology should not be done without definition of these terms. In future reviews, a supplementary list of definitions of terms and particularly acronyms would be helpful.

OPENING REMARKS
JULY 8, 1993
NSRRC MEETING WITH NUCLEAR REGULATORY COMMISSION

Good afternoon, Mr. Chairman and Commissioners. It's a pleasure for the NSRRC to meet with you and to discuss our current activities. This is the first meeting we have had with the entire Commission since the Committee was formed in 1988. However, the Chairman and individual Commissioners have met with us on a number of occasions over this period. I plan to make some general remarks on the role of the NSRRC and its accomplishments since its founding, and several of the members will introduce specific topics. All of the members, of course, are welcome to make comments as appropriate and answer any questions you may have.

As you know the NSRRC was established pursuant to a recommendation made by the National Research Council in its 1986 report, "Revitalizing Nuclear Safety Research." At that time, the National Research Council reached a conclusion that there were many structural and procedural problems that the NRC had to address if it were to have a sound research program. One of the management changes recommended was the "establishment of a strong advisory group that includes independent experts from industry and academia, along with representatives of organizations performing research." NSRRC was subsequently formed to provide advice to the Director of the Office of Nuclear Regulatory Research and through him the Commission, on matters of overall management importance in the direction of the NRC's program of nuclear safety research.

Many changes in the management and content of NRC's research program have occurred since the establishment of the NSRRC, and as one of the charter members, I like to think that we have been partially responsible for some of these changes. The NSRRC has encouraged and observed improvements in NRC's planning for research, the transition to a users' needs driven agenda and the

incorporation of PRA's as a means of setting research priorities, strengthening of project management and accountability, implementation of a peer review process of research products, a continued focus on the use of the best researchers to perform the research, and expansion of the involvement of universities and small businesses in the research program.

In our letter of January 27, 1993, to the Office of the Inspector General (Mr. Thomas J. Barchi), we took exception to the impression of that Office that the research program is grossly mismanaged and that adequate management tools have not been established. NSRRC has adopted a practice of program review and assessment that involves both full committee meetings to gain an overview and perspective of all of the research activities and subcommittee meetings through which major program elements are reviewed in detail and facts and analyses are developed for the full Committee's consideration. These assessments are thorough and objective, and our conclusions are drawn after considerable discussion among the members of the NSRRC who are indeed independent, recognized technical experts. Overall we have observed within the NRC an evolving research program that is redirecting the limited resources at the most important problems facing the regulators while maintaining technical quality in research products and preserving technical competence to support future regulatory needs.

For example, over the five-year period that the NSRRC has had the opportunity to review the research program, we have noted (1) significant redirection of the severe accident research program and establishment of criteria and a timetable for closure, (2) the reduction in the number of accident codes that are supported by the NRC, (3) a redirection in the human factors research program to emphasize the safety implications brought about by

the transition to advanced digital control systems, (4) identification of research needs for the advanced reactors research program, and the establishment of its research objectives and priorities, (5) completion of research on the accident source term, and (6) the reorientation of the high level waste research efforts toward the most critical problems. These changes in NRC's research program are typical of a well-managed research program responsive to changing events and needs. Research is a dynamic process and as more knowledge is obtained on a given topic, the research efforts must be redirected by dropping less important items and adding more important ones.

What hasn't changed since 1986 is a stagnant market for new nuclear power plants, and the difficulty of both government and industry to make major investments in nuclear safety research and development. The challenge to NRC over the next 5 to 10 years will be to maintain a strong independent technical base and to extract full value from level or decreasing federal expenditures. Doing more with less means working smarter and being even more certain that the best people are performing the research. NRC must find means to conduct collaborative R&D projects with the industry it regulates while maintaining its independent posture. This will be especially true in the case of advanced reactors. NRC will also need to gather experience from other agencies such as the DOD, NASA and FAA in human-systems interactions and to strengthen its technical base in the design and development of advanced instrumentation and control systems. International cooperation in reactor safety research will continue to be an area of emphasis for NRC. As a result of our review of the research program yesterday, and in light of the pressures to do more with less, the NSRRC plans to focus on the efficiency and effectiveness of the various activities within the research program over the next year.

NUCLEAR REGULATORY COMMISSION

CHARTER

NUCLEAR SAFETY RESEARCH REVIEW COMMITTEE

1. **Committee's Official Designation**

NRC Nuclear Safety Research Review Committee (NSRRC)

2. **Committee's Objectives, Scope of Activities, and Duties**

On a continuing basis, NSRRC will provide advice to the Director of the Office of Nuclear Regulatory Research and through him the Commission, on matters of overall management importance in the direction of the NRC's program of nuclear safety research. Matters requiring NSRRC's attention will be posed by the Director of the Research Office, or as an outcome of prior NSRRC deliberations. Nuclear safety research is understood to encompass technical investigations of the implications for public health and safety of the peaceful uses of atomic energy and the reduction of those investigations to regulatory practice.

NSRRC activities will include assessment of and recommendations concerning:

a. Conformance of the NRC nuclear safety research program to the NRC Philosophy of Nuclear Regulatory Research, as stated in the Commission's Strategic Plan, and to specific Commission directions.

b. Likelihood of the program meeting the needs of the users of research.

c. Appropriateness of the longer range research programs and the correctness of their direction.

d. Whether the best people are doing the work at the best places; whether there are other options, including cooperative programs, that would yield higher quality work, or otherwise improve program efficiency.

e. Whether the program is free of obvious bias, and whether the research products have been given adequate, unbiased peer review.

In addition, NSRRC will conduct specialized studies when requested by the Commission or the Director of the Office of Nuclear Regulatory Research. If appropriate, these studies will be published as reports.

applied research; (2) demonstrated expertise in one or more disciplines of applied science and engineering; (3) broad acquaintance with the public health and safety issues associated with the peaceful uses of atomic energy, and (4) a balance of experience in the academic, industrial, and national and not-for-profit laboratory environments.

11. **Date of Filing:** February 10, 1992

John C. Hoyle
Advisory Committee Management Officer

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1. DEPARTMENT OR AGENCY	2. COMMITTEE OR SUBCOMMITTEE (Full name, as chartered)	3. FISCAL YEAR
NRC	Nuclear Safety Research Review Committee	1992

4. NAME, ORGANIZATIONAL TITLE, AND AGENCY ADDRESS OF DESIGNATED FEDERAL OFFICER:

George Sege
Technical Assistant to the Director
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Washington, DC 20555

5. TOTAL NUMBER OF ALL MEMBERS SERVING DURING FISCAL YEAR 12

6. LIST OF MEMBERS SERVING DURING FISCAL YEAR
(NOTE: Indicate chairperson(s) by placing an asterisk (*) to the left of name.)

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*Morrison, Dr. David L. (Chair)	Technical Director, Energy, Resource, and Environmental Systems Div., MITRE Corp.
Burstein, Mr. Sol	Vice Chairman, Wisconsin Elec. Pwr., (Retired)
Boulette, Dr. E. Thomas	Vice-Pres., Nuclear Operations and Station Director, Pilgrim Station, Boston Edison Co.
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Vogel, Dr. Richard C.	Sr. Scientific Advisor, EPRI (Retired)
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